Promoting Excellence in the Teaching of Human Anatomy & Physiology
Why thousands of users support the Biopac Student Lab System!

The Biopac Student Lab System is an integrated, flexible solution that includes hardware, software and a dynamic laboratory manual.

The student-friendly system can be used to guide students through a series of existing lessons that explore fundamental concepts or to create your own protocols for active learning and advanced studies.

- Reduce setup times by 90%
- Over 40 lessons available
- Fast and sophisticated analysis
- Human & Animal experiments
- Quick Start templates & presets
- Automated calibration
- Dynamic Lab Manual (> 500 pages)

- Create your own lessons – no programming required
- Wide array of easy-to-use transducers available
- Use with existing lab equipment
- "Smart Sensor" hardware lets you connect and collect

See what you're missing...

Call for a demo and we'll visit your lab to give you a hands-on opportunity to see for yourself what thousands of more than satisfied users already know... that the flexible, user-friendly Biopac Student Lab System is the complete teaching solution.

REQUEST YOUR FREE DEMO CD WITH PBS VIDEO TODAY!

Why aren't you using it yet?
Greetings From Your President ........................................... 3
Bill Perrotti

HAPS 2003—Philadelphia, Pennsylvania
Conference Update .............................................................. 6
Lakshmi Atchison, Ph.D.

The Cutting Edge
Anthrax Endospores Interact With Host Macrophages in the Lungs to Escape Body’s Defense System .............................. 8
Shane D. Killian and Sarah Cooper.

An Overview: How Do We Become Males or Females .................. 11
Rod Seeley, Ph.D.

Educational Issues
Are High School Graduates Adequately Prepared For the Rigors of College ......................................................... 13
Dayton Ford, Ph.D.

Implementing Interactive Learning Activities in Anatomy Lectures .......................................................... 15
Valerie Dean O’Loughlin, Ph.D.

Teaching Tips
Using Clinical Situations to Stimulate Critical Thinking in College Anatomy and Physiology Classes ............................ 17
Joyce Ricker Kronberg

Initiating Cooperative Learning in the Anatomy and Physiology Classroom: Activities for the First Week of Class .......... 18
Murray Jensen, Ph.D.

HAPS Committee Updates
Regional Conference Committee ......................................... 19
Mary Bracken

Grants and Scholarship Committee ...................................... 7
Richard Faircloth, Ph.D. 

HAPS-EDucator - Summer 2002 - page 1
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. HAPS was established in 1989.

Annual membership dues are $50. Annual membership renewals shall be due on January 1, April 1, July 1, or October 1. New members shall renew on whichever date most closely follows the date of their initial membership. HAPS Hotline: (800) 448-HAPS (4277). Information on membership, meetings, and more! Send correspondence to: HAPS, 8000 Bonhomme, Suite 412, St. Louis, MO 63105. Check out our new webpage at: http://www.hapsweb.org/

SUBMISSIONS TO HAPS-EDucator

Papers for publication, requests for information, positions available and wanted and letters to the editor are welcome. Articles may be submitted to the editor by e-mail attachment as Microsoft Word or Word Perfect file or on 3.5" double density disks—please include a hard copy as a backup. If references are included, please follow the methods suggested in Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers. 6th Edition, Style Manual Committee (Council of Biology Editors) Cambridge, Cambridge University Press, 1994.

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 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.

DEADLINES FOR SUBMITTING MATERIAL TO HAPS-EDucator: April 15 (Summer issue); August 1 (Fall issue); November 1 (Winter issue); February 1 (Spring issue).

CONTACT THE HAPS-EDucator Editor: Susan Baxley, Troy State University Montgomery, College of Arts & Sciences, P.O. Drawer 4419, Montgomery, AL 36103-4419, (334) 241-5473, (334) 241-8665 fax, sbaxley@tsum.edu
GREETINGS FROM YOUR PRESIDENT

William Perrotti, HAPS President

My last installment... Although I am writing this less than two weeks prior to the Phoenix conference, you will read it after my presidency is concluded. By now Mike Glasgow has taken over, a new Board is in place, and things are surely humming along nicely. My year as president has just flown by. Looking back, I feel a mix of emotions. I regret not being able to complete more of what I had hoped to do, but I am thankful for all the work that was done and the support provided by so many colleagues. I’m relieved that I’ll now be less in the limelight but yet excited to be serving HAPS in a different role in this new year.

First the many thanks to those who have left the Board... Henry Ruschin, our outgoing Past President, for his patient and always helpful mentorship. John Waters, our outgoing Treasurer, for the terrific work he did in revamping our approach to budget and finances and for his clear, incisive vision of issues. Don Kisiel, outgoing Northeast Regional Director, who truly kept us focused during the year, set a never to be equaled standard for proofreading, always offered thoughtful insight into whatever discussion was in progress, and taught me the value of Robert’s Rules. Izak Paul, outgoing West Regional Director and 2004 annual conference coordinator, for his calm and confident decisiveness and his willingness to host our second conference north of the border (Calgary 2004). Thanks also to the Board members who remain... Mike Glasgow for putting together a quality slate of candidates and for his ability to make me feel wise and in control when I really did not have a clue about what to do next. Barb Cocanour, our Secretary, who somehow managed to record board business despite my chaotic approach to meetings. Deb Wiepz and Bobby Balbridge, the new regional directors “on the block” for their enthusiasm and forthright opinions, and Caryl Tickner for her always sage advice and candor. I have been fortunate to have worked with an energetic, supportive, and congenial Board. It has been nothing less than a pleasure.

We have lost some exceptional chairpeople: Sam Drogo (Testing), Tom Lancraft (Technology), Dan Lemons (Core Curriculum and Assessment), Dave Parker (Annual Conference). We are fortunate to have replaced them with a new generation of committee leaders who will carry on their work: These include Dayton Ford (Technology), Janis Thompson (Testing), and Murray Jensen and Chuck Wert (CCAC). The business of HAPS rolls on. The new Safety Committee is surging along under Karen McMahon’s leadership. Mary Bracken just keeps regional conferencing along and membership is UP! Life is good. All I can say is thanks for work already done and work that is yet to be completed.

I also owe special thanks to Gail Jenkins for her visionary work with vendors and advertisers, to Donna White, Carl Shuster, and Murray Jensen for their efforts in bringing our new web site into fruition, to Phil Tate for truly Herculean work in codifying much of the annual conference coordination process and for hosting Phoenix 2002, and to all our other committee chairs for a productive year. Last, although the election is by now decided, let me sincerely thank all eight candidates (Laurie Choate, David Evans, Elizabeth Harper, Gail Jenkins, Ted Namm, Jim Pendley, Phil Tate, and Donna White) for stepping forward to run for office. It is a shame that all eight could not be elected.

As for the year of my presidency... I can sum it up in just a few phrases... Constitution and Bylaws, emeriti, web page, outreach activities, distance education, policies and procedures, outcomes, BiosciEdNet, safety, and e-mail. Let me elaborate. HAPS by now has a new Constitution and Bylaws that are much more comprehensive than the previous document and that should serve the organization nicely well into the future. The process of its development involved the Board of Directors with helpful input from a number of our Presidents Emeriti. There are many items in the new document that I am pleased about but maybe nothing more than the new standing committee, the Presidents Emeriti Advisory Committee. In the years I have been involved in the leadership as a committee chair, regional director and in these more recent roles, I have often heard different members in different venues talk about the history and the personality of HAPS. I think that is inseparable from the individuals who have led the society at different points in its evolution. This new committee codifies our desire to remain connected to our history and to always value and utilize the expertise of the individuals who have served in the presidency and still remain committed to the goals and ideals of HAPS. This committee connects us to our roots and will long give us the benefit of the counsel of our “elders.” (You can bet I will hear about that phrase more than a few times down the road.)

By now our new web page is up and running with some areas accessible by anyone and a restricted area that can be accessed by members only. As I write this, we are trying to complete the Greetings - continued on page 4
HAPS-EDucator - Summer 2002 - page 3
Greetings - continued from page 3

changeover from the old site to the new before Phoenix. From that point, there will be a steady progression of changes, added features, and improved capability that will be incorporated into it and enjoyed by us all. Rather than try to predict the future for you as I write, I urge you to go to the site right after you read this issue of HAPS-ED and see for yourself if you have not already done so. Do not forget, hapsweb.org.

It has also been a busy year in terms of interacting with other professional societies. We are so fortunate to enjoy very strong and cordial ties with the American Association of Anatomists (AAA), the American Physiological Society (APS), and the National Association of Biology Teachers (NABT). I have represented HAPS for two years now at the Experimental Biology (FASEB) meetings and participated in AAA sponsored symposia about anatomy education. Kevin Petti did likewise at the most recent NABT convention in Montreal and delivered a keynote address. HAPS should be a presence every year at these meetings. At the invitation of Dee Silverthorn, HAPS is now represented on the Editorial Board of Advances in Physiology Education. These ties are growing even stronger as we all better recognize the essential symbiosis that must exist between our disciplines and our societies. For a long time, many of us (myself probably included) saw A&P as a service course for nursing and allied health students. However, the reality is that A&P is much more. It serves a much wider audience and occupies a much more important niche in the education spectrum. We must never lose sight of the fact that A&P is science... actually it's TWO sciences. Not only do we learn it, we do it! We who teach undergraduate human anatomy and physiology are in a position to inform and excite students about science, about anatomy, about physiology, and of course about A&P. We are potentially a gateway to a career in research, education, or medicine. Each year we see so many students, many of them incredibly talented and motivated. Some will become nurses, respiratory therapists, or athletic trainers, but others may gravitate toward basic science and become anatomists or physiologists. We can influence outcomes by how we approach our discipline. And do not forget this connection extends to secondary schools as well. Not only must HAPS look toward continued higher education, but we must also look to linkages and cooperative ventures with high school educators. That can only be fostered by the resources that are increasingly more open to us from AAA, APS, and NABT.

Following a suggestion from APS, we have also applied to become a contributing partner in the BiosciEdNet (BEN) Project. This brings together a vast array of digital resources on the Internet to support science education. Our participation will allow HAPS to expand and refine our existing anatomy and physiology learning objectives to allow for the easy and comprehensive cataloguing of existing BEN archive objects. As a partner in the project, we hope to link the specific learning outcomes in the HAPS database to the growing array of digital resources in BEN. In addition, we plan to compile and submit a set of relevant articles collected from past issues of the HAPS-EDucator to be incorporated into the BEN Teaching Archive. In a very real sense, this links HAPS and all of our members to a much larger, dynamic and exciting education universe. My thanks to Dan Lemons and Murray Jensen for their efforts in getting this initiative started.

This year we also completed a revision of the HAPS Position Statement on Distance Education that brings it fully into consistency with our existing animal use and cadaver use statements. All three official statements strongly endorse the importance and essential nature of "hands-on" and investigative activities in A&P laboratory education. Simulations, distance exercises and the like are seen as very useful adjuncts to the laboratory experience but not as substitutes for, or to the exclusion of, more traditional lab approaches. These statements seem to provide the kind of leverage that many of us require on our individual campuses when hands-on activities come under fire while at the same time providing support for all sorts of innovative activities that are and should remain important elements in the overall laboratory education of a student.

Policies and procedures are under review all the time... ask any Past President. The years 2001-2003, however, special in this regard because of the new Constitution and Bylaws and our new web page. There is much that must be updated and revised to be consistent with our new governing documents. Henry took over from Cris Martin and got things going this year. This winter the Board got a big boost from a series of insightful proposals from Phil Tate and totally revamped the policies relating to the conduct and coordination of the annual conference. Now Henry has reluctantly passed this all on to me, and I hope that by the end of Mike's term, the entire Policy and Procedures Manual will be fully updated and on-line. After that, the lives of future past presidents should be much more comfortable.

Last on the above list... e-mail. Just get it! This is such an easy way to communicate quickly and efficiently and really is the ideal way for the leadership to keep members informed and updated. If we ever see HAPS becoming more active in public policy as I have advocated before, the combination of e-mail access and a good web page are essentials. So, if you do not have email, please give serious thought to getting on-line. (I do hope that President Emeritus Bob Anthony is reading this. He just recently retired from Triton College after many years of dedicated service to students and colleagues, and HAPS... but he has been a bit slow to get with this technology stuff.) And if you do have it, please remember to let us know if your address changes. We do not want anyone escaping.

But maybe the most significant accomplishment of my year as president and my years in HAPS is the culmination of an effort that began in San Diego in 1992 and has continued without respite every year right up to the present. This year in Phoenix, baseball for the first time officially made it into the conference brochure. My life is now complete. Thanks Phil. And remember, Philadelphia also has major league baseball. So, see you at the ballpark in 2003. By the way, how far is the nearest ballpark from Calgary?

Thanks for a great year.
"It's time to chime!"

HUMAN ANATOMY AND PHYSIOLOGY SOCIETY

17th Annual HAPS Conference
May 30-June 4, 2003
Philadelphia, Pennsylvania

Update Seminars, Keynote Address & Workshops
Promoting Excellence in the Teaching of
Human Anatomy & Physiology

Banquet and Live Band

For Conference Information Contact
Lakshmi Atchison, Ph.D.
Conference Coordinator & Chair
Biology Department
Chestnut Hill College, Philadelphia
Tel: 215-248-7159, Fax: 215-248-7155
E-mail: latchiso@chc.edu

Accommodations and Info. on Philadelphia
Wyndham Franklin Plaza Hotel,
17th and Race Streets, Tel: 215-448-2000
www.wyndham.com
http://www.gophila.com

For information about HAPS, please go to our website:
http://www.hapsweb.org

CHESTNUT HILL COLLEGE
http://www.chc.edu
Dear HAPS Members: As you all well know, time passes quickly and before you know it, the 2003 17th Annual HAPS conference will be here! Are you planning your trip to the East Coast? Your host institution will be Chestnut Hill College. The College community is very anxious to welcome you all to Philadelphia, the city that loves you back! Folks, "It's time to chime" at the home of the Liberty Bell. Philadelphia is known as the "city of neighborhoods" for a good reason. It has more than 150 neighborhoods and areas of interest. No matter how many trips you make to the city, you will never run out of fascinating places to explore. From the city's waterfront and historic parks to the Avenue of the Arts and the Parkway Museum area, the city holds an assortment of treasures and attractions. There are museums, both large and small, and historic sites to explore, as well as shopping and dining. Your most difficult task may be deciding when to get some rest, since there is so much to see and do.

Here is my list of the Top Ten attractions. Some of these attractions are within walking distance from the conference site, or you may hop into a cab, drive, or car pool.

The Conference site: Wyndham Philadelphia at Franklin Plaza, 17th and Race Street. This hotel is one of Philadelphia's best luxury values with 55,000 square feet of flexible meeting/exhibit space. The Wyndham Ballroom is 20,000 square feet. A continental restaurant, full service café, lobby bar and room service are also available. The hotel is located in the downtown area, within walking distance of museums and historic attractions. For details go to the website (www.wyndham.com.)

The Franklin Institute Museum (for the science minded) at 20th Street and Ben Franklin Parkway (www.fi.edu) is the most visited museum in Pennsylvania. You will find this great science museum within walking distance (~3 blocks) from the conference site. The Franklin Institute offers two exciting, new attractions: a 3D theater and an indoor SkyBike. In addition, the museum features a giant walk-through heart, four floors of interactive, electrifying exhibits in the Mandell Center, thrilling Tuttlemann IMAX movies, and Fels Planetarium shows.

The Academy of Natural Sciences, at 1900 Ben Franklin Pkwy: (www.acnatsci.org.). This is yet another attraction situated almost next door to the HAPS conference site! Come face to face with the largest meat-eating dinosaur, dig for fossils like a real paleontologist, witness a butterfly emerge from its chrysalis, and explore wildlife on every continent. Four floors of exhibits from the Academy’s world-renowned collections are offered, plus live animals and hands-on activities for the whole family.

College of Physicians of Philadelphia 19 S. 22nd Street (for the health minded) is a health information resource for the public includes the new College Gallery, the C. Everett Koop, M.D. and Community Health Information Center, medicinal plant garden, and the Mutter Museum, along with the visiting exhibit, “Emerging Infectious Diseases: Ancient Scourge and Modern Menace.”

Pennsylvania Academy of the Fine Arts (for the art minded) is at Broad and Cherry Streets (www.pafa.org.) Discover America’s first art museum. Opened in 1876 to celebrate the Centennial, the museum building is a National Historic Landmark. The Academy’s renowned collection of American paintings and sculpture spans three centuries and includes works by our country’s greatest artists.

Philadelphia Museum of Art at 26th Street and Ben Franklin Pkwy (www.philuseum.org) is a great art museum contains showcases consisting of more than 2000 years of human creativity. The collections and special exhibitions present masterpieces of painting, sculpture and decorative arts and architectural settings from Europe, Asia, and the Americas. The striking neoclassical building is an oasis of beauty which includes enriching activities, family programs, lectures, concerts and films.

Philadelphia Zoo (for fun loving and wild living) is at 3400 W. Girard Ave. (www.philadelphiazoo.org.) Did you know this is America’s first zoo? Home to nearly 2000 animals, it features white lions, polar bears, elephants, reptiles, and magnificent birds from around the world. The 42-acre Victorian Garden features naturalistic exhibits. Come closer and get in touch with Philadelphia’s wild side!
HAPS 2003 - continued from page 6

**Fairmount Park** (for sightseeing): is the nation’s largest landscaped city park offers a variety of sights and adventures. Beginning at the Ben Franklin Parkway, Fairmount Park encompasses more than 8,900 acres with winding creeks, rustic trails, lush green meadows and 100 miles of jogging, bike and bridle paths perfect for exploration, sightseeing, and sports. The park is divided by the Schuylkill River into East and West Fairmount Park. It contains everything from fields and streams to historic landmarks and the nation’s first zoo.

*The New Avenue of the Arts* (for entertainment) is the city’s premier arts district. The avenue extends more than three miles along Broad Street through the heart of the city and includes more than 20 major educational and performing arts facilities. The avenue’s newest jewel is the Kimmel Center for the Performing Arts at Broad and Spruce Street. (www.rpac.org). This is the new home of the Philadelphia Orchestra, as well as resident performing arts groups, national and international cultural programs, and popular music events. The state-of-the-art venue which opened in 2001 includes a 2,500-seat concert hall, a 650-seat recital theater, a 15-seat black box theater, an arts education center, a rooftop garden terrace, public gathering space, and a restaurant. For more information, visit www.avenueofhearts.org.

*The Independence National Historic Park* (the birthplace of our Nation’s freedom) is America’s most historic square mile is a place where history comes alive. More than a dozen of our nation’s most important historic attractions can be found here including the Liberty Bell and Independence Hall, two of the most treasured monuments celebrating American freedom. In addition, an interactive kiosk called “Touch and See Philadelphia” in the visitors center brings the park into the electronic age. Discover information about Philadelphia’s other attractions, shopping, culture, recreation, and entertainment. A must on everyone’s list should include one of the world’s most famous symbols of freedom—The Liberty Bell, Independence Hall, Congress Hall, The Second Bank of the United States, Carpenter’s Hall, Franklin Court, Christ Church Burial Ground, The Declaration House (Graft House), and the Edgar Allen Poe National Historic site. When you are ready to leave the park, do not forget to stop at one of the following places: First, the Independence Seaport Museum on Columbus Blvd. and Chestnut Streets. This museum offers an interactive exploration of Philadelphia’s heritage as a port city. Then, make sure to visit the Betsy Ross House (3rd and Arch Street), a wonderful example of surviving colonial architecture. Whether or not you believe Betsy actually lived here and sewed the first US flag, this historic site paints a nice picture of everyday life during the period. Finally, the United States Mint is just three blocks west on Arch Street. This is the largest mint in the world producing some 35 million coins daily. You can get in on the action (sort of) by watching the proceedings from up on high.

Once again, folks, this is only a small glimpse of what the city is all about. The Philadelphia information bureau on-line service, (www.pcvb.org,) will provide greater insight into all our city has to offer. They have been very gracious to assist me in getting information about the city and they welcome all HAPS members to Philadelphia, the place that loves you back.

### HAPS Grants and Scholarships

The HAPS’ Board of Directors has awarded the following grants and scholarships for 2002.

**FACULTY GRANT RECIPIENT 2002**

Chaya Gopalan for the proposal “Introduction of research techniques to facilitate the understanding and exploration of neuroanatomical and physiological relationships”

St. Louis Community College at Florissant Valley

### Call For Proposals 2003

Any questions regarding grants and scholarships contact the 2003 HAPS Grants and Scholarship Committee Chair:  
**Dr. Richard Faircloth at 410-777-2272**  
or  
e-mail at RFaircloth@aacc.edu

The 2003 Call for Proposals and applications will be available on the website [www.hapsweb.org](http://www.hapsweb.org) after July 1, 2002
Bacillus anthracis, the causative agent of anthrax, is a gram-positive, rod-shaped bacterium commonly found in soil around the world. Anthrax is considered a zoonosis, primarily affecting cattle, sheep, and other grazing animals. Once infected, these herbivores have a high mortality rate and tend to bleed from the nose, mouth, and bowel (Shafazand et al., 1999). The vegetative bacterial cells are then deposited in the soil and subsequently produce resilient endospores by a process known as sporulation. Endospores remain in the soil until contact with host tissue that arises via ingestion, inhalation, or cutaneous contact. Historically, the majority of human cases of anthrax have been due to occupational or agricultural exposure to spores. Infections with spores can occur through a cut or abrasion (cutaneous anthrax), ingestion of contaminated food (gastrointestinal anthrax), or via the respiratory route by aerosolized spores (inhaled anthrax). The latter is the most deadly form of this disease, causing death 1-7 days after infection (Dixon et al., 1999). Until now, inhalational anthrax cases in the United States have occurred by accidental exposure to aerosolized spores from contaminated animal hides or as a result of frequent work with domestic livestock (Shafazand et al., 1999).

Although anthrax has recently become a public health concern, it has always been a disease of historical interest because of its potential as a biological warfare agent (Shafazand et al., 1999; Swartz, 2001). Many countries, including the United States have conducted experiments regarding the use of anthrax spores as biological weapons. Because of the growing fear of anthrax challenge during the Gulf War, a total of 150,000 US troops were vaccinated with anthrax toxin components. The CDC has estimated the economic impact of anthrax exposure to be $26 billion per 100,000 people exposed (Kaufmann et al., 1997). Today the United States continues to try to prepare itself for the possibility of a massive assault involving anthrax spores.

Endospores are produced by many bacterial species during times of environmental stress to ensure the survival of the species. These structures are incredibly resistant to extreme temperature, pH fluctuations, dehydration, and ultraviolet radiation (Harley et al., 1999). Endospores do not have any measurable metabolism, ATP production, or macromolecular synthesis; they simply contain genes for germination and infection that are protected by hard outer cellular layers (Hanna et al., 1999). Endospores are essential for B. anthracis to infect host tissues and cause disease. The anthrax endospore is a complex structure composed of many different layers (see Figure 1). The exosporium is the loose outermost layer composed of proteins, carbohydrates, and lipids which functions in preventing extracellular enzymatic attack and destruction of the inner layers (Mock and Fouet, 2001). Below the exosporium, the protein-layered spore coat is largely responsible for the chemical resistant properties of anthrax spores (Harley et al., 1999). The protein layers consist mostly of dipicolinic acid complexed with calcium ions. This calcium-dipicolinate complex is responsible for the spore's resistance to heat and oxidizing agents. Beneath the spore coat, the cortex is made up of peptidoglycan and may occupy as much as half of the total spore volume. Normal cell structures like ribosomes and a nucleoid are found in the center of the spore. These structures are separated from the spore coat by the spore cell wall.

Inhalation anthrax is a rare and deadly disease caused by inhaling anthrax spores deep into the respiratory epithelia. Often, spores clump together increasing their size to >5 μm which enhances their chance of being trapped by mucus in the respiratory system. However, individual anthrax spores have a diameter of about 1 to 2 μm, which enables them to escape primary immune barriers such as mucus.

Figure 1: Electron micrograph of Bacillus anthracis endospores (x151,000). (From Microbiology, fourth edition by Harley et al. (1999:67) The following endospore structures are noted above: exosporium (EX), spore coat (SC), cortex (CX), core wall (CW), and the protoplast/core with its nucleoid (N) and ribosomes (CR) (Harley et al., 1999:67).

Cutting Edge - continued on page 9
Cutting Edge - continued from page 8

secretion in the lungs. Once the spores reach the alveolar sacs, residential macrophages readily engulf the spores by phagocytosis (Guidi-Rontani et al., 1999). These alveolar macrophages are the first immune cells to contact inhaled anthrax spores. After phagocytosis of endospores, the alveolar macrophage migrates to mediastinal or tracheobronchial lymph nodes to alert other immune cells to the presence of the foreign spores. Instead of being destroyed by the alveolar macrophage, the spores germinate inside the macrophages producing metabolically active *B. anthracis* bacterial cells, commonly called vegetative cells (Grinberg et al., 2001). The vegetative *B. anthracis* cells break out of the macrophage and enter a nearby lymph node cell. Here the bacterial cells begin to replicate, secrete their toxins, and enter the blood stream. After initial infection, death occurs within 2-4 days (Swartz, 2001).

No minimal dose of inhaled spores has been determined for human anthrax infections. However, the US Department of Defense estimates that the lethal dose for 50% of test subjects is between 8,000 and 10,000 spores (Franz, as cited in Dixon et al., 1999).

The symptoms associated with inhalational anthrax occur in two distinct phases. The first or initial phase consists of fatigue, fever, some chest pain, and an irritating cough. These symptoms are not specific and are often brushed off as a common cold or the flu. Because of its historical rarity, anthrax has rarely been considered as a possible cause of infection. Misdiagnosis of anthrax at an early stage enables the infection to worsen. Two to three days after initial infection, the second phase occurs abruptly and is characterized by high fever, massive bacteremia, toxemia, and edema. At this stage, radiographs show a widened mediastinum, evidence that hemorrhagic mediastinitis (extensive bleeding and inflammation of the mediastinum) and pleural effusions (accumulation of fluid within the pleural space) are present. Once *B. anthracis* reaches the blood stream, the infection has a mortality rate approaching 100% with death occurring within two days. The bacteria multiply in the blood stream until there are as many as 10^9 or 10^10 organisms per milliliter of blood, causing massive septicemia (Dixon et al., 1999).

When the spore begins to germinate, it transcribes toxin and capsule genes, which are virulence genes found on two different bacterial plasmids designated pXO1 and pXO2 respectively. The pXO2 plasmid is responsible for capsule synthesis, while the pXO1 plasmid carries the toxin genes, pagA, lef, cya, and a three-gene germination operon, gerX. Bicarbonate, temperature, and pH affect transcription of the three toxin genes found on pXO1 (Mock and Fouet, 2001). AtxA, a transcriptional activator discovered by Koehler et al. (1994) and Uchida et al. (1993), is responsible for controlling the transcription of the genes on pXO1 and pXO2. In the absence of atxA, toxin genes may not be transcribed, making atxA crucial to the release of vegetative cells from infected macrophages (Dixon et al., 2000).

The anthrax capsule, an important virulence factor itself, has a negative charge and is composed of poly-D-glutamic acid. It protects the bacteria from dehydration and may inhibit phagocytosis of vegetative cells by the host immune system (Harley et al., 1999). The capsule is believed to be inaccessible to antibodies, enhancing *B. anthracis* ability to dodge host immune defenses. By using immunolabeling and electron microscopy, Mesnage et al. observed that the *B. anthracis* capsule functions as a "one-way" filter, allowing anthrax toxins to diffuse extracellularly while blocking antibodies from reaching the cell surface. This one-way sieve function allows *B. anthracis* to secrete its toxin components and protect itself from host immune defenses like phagocytosis and antibodies. While the capsule protects the vegetative cell, the secretion of toxin components is responsible for the rapid death characteristic of an inhalational anthrax infection.

After spore germination *in vivo*, the vegetative cells begin to transcribe the toxin genes found on pXO1. Three proteins are produced: Protective Antigen (PA), Lethal Factor (LF), and Edema Factor (EF). The anthrax toxin receptor has recently been identified as a 368 amino acid human protein. The Protective Antigen binds to the anthrax toxin receptor of host cells and endocytosis occurs. Anthrax toxins then move into the cytoplasm of host cells. Lethal Toxin (LeTx) is more potent than Edema Toxin (EdTx); therefore, Lethal Toxin plays a greater role in anthrax pathogenesis. Lethal Factor (LF) is largely responsible for the massive shock and rapid death caused by systemic anthrax infections (Hanna, 1999). LF is a highly specific Zn^2+ metalloprotease that cleaves members of the mitogen–activated protein kinase kinase family (MAPKKs). The MAPKK family largely regulates the signal transduction pathway for cell division. Lethal Factor produced by *B. anthracis* is able to inhibit this pathway by cleaving MAPKK molecules (Duesbery et al., 1998).

Edema Factor (EF) is an adenylate cyclase that increases intracellular concentrations of cyclic AMP in eukaryotic cells (Mock and Ullmann, as cited in Drum et al., 2000). After translocation of Edema Factor toxin into the cytosol of host cells, Edema Factor causes the production of unregulated levels of cAMP within the cytosol of host cells. Increased levels of cAMP in host cells upsets cellular homeostasis, creating abnormal hypertonic/hypotonic environments, increasing cellular apoptotic rates, and inducing edema formation (Drum et al., 2000; Grinberg et al., 2001).

After challenge with antigen, macrophages generally become activated, exhibiting greater phagocytic ability and increased secretion of inflammatory mediators. When activated, macrophages secrete three cytokines, IL-1, IL-6, and TNF-alpha. These cytokines are part of a complex signaling system that involves production of chemokines and the activation of other phagocytic cells like neutrophils. Once activated, these cells exhibit increased phagocytic activity and an increase in the production and release of lytic enzymes to host tissues. In systemic anthrax, the macrophage activation chain is further enhanced because millions of viable *B. anthracis* cells invade the blood stream stimulating further phagocytosis and lytic enzyme secretion, poisoning the host and contributing to the toxemia, septicemia, and rapid death associated with systemic anthrax (Grinberg et al., 2001).

Once the anthrax bacillus is internalized by macrophages, it is contained in a membrane bound structure called a phagosome. The phagosome eventually fuses with a lysosome to form a phagolysosome. Lysosomes typically contain hydrolytic enzymes, which digest and destroy ingested foreign material (see Figure 2). Normally, antigen challenged macrophages also produce reactive forms of oxygen that aid in the destruction of the foreign material. Inhalational anthrax infections are able to bypass this defense system and recruit macrophages to aid in host cell destruction via the cytokine signaling system.

The exact method that *B. anthracis* uses to bypass destruction within the phagolysosomal network has not been discovered. It is known, however, that certain other bacteria have devised methods to survive destruction in macrophages. For example,
Mycobacterium tuberculosis prevents exposure to lysosomal contents by inhibiting fusion with lysosomes, and Shigella flexneri lyases the phagosomal membrane before fusion with lysosomes can occur. Current investigations are being performed to determine the exact method B. anthracis uses to survive within the phagolysosomal network of macrophages. It is possible that Lethal toxin produced by the anthrax bacilli may cause macrophage lysis, allowing newly germinated B. anthracis cells to escape from the phagolysosome before they can be deactivated by host enzymes and other immune responses.

Inhalation anthrax, with a mortality rate close to 100% and links to bioterrorism, is a high profile disease within the military and medical community. There is a need, both now and in the future, to create effective treatments for anthrax infections and to pursue measures that will prevent acts of terrorism. The only licensed human anthrax vaccine in the United States is called Anthrax Vaccine Absorbed (AVA). BioPort Corporation in Lansing, Michigan produces and prepares it using a toxigenic, nonencapsulated strain known as V770-NPI-R. The vaccine is derived from a cell-free filtrate of B. anthracis culture devoid of dead or living bacteria. Although the mechanisms of AVA-induced protection remain unknown, the protective antigen (PA) component of the anthrax toxins has been determined as the primary antigen (Welkos, et al., 2001). The AVA dosage is complex, requiring three subcutaneous injections at 0, 2, and 4 weeks, and three booster vaccinations at 6, 12, and 18 months. An annual booster injection is recommended to maintain immunity. The AVA dosage regimen is extensive and must be employed many months prior to challenge with anthrax endospores in order to be effective (Advisory Committee on Immunization Practices, 2000).

Continuing research regarding the biochemical pathway anthrax toxins utilize to immobilize host immune defenses is underway. Due to the recent anthrax attacks, research has also begun to carefully examine the role surface structures like the capsule and S-layers play in intracellular survival, germination, and replication. A better understanding of toxin and cell surface interaction unique to anthrax pathogenesis will give microbiologists the chance to create more efficient treatments and vaccines, a crucial step in preparing for acts of bioterrorism.

References
Embryos develop to form unambiguous males or females, except in a small percentage of cases. The sex chromosomes play an essential role in this process. Zygotes with two X chromosomes are genetic females and zygotes with an X and Y chromosome are genetic males. The mechanisms by which genes on the sex chromosomes direct the development of the reproductive system include the synthesis and secretion of specific hormones at critical periods of time during development. These hormones control the differentiation of reproductive structures and parts of the nervous system, they have dramatic effects on sexual behavior, and some data suggest that they influence sexual preference in humans.

The genetic sex of humans and other mammals is established at the time of fertilization. During early development, however, the embryonic gonads are, for a short time, indifferent, and thus have the potential to give rise to either ovaries or testes. Indifferent gonads form ovaries in mammals unless influenced by genes located on the Y chromosome.1 The SRY gene located on the short arm of the Y chromosome may function as a "master switch" for other genes "downstream" in the course of sexual differentiation by coding for a testis determining factor.2 The testes differentiate under the influence of the Y chromosome during the 7th week of gestation in the human, whereas ovarian development usually does not begin until 13 to 16 weeks.3 Females with a single X chromosome develop only partially differentiated ovaries. Consequently, it appears that two X chromosomes are necessary for the development of normal ovaries.

The precursors to both male and female internal reproductive structures begin to develop in embryos. Müllerian (paramesonephric) ducts form female internal reproductive structures such as the ureterine tubes, uterus, and part of the vagina. Wolffian (mesonephric) ducts form male internal reproductive structures such as the epididymides and the ductus deferens. Shortly after the testes begin to form, they secrete testosterone and a glycoprotein called Müllerian regression factor. Testosterone binds to testosterone receptors in cells of the Wolffian ducts causing them to form male internal reproductive structures. Müllerian regression factor causes atrophy of the Müllerian ducts. Development of the female internal reproductive structures does not appear to depend on ovarian hormones. The Müllerian ducts form female internal reproductive structures if ovaries are present in the embryo, or if gonads fail to develop. As long as no testosterone is secreted, the Wolffian ducts atrophy, and without Müllerian regression factor, the Müllerian ducts develop to form female internal reproductive structures.

External genitalia of males and females develop from the same precursor tissues. Development of female external genitalia does not require ovarian hormones. Removal of the gonads from early embryos of either sex results in the development of female external genitalia. In contrast, the development of the penis and scrotum of males begins shortly after the onset of Wolffian duct development. Testosterone, produced by the testes during this period (before 11 weeks of gestation), causes development of the penis and scrotum.

The active hormone that causes the development of the male external genitalia, is dihydrotestosterone (DHT), not testosterone. An enzyme, 5α-reductase, found in cells of the external genitalia, converts testosterone to dihydrotestosterone (DHT). DHT binds to an intracellular DHT receptor and promotes the development of male external reproductive structures. If 5α-reductase is absent or nonfunctional, female external genitalia develop, even though the embryo may have an XY genotype, testes that secrete testosterone, and male internal reproductive structures. If 5α-reductase is only partially functional, ambiguous external genitalia may develop in genetic males.4

Hormones secreted by gonads also influence the development of
Cutting Edge - continued from page 11

structural and functional differences between male and female ner-
vous systems. In adult male mammals, secretion of pituitary gonadot-
ropins is relatively tonic (generally consisting of small pulses), whereas
in adult female mammals, secretion of pituitary gonadotropins hor-
mones is more cyclic in nature. A substantial increase in the secretion
of gonadotropins triggers ovulation. Testosterone secreted during devel-
ment, by developing testes, establishes the male pattern of gonad-
otropin release that occurs after the onset of puberty. The absence of
testosterone, during development, results in the female pattern of
gonadotropin release that occurs after the onset of puberty. A critical
period for this effect of testosterone is during days 1 and 2 postpartum
for rats, or before birth in other mammals with longer gestation peri-
ods. The influence of testosterone is on the development of the hypo-
thalamic area of the brain and not on the pituitary gland. 4

Hormones secreted during development, in non-human mamma-
lian species, have been shown to influence aspects of sexual behavior
exhibited by adults. The presence of testosterone during development
causes an increase in at least some sexual behaviors characteristic of
males, in adults. A lack of testosterone during development causes an
increase in at least some sexual behaviors characteristic of females, in
adults. Testosterone injected into female rats within 1 to 2 days fol-
lowing birth results in a male-like pattern of gonadotropin release from
the pituitary and an increase in male sexual behavior (such as mount-
ing behavior) at puberty. In contrast, removal of the testes prior to the
10th day of gestation results in female testosterone-replaced male rats,
results in a female pattern of gonadotropin secretion and female sexual behavior
(such as lordosis) at puberty. Surprisingly, testosterone enters cells of
the brain and, at least in some brain nuclei, testosterone is converted to
estradiol by the enzyme aromatase. Estradiol molecules bind to intracel-
lar receptors and play a role in the development of the male pattern
of gonadotropin secretion and subsequent male sexual behav-
ior.

Differences in the structure of hypothalamic nuclei of male and
female brains develop under the influence of hormones secreted dur-
ing development. Also, these brain nuclei are found in areas of the
brain that are important in controlling sexual behavior exhibited by
males and females. The sexually dimorphic nuclei of the preoptic area
(SDN-POA) in the rat hypothalamus are larger in volume in males
than in females. The difference is due to a larger number of cells in the
SDN-POA of males. The incidence of apoptosis was determined in
part of the SDN-POA over the first 13 days postnatally in male and
female rats. Testosterone had a profound inhibitory effect on the inci-
dence of apoptosis between days 6 and 10. Thus, it appears that the
structural differences between brain nuclei of male and female rats
develop early and are at least in part, due to the inhibitory effect of
testosterone on apoptosis of neurons. 5

Data from human brains support the concept that brain nuclei that
develop early in life differ between males and females and are consist-
ent with the hypothesis that hormones influence their structure. The
sexual dimorphic nucleus (SDN) of the hypothalamus, the interstitial
nucleus of the anterior hypothalamus 3 (INAH3), a darkly staining postermelial component of the bed nucleus of the stria terminais, and
the suprachiasmatic nucleus (SCN) 6,7,8 are all larger in males than
in females. In some of the nuclei, the shape of the nuclei and the
number of cells in them differ between males and females, as well as
the size of the nuclei. Some of these nuclei are associated with areas of
the brain thought to be responsible for the control of sexual behav-
ior. For example, the INAH3, in the part of the brain that participates
in the regulation of male sexual behavior, was found to be more than
twice larger in heterosexual men than in heterosexual women. 10 Other
investigators failed to confirm these differences, although they reported
that the difference in the number of cells between the nuclei did ap-
proach significance. 11 Inconsistency in these reports may be due to
the use of different techniques used to stain, section, and assess the size of the
nuclei. In addition, the SCN was found to be larger in homosexual
males than in heterosexual males. 12 Thus, there is support for the hy-
pothesis that sexual orientation may be influenced by differences that
develop in response to reproductive hormones early in life. 13

The anterior commissure was also found to be larger in homosexual
men than in women and even larger than in heterosexual men. This
finding of a difference in a structure, not known to be related to repro-
ductive functions, supports the hypothesis that factors operating early in
development result in sexually dimorphic structures and may play a
role in determining adult behavior. 13 Men were found to have twice as
many somatostatin neurons as women in the central part of the bed
nucleus of the stria terminalis. Also, the number of neurons in male-
to-female transsexuals was similar to females, and the number of neu-
rons in female-to-male transsexuals was in the male range. 14

Differences that develop in some sexually dimorphic nuclei do so
later in life than was once expected. Also, some hypothalamic nuclei
change in structure throughout the life of the individual. For example,
the maximum number of cells in the SDN of both sexes is achieved
between 2 and 4 years of age and then maximum difference between
males and females is reached by puberty. 4,15,16,17 Consequently, it is
possible that many factors influence the structure of the hypothalamic
nuclei.

Some differences between males and females are obvious, but not
all of them are. In addition, how females and males develop is com-
plex. Differentiation of internal and external reproductive structures is
controlled by hormones, secreted by the developing gonads. That the
structure and function of certain brain nuclei are influenced by repro-
ductive hormones early in life is strongly supported by data from non-
human animal studies. Data collected from humans is far from con-
clusive, but they are consistent with the nonhuman animal data. Thus,
there is support for the conclusion that human sexual behavior exhib-
tied by adults is influenced by hormones early in life, and these behav-
iors may include sexual orientation. A great deal remains to be learned
about how we become male or female, but the strong relationships
between structures and their functions should be considered when ex-
amining attitudes and policies related to issues such as sexual orientation.

References
Are High School Graduates Adequately Prepared For the Rigors of College?

Dayton Ford
St. Louis College of Pharmacy
Biology/Pharmaceutical Sciences
4588 Parkview Place
St. Louis, MO 63110
(314) 367-8700 x 1307
dford@mail.stlcop.edu

Once again a very interesting discussion took place on the HAPS listserv that concerns all of us who are concerned with our students’ abilities and performance. The main topic of discussion was whether or not our current crop of students are adequately prepared for courses (such as anatomy and physiology) that require higher order thinking. Some sub-topics that also popped up during the discussion were: 1) are students now as well prepared as they were ten or twenty years ago, and 2) are our public schools doing a good job? Obviously the space provided will not allow for a very detailed analysis of these issues, so I will attempt to focus my attention primarily on whether or not our students are adequately prepared for the rigors of college course work.

If you were to ask a conservative this question, the answer would be no. You would then be given a lecture (diatribe may be more appropriate here) about how poorly our secondary schools perform in comparison to the golden age of the 1950’s and how we need to cut government mandates for education spending and bring God back into the classroom. Ask the same question of a liberal and the answer would again be no. You would then be subjected to another lecture (I still like the word diatribe here) about how little teachers are paid, in comparison to other professions, and how desperately we need to spend more on education in this country. Since I am writing this article, it is probably important for the readers to know that I am neither a conservative nor a liberal. I am a moderate with Republican leanings (still registered Independent though). Therefore I believe that both of the above answers are incorrect for several reasons.

My answer to the question would be a definite no. I have to qualify the following statements by saying that none of what appears in this paragraph is fact. All of this is opinion based upon my personal teaching experiences. It has been my experience that our students are more concerned these days with: 1) the letter grade that they will receive, and 2) how they can “get a good grade” in the class. Ask students what their primary concerns are (and I have) and these are the two statements that will always appear. In my experience, roughly 10-20% of students will express their concern for how much they will learn and how it will apply to their future career. I would be willing to bet money that almost every human A&P instructor reading this has at least one student ask him or her about extra credit each and every semester. The point is that our students are focusing on the grade and not on the content (or the learning). If this statement is in fact true, then the next logical question is why.

Secondary education in America may be classified into several eras, based upon which group of education reformers holds power during that era. For those of you who are interested in the history of education reform in the U.S., I highly recommend Left Back: A Century of Failed School Reforms, by Diane Ravitch. For the purpose of this article, I would like to focus on three eras in secondary education, the first being the pre-1960’s, the second, encompassing the period from the 1960’s to the 1990’s, and the third being the present period.

In the early 1960’s, secondary education was considered by many to be at its zenith. Ask any conservative when our public schools begin to decline and the year 1963 will most likely be the answer. This is because SAT scores have steadily declined since 1963 (They have increased in the 1990’s, but these scores are not comparable to 1963 because the scoring system has changed and the test has been “dumbed down.”). During this period, the secondary education teacher played several roles: educator, surrogate parent, authority figure, etc. During the late 1960’s and early 1970’s authority figures became subjects of scorn and disdain (not surprisingly I may add due to the Vietnam War and the political scandals). Two popular slogans from this era were: 1) “question authority,” and 2) “don’t trust anyone over 30.” It was during this period of time in which public school teachers lost much of their power and authority. They lost their ability to act in loco parentis; not only were they unable to discipline students as they had in the past, but the students knew it. Also during the 1970’s, there began an increase in the number of lawsuits filed by parents against teachers and school boards. If parents did not like the grade or the pun-
ishment that their child received from a particular teacher, or from the principal, then a lawsuit was filed. Lawsuits were not filed in every case, but just enough so that administrators (who were beginning to play a more prominent role in education) would change the way that students were disciplined. Teachers (knowing that administrators were fearful of lawsuits and would probably not back them up) then relinquished their roles as authority figures and surrogate parents. Thus began an increase in student disorderliness and truancy that had not been seen before in American public education. By the early 1980's, public school teachers were virtually powerless to discipline unruly students, administrators were increasingly fearful of lawsuits, and the federal government was increasing its role in the education of our children.

In April of 1983, the National Commission on Excellence in Education (a commission appointed by T.H. Bell, then Secretary of Education) released a scathing critique of American public school education titled, A Nation at Risk: The Imperative for Education Reform. The findings of the commission may be found at (http://www.ed.gov/pubs/NatARisk/findings.html). In summary, the commission found the following: that the curriculum was watered down, the three R's (readin', 'ritin', and 'rithmetic) were not emphasized; minimum competencies were too low; expenditures for textbooks and materials had declined markedly; not enough time was spent either in class or doing homework assignments; teachers were drawn from the bottom quarter of graduating college classes; and teachers needed to be paid more if we wish to be able to recruit better teachers. Many have criticized the commission's findings (rightly so in some cases because they compared test scores in the early 1960's to test scores in the early 1980's even though they were different tests), but some of the findings of the conservative commission were reiterated by a liberal in the 1990's. Albert Shanker made the following statements prior to his retirement as president of the American Federation of Teachers (bear in mind that these statements are from an address given in January of 1990, but many such statements may be found in all of his writings and speeches):

- Some have explained this condition by calling our system a "failed monopoly." I believe it would be more accurate to compare it to a planned economy. (Shanker was referring to the resistance to change in our public schools of teacher's unions, politicians and administrators.)

- Crossroads in American Education, released in 1988 by the National Assessment of Educational Progress, gives an overview of 20 years of assessments of reading, math, and science. It shows that we have had an educational disaster on our hands that involves all students.

- The assessment results for 17-year-olds who are still in school are particularly dismaying. Most of the 25% of high school students who drop out are gone. The 17-year-olds who are there to be tested are our successful students, the ones who are about to march down the aisle and get diplomas. Yet the findings of the NAEP indicate that few of these students are ready to do real college-level work or to handle a good job. For example, only 6% could solve the following multistep math problem: "Christine borrowed $850 for one year from the Friendly Loan Company. If she paid 12% simple interest on the loan, what was the total amount she repaid?"

- Asked to write a letter to a high school principal advocating a change in school rules, only 2.6% of 17-year-olds could come up with one as good as this: "I am writing this letter in order to discuss the rule of 'sharing lockers.' I know I don't like this rule and I'm sure many other people don't like it either. I think I can under-

HAPS-EDUCATOR - Summer 2002 - page 14
Educational Issues - continued from page 14
it is distributed and spent needs to change. Of all of the industrialized nations in the world, only Finland and the U.S. spend a larger proportion of their education dollars on non-educational items. This means that teacher salaries, textbooks and materials, computers and software, and other items that have a direct educational function are receiving a smaller portion of the pie than administrator salaries, compliance fees, etc. In order to rectify this situation, I propose that we eliminate many federal and state mandates (but not all), thus eliminating the need for all of these administrators (most of whom are high-priced bureaucrats anyway) and freeing up dollars to be used for buying textbooks and recruiting better teachers (who will be paid better than the current crop of teachers are). This would satisfy (to some extent) both the conservatives, and their desire to pare down the bureaucracy of education, and the liberals, and their desire to increase teacher salaries and recruit better qualified teachers.

The most important part of my solution to this problem is a renewed partnership between parents and teachers. Too often we hear about the conflicts between parents and teachers and not about their similarities in opinion regarding the education of our children. When asked what matters most in the education of U.S. children, both parents and teachers state that the knowledge and skills necessary to succeed later in life are of paramount importance. When pressed, parents state that the fundamentals of reading, writing and arithmetic are more important than cultural sensitivity courses, broad-based history courses that place a premium on affirmative action-type history at the expense of American history and civics, and classes whose sole intention is to build self-esteem.

Finally, parents need to be more involved in the education of their children. This involves not just attending PTA meetings, but also being more accepting of the punishment and grades that their children receive. Currently it is not uncommon for the average grade in a high school class to be a B or B+. In plain English, that is grade inflation. The average grade should be a C or C+. Pressure by parents on school boards, administrators, and teachers to award grades that do not accurately reflect the abilities of the student is in effect rendering the entire grading process useless to college admissions officers. Almost every student that I see had a 3.5 or better (out of 4.0) in high school and cannot understand why it is that they are receiving D’s in college! We need to more accurately assess the abilities of students in high school so that colleges no longer need to remediate 30% of incoming freshmen in math and/or English.

Implementing Interactive Learning Activities in Anatomy Lectures

Valerie Dean O’Loughlin, Ph.D.
Medical Sciences Program
Indiana University, Bloomington, IN 47405
vdean@indiana.edu
(812) 855-7723
(812) 855-4436 fax

Introduction
As many of us well know, large enrollment classes are considered “cost-effective” by the administration, but these classes tend not to be the most effective method for student learning. By their very nature, large classes discourage students from participating and taking a more active role in their own learning. In addition, many of these courses are taught in traditional lecture format, whereby the lecturer transmits information and the students take a passive role of note-takers.

Science education research has demonstrated that active and cooperative learning techniques tend to be more effective for learning than traditional lectures alone. Active learning strategies allow the student to assume responsibility for his/her own learning. Further, these strategies can provide valuable feedback to the student about his/her own learning, and allow the student to modify his/her study techniques accordingly.

Many active learning strategies typically take place in smaller classes, as it is easier to use these techniques in a smaller class than a large-enrollment class. While implementing these active learning strategies can be challenging in a large class, several educators have shown it is not impossible. These activities do not have to replace a traditional lecture; rather, they can enhance learning from a traditional lecture.

One way to develop interactive learning activities for a class is to use Classroom Assessment Techniques (or CATs) (Angelo and Cross, 1993). They describe CATs as activities that collect data on student learning, with the ultimate goal of improving this learning. CATs also may be used as interactive learning tools in their own right. CATs not only provide the instructor with feed-back about the teaching process, they can assist student learning and encourage students to take greater responsibility for their own learning.

Beginning the Fall 2000 semester, I modified several kinds of CATs into interactive learning activities and utilized them in my Anatomy A215 (Basic Human Anatomy) lecture. In this study, I compared the Fall 2000 and Fall 2001 classes to previous Fall semesters, to test the hypotheses that 1) the use of interactive learning activities in lecture will stimulate more student engagement in lecture and 2) the use of interactive learning activities in lecture would improve lecture exam performance and instructor/course evaluation measures.

Methods
Overview of Anatomy A215
Anatomy A215 (Basic Human Anatomy) is a 5-credit, one-semester undergraduate course offered at Indiana University, Bloomington. The course has separate lecture and lab components, whereby students meet in one lecture section, and then students attend one of 10-12 smaller lab sections. At the time of the first lecture exam, class size has ranged from 237 students (Fall 2000) to 323 students (Fall 1997). The course is a prerequisite for admission into many health programs, such as nursing, dental, physical education, and physical therapy.

In the past, this lecture was taught serially by two instructors (each would teach one half of the semester), and material was presented in traditional lecture format. Final grades were based on students’ performance on four 100-point lecture and four 100-point lab exams (for a total of 800 points). Many students were frequently
overwhelmed with the amount of material and were frustrated about how to study. Some students relied solely on rote memorization.

In the Fall 2000 semester, I became the sole instructor for the lecture portion of the course. Course material was still presented in traditional lecture format, but I also used non-graded, interactive learning activities to complement each lecture. These activities were used in lecture and were accessible on the course’s website (see http://www.indiana.edu/~a215/learningaids/tofc.html). The same type and number of lecture and lab exams were used to access student learning.

**Description and Utilization of Learning Activities**

Four kinds of interactive learning activities were used throughout the lecture portion of the course beginning Fall 2000: 1) memory matrices, 2) learning exercises, 3) sample exam questions, and 4) “muddiest point” surveys. Memory matrices (Angelo & Cross, 1993) were two-dimensional grids that help recall and organize information from lecture. One example was a body tissues memory matrix (see: www.indiana.edu/~a215/learningaids/epithelium.htm ). Body tissues were given in one column, and in the next two columns, students had to list the tissue characteristics and a body location of the tissue. Learning exercises helped students understand anatomical processes. For instance, one learning exercise (www.indiana.edu/~a215/learningaids/heartbloodflow.htm) asked students to make an ordered list of the pathway of blood through the heart and blood vessels. Sample exam questions were used in every lecture. The class would choose the correct answer and then we would discuss why the other answers were incorrect. The “muddiest point” survey (Angelo & Cross, 1993) was modified into a group (versus individual) activity. Students were asked to write down an unclear point of lecture, work in a small group to see if they could clarify points of confusion, and write whether the group was successful. If I felt the majority of the class was unclear about a particular subject, I would take time during the next lecture to review the material.

One or more interactive learning activities were administered during every lecture session. In-class student participation was voluntary, done in groups, and anonymous. While the students were working, I would walk around the room and answer questions. Instructor feedback was given either during the present lecture or the following lecture (after I had a chance to collect and review group responses). Five to fifteen minutes of each lecture were allotted for the activities. In addition, all learning activities were on the A215 Web site (see URL www.indiana.edu/~a215/learningaids/tofc.html), so these activities could be reviewed as “homework” assignments.

**Methods of Analysis**

The Fall 2000 and 2001 semesters (the “innovative” classes) were compared to Fall 1997, 1998, and 1999 semesters (“traditional” classes). Human subjects approval for this study was received in July 2000. Qualitative assessment of the CATs’ effectiveness was determined through the use of mid-semester and instructor evaluations. Mean lecture exam performance was compared among semesters in order to see if the Fall 2000 and 2001 classes demonstrated improved lecture exam performance versus the other semesters. Note that lecture exams across semesters were identical in format and point value and very similar in terms of question content.

**Results (In other words, did these learning activities work?)**

In lecture, at least 85% (and in many cases, 100%) of the class would voluntarily participate in the learning activities. Although students were encouraged to work on the activities, they were not penalized if they did not do so. I also checked web page requests to see if students were accessing the activities from the A215 website. Each learning activity page had approximately 200 hits per semester. This indicates that most students were accessing the material.

Students responded very positively to the interactive learning activities. Most enjoyed working in groups, and virtually all said the activities helped them stay focused, learn the material better, and provide ample opportunity for instructor feedback. Student engagement was increased in the Fall 2000 and 2001 semesters. As one student commented on a mid-semester evaluation of the course: “Most lecture classes don’t let the student get this involved.”

Table 1 shows that Fall 2000 and 2001 semesters scored consistently higher on their lecture exams than the classes that did NOT have the interactive learning exercises. Typically I held a review session the morning of each exam. In Fall 2001, I was out of town one day and could not hold a review session the morning before Lecture Exam 3. Interestingly, the Fall 2001 class did NOT do as well on this exam.

<table>
<thead>
<tr>
<th></th>
<th>Exam 1</th>
<th>Exam 2</th>
<th>Exam 3</th>
<th>Exam 4</th>
<th>Overall Lecture Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>78.6</td>
<td>75.2</td>
<td>75.6</td>
<td>84.1</td>
<td>77.7</td>
</tr>
<tr>
<td>2000</td>
<td>80.3</td>
<td>75.3</td>
<td>79.6</td>
<td>81.2</td>
<td>79.0</td>
</tr>
<tr>
<td>1999</td>
<td>74.4</td>
<td>72.5</td>
<td>76.5</td>
<td>76.9</td>
<td>75.1</td>
</tr>
<tr>
<td>1998</td>
<td>71.6</td>
<td>71.8</td>
<td>78</td>
<td>82.4</td>
<td>75.9</td>
</tr>
<tr>
<td>1997</td>
<td>74.7</td>
<td>69.8</td>
<td>75</td>
<td>78.3</td>
<td>74.5</td>
</tr>
</tbody>
</table>

Withdrawal rates have remained relatively constant over the years. So, the teaching intervention does not appear to affect whether students remain in the course. This is a factor I would like to examine further. Student retention is a problem in this course, and it appears this teaching intervention was not sufficient to correct the problem.

**Instructor Evaluation Score**

(1 = lowest score, 5 = highest)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Evaluation Score</td>
<td>4.07</td>
<td>4.08</td>
<td>4.21</td>
<td>4.73</td>
<td>4.71</td>
</tr>
</tbody>
</table>

The instructor evaluations were the highest for Fall 2000 and 2001, and almost all comments were very positive about the course. Students felt that the different learning techniques made learning the material easier, and that they received more personal attention than in other lecture classes. A sampling of comments follows:

“She made learning easier by using different teaching techniques”

“She gave more personal attention in a class of 250+ than many do with much smaller classes. She consistently made us feel she wanted us to succeed, and that she would go the extra distance to make that happen.”

“Dr. O’Loughlin is an excellent teacher. I speak as a humanities student who might turn to science if every science instructor were like her.”

**Educational Issues - continued on page 17**
Educational Issues - continued from page 16

Conclusions

My work suggests that interactive learning activities played an important role in increasing student engagement, improving lecture exam scores, and promoting positive attitudes about the subject of anatomy. Students felt I was an effective instructor, and I gave them the personal attention they needed, even in a class of more than 250. The Fall 2000 and 2001 students were more satisfied with the class and felt they learned the material well. It is unclear at this time what effect other factors (e.g., having a single instructor for the whole course) may have played in this analysis. Further analysis with my future anatomy classes is needed so I can see if these positive educational outcomes continue.

Where to from here?

While these interactive learning activities have improved many factors in the lecture portion of the course, there still are many more pedagogical challenges to overcome. I want to make the lecture portion of the course increasingly more interactive, and rely less on traditional lecture instructional methods. I still need to find a way to address those students who withdraw from the course. Are there some strategies I can use to increase student retention?

The activities I used only addressed the lecture portion of the course. These activities did not appear to have an effect on lab performance, nor did I expect them to, which is why lab per-

formance (and overall class performance) measures were not discussed here. Much work still needs to be done with the lab portion of the course. The lab uses traditional, non-inquiry based teaching methods. Clearly, there is great room for improvement. In the near future, I plan to develop and implement methods to improve lab instruction.

References and Websites


Anatomy A215 Website
http://www.indiana.edu/~anat215 (please note: my lecture notes and learning activities are on the site only during the Fall semesters—during the spring semester, another instructor uses the website)

Anatomy A215 Interactive learning Exercises
http://www.indiana.edu/~anat215/learningaids/tofc.html

The information presented in this article was originally presented as a poster at the 2001 HAPS Conference, Maui, Hawaii. Additional data has been included.

TEACHING Tips

Using Clinical Situations to Stimulate Critical Thinking in College Anatomy and Physiology Classes

Joyce Ricker Kronberg
West Virginia University-Parkersburg
300 Campus Drive
Parkersburg, West Virginia 26101
(304) 424-8315 fax
(304) 424-8226
jkrongberg@alpha.wvup.wvnet.edu

Many students in community college nursing programs are older students who are returning to school or changing careers. These students must juggle children and outside work commitments, plus academic work. Research done on these adult learners suggests that they are extremely practical in their learning (Brookfield, 1968; Wlodkowski, 1990). They want the education to be useful and based on real-life practical applications before they devote a great deal of time to the subject matter. As is stated in the “Seven Principles for Good Practice in Undergraduate Education” (O’Banion, 1997), returning students have diverse talents and different ways of learning which need to be recognized when teaching strategies are developed. Active learning activities and cooperation among students also need to be encouraged. In the health care area, introducing real life situations is rather easy when actual clinical situations can be used in the classroom.

Teaching Tips - continued on page 18
HAPS-EDucator - Summer 2002 - page 17
Teaching Tips - continued from page 17

as part of the curriculum. This certainly involves the students actively and may be used in collaborative work. Likewise these situations can be used in doing analysis questions (Kronberg and Griffin, 2000).

For nursing students in my community college’s nursing program, I have found that using actual “things” or examples can enhance learning and keep the students interested. It also serves as a powerful reinforcement for remembering concepts. Some items, actual situations, equipment, or literature that can be used in the health care area are:

1. Items—“Things” can serve as a basis for developing critical thinking. Including:
   a. Vaccines—used to discuss the effect on the immune system, concepts of active and passive immunity can be explored, and natural versus artificial immunity can be determined and discussed.
   b. Hormones—Animal and human hormones are very similar. Animal hormones, along with a discussion of their veterinary uses, can be used to discuss metabolism or regulation, target organs, actual gland of production, and chemical types of hormones. I use insulin and oxytocin.
   c. Gall stones—I use stones from three different patients to show different forms, shapes, colors, and textures.

2. Actual Situations—These can be from: active or functioning farmland veterinary examples; hospital laboratory or blood work, urine tests, etc. can be used; or personal experiences. All of these situations work well as group projects involving interviews and reports about clinically significant problems.

3. Equipment—I get many items from my students including:
   a. Dialysis units—These lead into discussions of kidney failure and its symptoms in the patient, electrolyte and pH imbalances, and edema.
   b. Metal for hip or knee replacements—These lead into discussions of spongy bone, red marrow, as well as gluing vs. pins and screws.

   c. Shunts—These show the diameter differences called for in different uses and lead to discussions of arterial surgeries or hydrocephalus.

4. Medications—These are used to initiate discussions about reasons for using drugs, their chemical properties, and absorption across different body membranes such as is seen in sublingual tablets, patches, ointments or creams, and injections.

5. Current Literature
   a. I use newspaper articles, fiction, or even the Bible reports of cancer “cures” or treatments.
   b. Using fiction such as the James Harriot books, which describe the life of a British veterinarian during the 1930’s and 1940’s, can spark a discussion of diagnosis questions.
   c. The Bible presents information relative to food chains.

In summary, I have used many diverse items to stimulate critical thinking in my anatomy students. These “items” enhance cooperation among students, encourage active learning, provide more prompt feedback on concepts, emphasize more time on task, and promote diverse ways of learning.

References


Initiating Cooperative Learning in the Anatomy and Physiology Classroom: Activities for the First Week of Class

Murray Jensen, Ph.D.
University of Minnesota
General College
Minneapolis, MN 55455
(612) 625-1193, fax: (612) 625-0709
jense005@umn.edu

Cooperative learning is one of the most well researched teaching methods in all education (Johnson, Johnson and Smith, 1991). In order for cooperative learning to be successfully integrated into a course, the instructor must arrange and implement activities that facilitate cooperation during the first week of class. This article will examine simple, but effective, first week activities that facilitate cooperative learning.

The first activity is a simple name card game in which students use index cards to create an annotated name tag. The name tags include such information as career goals, hobbies, favorite movies, etc. Students use the name tags to introduce themselves to their fellow group members.

The second activity is the creation of a group web-page. Creating web-pages is a component of my anatomy and physiology course and this activity promotes student-to-student interaction as well as the basic elements and procedures of creating a web-page.

The third activity is a cooperative quiz that utilizes a CD-ROM anatomy game. Through the use of the game, students are able to learn how to complete a cooperative quiz, and how to use a CD-ROM game to learn basic principles of anatomy and physiology.

For cooperative groups to be successful, five different conditions must exist: individual accountability, positive interdependence between group members, group processing, face-to-face interaction, and effective use of social skills (Johnson, Johnson and Smith, 1991).

Reference

I am continually impressed with how hard our volunteers in this organization work. There are no paid positions within HAPS and yet many of the members put forth as much effort as they do in their own jobs. We had one conference in the Chicago area, hosted by Daniel Olson at Northern Illinois University. Their conference was held on April 27, 2002 and had good attendance by HAPS and their local chapter of CAAPS (Chicago Area A&P Society). Javanika Mody of Anne Arundel Community College in the Maryland area is hosting a conference October 19, 2002. Would you like to join the team? As an extra incentive, HAPS will pay your membership dues for one year and $50 toward the annual conference registration. How about that? You will get something for your efforts in hosting a regional conference.

Your regional conference can be one or two days in duration. You could have update speakers in the morning and workshops or panel discussions in the afternoon. We are in need of regional conferences for Fall 2002, Spring 2003, Fall 2003 and Spring 2004. Why not make the commitment now? Contact Mary Bracken or your regional director. We have lots of help for you. There is a step-by-step Guide for Hosts, along with sample budgets, registration packet samples, and more, just for the asking. We have vendors who are anxious to help with your conference. How much easier can it be?

Your first step is to contact your administration to get their support. Then decide who you would like to be on your committee. If you do not have anyone in mind, then we can find some people for you. Then choose your date. Right now it can be as vague as Spring 2003. We can pinpoint a date later. Then complete the proposal form found below. Send it to me via the postal service or email. You are well on your way to joining a winning team, HAPS, and helping your fellow HAPSters. A regional conference is a good way to meet people and enlist members. Help HAPS grow by hosting a regional conference.

Proposal for a Regional Conference

Name of Conference Coordinator ________________________________
Coordinator’s Address __________________________________________
Phone Number __________________________________________________

Please supply the following information on separate sheets of paper:

- We will provide you with a mentor who has prepared a budget to guide you through this process
- Written statement of administrative support/approval from the host institution agreeing to co-sponsor the HAPS Regional Conference and to allow use of its facilities

Send a copy to: Mary Bracken
Chair of HAPS Regional Conferences
Trinity Valley Community College
PO Box 668
Terrell, TX 75160
bracken@tvcc.edu

Proposed Site/Host
Institution ______________________________________________________
Proposed Date(s) ______________________________________________

- Request for seed money, if needed (see HAPS support in Guide)
- List of state(s) to be included in mailings (usually not more than a 250-mile radius)
Regional Conference This Fall in Maryland

Anne Arundel Community College, just north of Annapolis Maryland, will host a regional HAPS Conference on Saturday, October 19, 2002.

We will be featuring a panel discussion on the Human Genome Project and a talk on forensic evidence gathering from a clinical perspective. There will also be breakout workshops, exhibitors, door prizes and lunch discussions.

If you are interested in presenting a workshop, please contact Carol Veil at cbveil@aacc.edu (410-777-2848).

For additional information on the conference please contact Javni Mody at jmody@aacc.edu or (410-777-2265) or Rich Faircloth at rfaircloth@aacc.edu (410-777-2272).

Looking forward to seeing you in Maryland this October
HAPS COMMITTEES AND BOARDS

Have you ever wondered where you could obtain a standardized anatomy and physiology test? Or maybe you are thinking about an educational project and are looking for funding? Do you feel strongly about a particular issue and would appreciate an opportunity to discuss it with other HAPS members? The following committee chairs invite input from HAPS members and willingly provide information on the activities of their committees.

ANIMAL USE TASK FORCE
INACTIVE

A three-year plan included widely distributing the HAPS policy statement, developing animal use internet links on the HAPS Home Page, monitoring relevant legislation, and creating a resource packet for HAPS members. Suggestions and questions from members welcome.

ANNUAL CONFERENCE COMMITTEE
David L. Parker, Chair
801 SW 2nd Court
 Ft. Lauderdale, FL 3312-7109
 (954) 527-4162
Dparkertio@aol.com

The primary responsibilities of this committee are development of a standardized fees structure for the annual conference, formulation of guidelines and assistance for the conference coordinator, and generation of a calendar of conference sites.

CADAVER USE TASK FORCE
INACTIVE

The goal of this committee was to develop a set of guidelines for the use of cadavers in anatomy and physiology instruction.

COMPETENCY TESTING COMMITTEE
Sam Drogo, Chair
Mohawk Valley Community College
1101 Sherman Dr.
Utica, NY 13501
(315) 792-5409
sdrogo@mvcc.edu

This committee recently completed and tested an approved version of the HAPS Standardized Test for Human Anatomy and Physiology. Any HAPS member may obtain a copy of the test by writing to the Chair.

CORE CURRICULUM AND ASSESSMENT COMMITTEE
Dan Lemons, Chair
Dept. of Biology
City College of New York
Convent Ave. at 138th St., 3526
New York, NY 10031
(212) 650-8543
daniel@harold.sci.ccnv.cuny.edu

This committee has developed a second, revised edition of the HAPS "Human Anatomy and Physiology Course Guidelines." The second edition includes new guidelines relating specifically to the laboratory component of the course.

DISTANCE EDUCATION TASK FORCE
Tom Lancraft, Chair
St. Petersburg Junior College
Natural Science
P.O. Box 13489
6605 Fifth Ave. N.
St. Petersburg, FL 33733
(813) 341-4797
lancraft@email.spjc.cc.fl.us

This task force was responsible for developing and distributing a HAPS position paper on distance learning.

GRANTS AND SCHOLARSHIP COMMITTEE
Richard Faircloth, Chair
Anne Arundel Community College
101 College Parkway
Department of Biology
Arnold, MD 21012-1895
(410) 777-2272
RFaircloth@mail.aacc.cc.md.us

This committee is responsible for advertising all grants and scholarships, reviewing all grant and scholarship proposals, selecting proposals to receive funding, and submitting its recommendations to the Board of Directors for approval.

HAPS-EDucator EDITORIAL ADVISORY PANEL
Colin Wheatley, Chair
Members of the HAPS-EDucator Editorial Advisory Board provide advisory and support services to the HAPS-EDucator editor such as reviewing articles and proofreading the final draft of the HAPS-EDucator before it goes to press.

MEMBERSHIP SERVICES COMMITTEE
Kevin Petti, Chair
Dept. of Science & Health
Miramar College
10440 Black Mountain Rd.
San Diego, CA 92126-2999
(619) 536-7231
kpetti@sdccd.cc.ca.us

Committee members assist the Chair with recruiting members and compiling membership information.

NOMINATING COMMITTEE
Michael Glasgow, Chair
Anne Arundel Community College
Biology
101 College Parkway
Arnold, MD 21012-1895
(410) 777-2258
(410) 777-2525 Fax
MSGl Glasgow@aacc.edu

The committee chair is always the current President-Elect. The committee is responsible for recruiting nominees for the elected offices and appointed positions of the HAPS organization.

REGIONAL CONFERENCE COMMITTEE
Mary Bracken, Chair
Trinity Valley Community College
Biology Department
1200 East Interstate 20
Terrell, TX 75160
(972) 563-9573
bracken@tvcc.edu

The committee provides mentoring assistance to coordinators of regional conferences. Anyone interested in hosting a regional conference should contact the Chair.

SAFETY COMMITTEE
Karen McMahon, Co-Chair
University of Tulsa
Biological Science
600 S. College Ave.
Tulsa, OK 74104
(918) 631-3129
(918) 631-2762 fax
karen-mcmahon@utulsa.edu

Colleen Nolan, Co-Chair
St. Mary's University
Biological Science
One Camino Santa Maria
San Antonio, TX 78228-8511
(210) 431-4304
(210) 431-6746 fax
bionolan@stmarytx.edu

The Safety Committee is developing standards for safety in the laboratory.

TECHNOLOGY COMMITTEE
Tom Lancraft, Co-Chair
St. Petersburg Junior College
Natural Science
P.O. Box 13489
6605 Fifth Ave. N.
St. Petersburg, FL 33733
(813) 341-4797
lancraft@email.spjc.cc.fl.us

Jim Pendley, Co-Chair
Imperial Valley College
P.O. Box 158
Imperial, CA 92251
(619) 352-8320 x 303
pendley@imperial.cc.ca.us

The committee monitors and reports on technological changes influencing anatomy and physiology teaching, such as advances in instructional software and data acquisition equipment.

HAPS-EDucator - Summer 2002 - page 21