

**PROCEEDINGS OF THE ANNUAL CONFERENCE OF
THE AMERICAN ASSOCIATION OF VETERINARY
ANATOMISTS**

Western College of Veterinary Medicine
University of Saskatchewan

Saskatoon, Canada

June 22-24, 2006

Program

June 22, 2006

6.00 pm

**Welcome reception at the Marquis hall,
University of Saskatchewan campus**

June 23, 2006

Graduate student platform presentations (Room 2115, WCVM)

9.00 AM Dr. P. Malhi

**Effect of reproductive aging on meiotic
maturation of oocytes in cattle**

9.20 AM Dr. B. Bawa

**Neurodegeneration in cerebellar granule
cells of adult leaner mice**

9.40 AM Dr. K. Janardhan

**CD26/Dipeptidyl Peptidase IV
(CD26/DPPIV) in acute lung
inflammation**

10.30 AM

Coffee and snack break

11.00 AM

**Presentation by North Carolina
Biologicals (Anatomy Laboratory, WCVM)**

12.00 noon

Lunch in Alberta Room

Faculty presentations on Teaching (Room 2115, WCVM)

1.30 PM Dr. D. Sims

**Fixative-Glycocalyx Interactions in the
Vascular System**

1.50 PM Dr. L. Abbott

**Three dimensional modeling of the mouse
brain using the knife-edge scanning
microscope**

- 2.10 PM Dr. D. Sims **Difficult concepts made easy - integrating tissues & cells with a villus**
- 2.30 PM Dr. R. Henry **Survival: the challenge for providing a challenging course**
- 2.50 PM Dr. D. Sims **Whether or not to embrace virtual microscopy?**

.....
Coffee and snacks along with poster viewing and competition

- 3.00 PM M. Abrishami **Testis tissue xenografting as a novel tool for the study of testis function**
- C. Charvaryamath **Mechanisms of lung inflammation following exposure to swine barn air**
- C. Charvaryamath **Pulmonary angiogenesis following multiple swine barn air exposures**
- K. Janardhan **Integrin subunit $\beta 3$ in neutrophil recruitment in pneumococcal pneumonia**

Faculty poster presentation

- L. Sprunger **Assigned cadaver rotations enhance learning and collaboration in gross anatomy**
- RS. Sethi **Differentiation of adrenal gland during prenatal development in buffalo (*BUBALUS BUBALIS*)**

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6.00 PM **Banquet at Boffin's Club**
.....

June 24, 2006

9.00 AM **Tour of Wanuskevin and Western Development Museum**

Abstracts

THREE DIMENSIONAL MODELING OF THE MOUSE BRAIN USING THE KNIFE-EDGE SCANNING MICROSCOPE

Abbott LC*, Choe Y, Mayerich DM**, Keyser J**, Kwon J**, Melek Z** and McCormick B**.**

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Our long-term goal is to develop computational models of neurons and networks of the mammalian brain that accurately reflect how the brain functions. In order to be accurate, computational theories need to be based on real-life observations taken from neuroanatomical and neurophysiological measurements. A unique instrument developed by McCormick and colleagues, the Knife Edge Scanning Microscope (KESM), allows construction of multiscale datasets upon which neuroanatomical constraints can be systematically and globally collected. These types of detailed datasets will allow formulation of accurate computational models of the mouse brain. The KESM can scan an entire mouse brain at 300 nm resolution (600 nm in depth). We have developed several different methods of staining whole mouse brains that are subsequently embedded in plastic for sectioning. The first staining protocol we have developed uses the Nissl stain, thionin. We have immersion stained and perfused thionin into paraformaldehyde fixed mouse brain and then destained in 70% ethanol. The brains are dehydrated in ethanol and then acetone before being embedded araldite or epon. The second stain we have used on whole mouse brain is Golgi-Cox. We have made preliminary scans of thionin-stained and Golgi-Cox stained brain regions. In the future we will obtain global surveys of neuronal cell body distributions (Nissl), detailed neuron morphology (Golgi), and local circuit distributions (Golgi).

Supported by NIH/NINDS grant #1-R01-NS54252.

Presentation: Platform

Student Competition: No

Presenting Author: Louise C. Abbott

TESTIS TISSUE XENOGRAFTING AS A NOVEL TOOL FOR THE STUDY OF TESTIS FUNCTION

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Spermatogenesis especially in large animals and primates is difficult to study in situ. Testis tissue xenografting has recently offered a novel approach for the study and manipulation of spermatogenesis. In this method, small fragments of testis tissue from a variety of donor species are grafted under the back skin of immunodeficient mice, providing a suitable setting for the development of the grafted tissue and progression of spermatogenesis. We and other groups have produced viable and fertilization-competent sperm from immature mice, hamsters, pigs, goats, bulls, sheep, horses, cats and primates in a mouse host. Not only did xenografting of immature rhesus monkey testis tissue into mice result in complete spermatogenesis, but also the timing of testicular development was significantly accelerated. This, along with the survival of germ cells in grafts of adult human testis biopsies, points to the potential clinical strategy for restoring fertility in childhood cancer patients undergoing sterilizing therapy. This system also provided a previously unavailable system for production of sperm from sexually immature individuals of rare or valuable species. Because the morphological and functional integrity of the testis tissue is maintained in the graft, and the overall milieu of the host mouse is easier to manipulate, testis tissue xenografting provides an accessible laboratory model for the study of testis biology, endocrinology or toxicology for a variety of target species.

Supported by NSERC, SHRF

Presentation: Poster

Student Competition: Yes

Presenting Author: Mahsa Abrishami

NEURODEGENERATION IN CEREBELLAR GRANULE CELLS OF ADULT LEANER MICE

Bawa B and Abbott LC.

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We study leaner mutant mice, which carry an autosomal recessive mutation in the gene coding for the alpha1A pore-forming subunit of P/Q-type voltage-gated calcium channels (VGCC). P/Q-type VGCC are highly expressed by cerebellar neurons. Leaner mice exhibit severe ataxia and epilepsy. Leaner cerebellar granule cell death starts after postnatal day 10, but it is not known if the amount of granule cell death observed in adult leaner mouse is significantly different from wild type mice. We used TUNEL to visualize and quantify apoptotic cell death in leaner and wild type cerebellar granule cells. Alteration of calcium homeostasis, due to dysfunctional P/Q-type VGCC, can severely affect mitochondrial function leading to a cascade of events that eventually cause neuronal cell death. By using the mitochondrial and calcium indicator dyes, TMRM and Fura-2AM, we investigated calcium homeostasis and mitochondrial function in leaner granule cells. The central objective of this study was to determine the extent of cell death, calcium homeostasis and mitochondrial function in cerebellar granule cells of adult leaner mice. We observed a small but significantly higher number of apoptotic granule cells in adult leaner cerebella compared to wild type mice. Mitochondrial function was significantly reduced in leaner granule cells compared to wild type cells. However, no significant differences in calcium levels were observed.

Supported by CERH NIEHS P30ES09106 grant funds to LCA.

Presentation: Platform

Student Competition: Yes

Presenting Author: Bhupinder Bawa

MECHANISMS OF LUNG INFLAMMATION FOLLOWING EXPOSURE TO SWINE BARN AIR

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Swine farmers repeatedly exposed to the endotoxin-rich barn air report higher incidence of respiratory diseases. However, the in situ lung responses and the mechanisms involved are unclear. We hypothesized that, lung inflammation induced following barn air exposure is TLR4 dependent. We exposed C3HeB/FeJ (intact TLR4, WT) and C3H/HeJ (defective TLR4, mutant) either to the barn air (8 hours/day for 1 or 5 or 20 days) or ambient air. After every 5 days exposure, there was an interruption of two days to mimic occupational exposure pattern of swine barn workers. Following exposures (barn or air), airway hyper-responsiveness (AHR) to methacholine and bronchoalveolar lavage fluid (BALF) and lung tissue histology was analyzed. Both WT and mutant mice were similar in their AHR response ($P= 0.46$) following exposure and showed barn air exposure effect on AHR. Five day exposure induced higher AHR compared to control, 1 and 20 day exposure ($P < 0.01$), while control and 1 day exposed mice did not differ ($P > 0.05$). Following 20 exposure AHR was dampened to indicate an adaptive response. BALF total leukocytes were higher only in 1 day exposed WT mice compared to 1 day exposed mutant and WT controls, 5 and 20 day exposed mice. Septal neutrophilic influx was seen only in 1 and 5 day exposed WT mice while bronchiolar epithelial damage was seen in both the strains following 5 and 20 exposures. We conclude that swine barn air induced lung inflammation but not AHR, is regulated via TLR4.

Supported by Lung Association of Saskatchewan and CIHR's Strategic Training Fellowship in PHARE

Presentation: Poster

Student Competition: Yes

Presenting Author: Chandrashekhar Chandru

CD26/Dipeptidyl Peptidase IV (CD26/DPPIV) in acute lung inflammation

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CD26/DPPIV is expressed on the surface of lymphocytes, macrophages, and various epithelial and endothelial cells, as well as in a plasma soluble form. CD26/DPPIV promotes cell-cell and cell-ECM contacts, degradation of specific proteins and transendothelial migration of lymphocytes. CD26/DPPIV interacts with fibronectin to promote metastasis of tumor cells. As the function of CD26/DPPIV in acute lung inflammation (ALI) is presently unknown, we used wild-type (F344/Hann At Ztm) and CD26/DPPIV mutant (F344/CRL/GER; Karl et al., *Regulatory Peptides* 2003; 115:81-90) rats to elucidate its potential involvement. Rats were euthanized 9 hours after intratracheal instillation of *E. coli* LPS (250 µg). Semi-quantitative histology showed reduced ALI in the CD26/DPPIV mutant rats compared with the wild-type rats. Immunohistology with ED-1 antibody for monocytes/macrophages and HIS48 antibody for granulocytes showed reduced sequestration of these cells in the alveolar septa and alveolar spaces of mutant rats compared to the wild-type rats. However, both CD26/DPPIV mutant and wild-type rats had minimal granulocyte infiltration into the perivascular spaces of the lungs. Flow cytometry revealed higher percentage of granulocytes ($p < 0.001$) and monocytes ($p < 0.006$) in the peripheral blood of LPS-challenged CD26 mutants compared to the wild-type rats. To address the mechanisms of reduced ALI in CD26/DPPIV mutant rats, we used ELISA to determine concentrations of MCP-1, TNF- α and IL- β in lung homogenates from both the groups. The data showed no differences between the two groups in the concentrations of these inflammatory molecules ($p > 0.05$). These are the first data to demonstrate that CD26/DPPIV promotes migration of inflammatory cells in ALI. Because concentrations of MCP-1, TNF- α and IL- β were similar in the two groups, the data show that CD26/DPPIV promotes ALI independent of these pro-inflammatory mediators.

Supported by Natural Sciences and Engineering Council of Canada

Presentation: Platform

Student Competition: Yes

Presenting Author: Kyathnahalli Janardhan

SURVIVAL: THE CHALLENGE FOR PROVIDING A CHALLENGING COURSE

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Grade inflation is more rampant than economic inflation. Educators realize this but are unwilling to confront the issue. Ivy League schools also have recognized this issue. Princeton reported 46% A's in 2004, up from 31% in 1970. Since this report has surfaced, A's will be rationed, no more than 35% given. How can an 80% course average compete with an average of 92%? What is the ideal class average? Does your College have a suggested class average? Does anyone come close to that average? What can be done to protect junior faculty and allow them to maintain standards. Team taught courses have a disparity of effort put forth by students, especially when one member has a small % of the course. Should every test have to be passed for matriculation? Are pretest reviews that focus exclusively on exam questions ethical? Should students be given a major portion of the exam questions prior to the exam? Should tests be recycled yearly after they have been given back to students? Should questions routinely be thrown out? Are students brighter and better than twenty years ago? Should less be expected of our students? Is administration supportive of challenging courses even when students complain about the course? How can junior faculty, who have standards, survive in such an arena? The course average for anatomy since 1983 at Tennessee has been 80%. Percent A's per year 18.5%, B's - 47.8%, C's - 27.8%, D's - 5.2%, F's - 0.7. How can we survive? Do these issues need to be addressed?

Presentation: Platform

Student Competition: No

Presenting Author: Robert Henry

INTEGRIN SUBUNIT $\beta 3$ IN NEUTROPHIL RECRUITMENT IN PNEUMOCOCCAL PNEUMONIA

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Streptococcus pneumoniae(SP) is one of the most common causes of bacterial pneumonias in humans. Neutrophil migration into SP infected lungs is central to host defense. But the mechanisms of SP mediated neutrophil recruitment into lungs are not completely understood. Therefore, we assessed the role of an adhesion molecule, integrin $\alpha v\beta 3$, by evaluating the integrin's subunit $\beta 3$ in a mouse model of SP induced lung inflammation. Integrin subunit $\beta 3$ knockout ($\beta 3^{-/-}$) mice and the wild type (WT) mice were intratracheally instilled with either 50 μ l of SP (ATCC®6303; n=7/group) or saline (n= 4-7/group). Another group of WT mice were treated intraperitoneally with 25 μ g or 50 μ g of monoclonal antibody against integrin subunit $\beta 3$ (n=5) or with an isotype matched antibody (n=5), 1h before instillation of SP. All the mice were euthanized 24h after the treatments. Flow cytometry confirmed absence and presence of integrin subunit $\beta 3$ on peripheral blood neutrophils in the $\beta 3^{-/-}$ and WT mice, respectively. Bronchoalveolar lavage fluid (BALF) from $\beta 3^{-/-}$ mice and WT mice showed no difference in the number of recruited neutrophils. The number of neutrophils in BALF was less in $\beta 3$ -antibody+ SP treated mice compared to no-antibody+ SP treated mice. But, there was no difference between the isotype-antibody+ SP treated mice compared to $\beta 3$ -antibody+ SP treated mice. We conclude that integrin $\alpha v\beta 3$ is not critical for the neutrophil migration into the SP infected and inflamed lungs.

Supported by Natural Sciences and Engineering Council of Canada

Presentation: Poster

Student Competition: Yes

Presenting Author: Kyathanahalli Janardhan

PULMONARY ANGIOGENESIS FOLLOWING MULTIPLE SWINE BARN AIR EXPOSURES: ROLE OF TLR4

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Swine barn workers exposed to barn air suffer from lung dysfunction. Barn air contains endotoxin, gases, dust and bacteria. Because endotoxin is the ligand for TLR4, and TLR4 is involved in pro-angiogenic signaling we hypothesized that endotoxin influenced pulmonary angiogenesis in a TLR4-dependent manner. We studied the contribution of endotoxin in the barn air to pulmonary angiogenesis by exposing C3HeB/FeJ (wild-type) and C3H/HeJ (non-functional TLR4) mice to the barn air. Mice were exposed to barn air for 8 hours/day for 1, 5, and 20 days. Initiation of the inflammatory response was confirmed through differential leukocyte counts, with BALF and blood from wild-type mice exposed for one day showing higher total cell counts (macrophages, neutrophils and lymphocytes) compared to wild-type control and 20-day exposure groups ($p < 0.05$). Mutant animals showed no differences between groups suggesting TLR-4 dependent pulmonary inflammation following 1-day exposure. Vascular alteration was evaluated by expression of VEGF-A and two of its receptors, Flk-1 and Flt-1, and through vascular density analysis. Immunohistochemical staining showed no difference in VEGF-A or receptor expression between groups. ELISAs indicated slight decreases in VEGF in wild-type animals after 1-day exposure. Vascular density was increased in the septum of wild-type animals following 20-day barn air exposures, indicating a biological response to endotoxin in the barn air. These data suggest that TLR4 is involved in pulmonary angiogenesis following multiple barn air exposures.

Supported by PHARE and Toxicology Graduate Scholarship

Presentation: Poster

Student Competition: No

Presenting Author: Vanessa Juneau

EFFECT OF REPRODUCTIVE AGING ON MEIOTIC MATURATION OF OOCYTES IN CATTLE

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We tested the hypothesis that oocyte meiotic maturation is compromised in old cows and studied the role of LH in meiotic maturation. In Expt 1, mother-daughters (14-15 yr and 3-5 yr old, n = 7 pairs) were superstimulated with FSH in the presence of CL. Follicles were aspirated from right and left ovary on wave Day 5 and 6 i.e. before and after LH treatment. In Expt 2, mother-daughters (n = 10 and 12) were superstimulated. Luteolysis was induced on wave Day 3.5 followed by LH 32 hr later. Follicles were aspirated 18 hr after LH and COC were matured in vitro for 6 hr. Oocyte meiotic stage was evaluated after aceto-orcein (Expt 1) or giemsa staining (Expt 2). Data were compared by t-test and Chi-Square test. Circulating LH and P4 did not differ ($P > 0.4$) between age groups. In Expt 2, old cows had fewer ≈ 6 mm follicles (30 ± 3 vs. 47 ± 5 ; $P = 0.01$) at oocyte retrieval than young, but the difference was not significant in Expt 1 (27 ± 6 vs. 38 ± 3 ; $P = 0.12$). In Expt 1, $>90\%$ of oocyte recovered from old and young cows before or after LH exposure were in GV/GVBD stage. In Expt 2, old cows had more expanded COC (68/182 vs. 95/350, $P = 0.02$) and a tendency for more MII oocytes (69/115 vs. 101/203, $P = 0.08$) than young cows. LH treatment after luteolysis (Expt 2) resulted in a more MII oocytes (170/318 vs. 2/66; $P < 0.01$) than LH treatment during a high P4 phase (Expt 1). Thus oocyte meiotic maturation 1) was not compromised with age, 2) improved with luteolysis before LH treatment.

Supported by NSERC

Presentation: Platform

Student Competition: Yes

Presenting Author: Pritpal Malhi

PARTIAL CHEMICAL CHARACTERIZATION OF AN OVULATION-INDUCING FACTOR PRESENT IN THE SEMINAL PLASMA OF LLAMAS

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The objective of the study was to characterize the chemical structure of an ovulation-inducing factor present in the seminal plasma of llamas. Llama semen was centrifuged at 4000 g for 35 min to obtain seminal plasma. In Experiment 1, females were assigned randomly into 4 groups to receive 2 ml of llama seminal plasma i.m (n=7 per group) treated with: 1) 500 µg/ml of proteinase-K at 38C for 1 h, 2) dextran:charcoal at 4C for 12 h, 3) heat treatment at 65C for 1 h, or 4) seminal plasma incubated at 38C for 1 h (Control Group). Llamas were examined daily by ultrasonography until Day 2 (Day 0=treatment) to detect ovulation, and again on Day 8 to detect the presence of a corpus luteum (CL). In experiment 2, female were assigned randomly to receive 2 ml of llama seminal plasma i.m (n=10 per group) treated with: 1) 500 µg/ml of pronase-E at 38C for 12 h, or 2) seminal plasma incubated at 38C for 12 h (Control Group) Llamas were examined as described in experiment 1. Data were analyzed by ANOVA and Chi-Square analysis. In experiment 1, ovulations were detected in all the females from each treatment group and CL was detected in all ovulated females. In experiment 2, ovulations were detected only in the Control Group 9/10 versus 0/10 from pronase-E group. CL was detected in all ovulated females from the Control Group. In conclusion only llama seminal plasma treated with pronase-E was able to abolish the bioactivity of OIF suggesting that this factor is a protein molecule.

Presentation: Poster

Student Competition: No

Presenting Author: Marcelo Ratto

DIFFERENTIATION OF ADRENAL GLAND DURING PRENATAL DEVELOPMENT IN BUFFALO (*BUBALUS BUBALIS*)

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The adrenal glands from 43 buffalo foetuses ranging from 39 mm to 890 mm Crown Rump length (CRL) were used for the study. The earliest primordia of glands were situated between the mesonephros as a mass of mesenchymal cells without any connective tissue capsule at 39mm CRL stage, however, the primordia became triangular in shape at 57mm CRL stage. The neuroectodermal cells (primordial medullary cells) started migrating into the adrenal primordia by 80mm CRL and onward stages and gland was differentiated into cortex and medulla by 109mm CRL stage. The gland was fully encapsulated in the fibrous tissue, predominantly made up of collagen fibres by 210mm CRL stage. The connective tissue trabeculae arose from the inner aspect of the capsule and pierced cortical parenchyma of the gland to reach the medulla along with the medium sized blood vessels and nerve fibres by 250mm CRL stage. In 300mm to 375mm CRL stages the cortex was further differentiated into definite and foetal cortex. The adrenaline and nor adrenaline secreting cells were identified in the outer and inner zone of the medulla, respectively by 210mm and onwards stages. The capsule of the gland became fibromuscular and had high proportion of collagen fibres intermingled with the reticular fibres, smooth muscle cells and a good number of blood vessels and nerve fibres in 470mm CRL and onward stages. The intensity of the migration of the neuroectodermal cells decreased with age but migration continued even unto 890mm CRL stages. The medulla occupied a greater proportion of the gland. The foetal cortex and inner medullary zone were the main constituents of the cortex and medulla, respectively.

Presentation: Poster

Student Competition: No

Presenting Author: RS Sethi

FIXATIVE-GLYCOCALYX INTERACTIONS IN THE VASCULAR SYSTEM

Sims DE

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Carbohydrate complexes are integral to the functioning of many lipids and virtually all proteins, but have been difficult to maintain for ultrastructural analysis. A popular explanation is that carbohydrates are not bound by aldehydes, and dissolve in the aqueous buffers used during fixations. An alternative method of preservation, known as non-aqueous fixation, was created to maintain carbohydrate complexes in situ. The objectives of this study were to determine if non-aqueous fixation could preserve vascular glycocalyx, and to describe its ultrastructure. Glycocalyx is implicated in vessel permeability, signaling for recruitment of leukocytes, and antioxidation functions.

The aortas of anesthetized rats were briefly perfusion-cleared with buffered saline, then exposed to one of seven different treatment protocols. These included immediate fixation with non-aqueous fixative or conventional glutaraldehyde-based fixation, post-fixation with glutaraldehyde after non-aqueous fixation, and varying lengths of delays in processing after fixation. Results indicate that glutaraldehyde fixative, applied initially or after non-aqueous fixative, removes the glycocalyx. Conversely, non-aqueous fixative preserves a distinct glycocalyx that is resistant to decay or deterioration in fluorocarbon. Preserved glycocalyx conforms with predicted dimensions, being up to 500-600 nm in height, with a lattice-like appearance consistent with long strands of polymeric carbohydrates.

Presentation: Platform

Student Competition: No

Presenting Author: David Sims

DIFFICULT CONCEPTS MADE EASY - INTEGRATING TISSUES & CELLS WITH A VILLUS

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A digestive tract villus is an excellent example of reticular connective tissue containing many types of defensive cells, smooth muscle, lymph vessels and microcirculation, without the complication of heavy connective tissues. The defensive cells are typically organized in a fashion that links structure and function. If the specimen comes from an older animal, hemosiderin inclusions in the macrophages help students to feel more confident about the roles of phagocytes. The epithelium of the villus is easy to appreciate, yet contains mitotic figures, transitory lymphocytes and goblet cells.

This talk will describe how a villus can be used early in the first semester of histology, well before the digestive tract is covered, to integrate many diverse functions other than digestion.

Presentation: Platform

Student Competition: No

Presenting Author: David Sims

WHETHER OR NOT TO EMBRACE VIRTUAL MICROSCOPY?

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Virtual microscopy is to histology what web-based maps are to cartography. Large images (usually stored as jpeg files) are rapidly delivered from a web server to a computer screen in small packets, so that a viewer can select whatever part of an overall image is desired, at various levels of magnification. In the case of histology, the third dimension, the so-called z-plane, can also be included. Depth of focus allows for thorough examination of the parts of an embryo, parasite, or even a 5 micrometer tissue sample.

Virtual microscopy is still in early stages of evolution. In this demonstration and discussion session, advantages, problems, and practical experiences with virtual microscopy will be assessed.

Presentation: Platform

Student Competition: No

Presenting Author: David Sims

ASSIGNED CADAVER ROTATIONS ENHANCE LEARNING AND COLLABORATION IN GROSS ANATOMY

Sprunger LK

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Traditionally, dissection-based anatomy courses assign a specimen to a group for the entire course. Despite encouragement to examine other specimens to appreciate of normal variations, most students spend little time doing so. For four years, we have rotated cadaver assignments such that each group studies a different specimen each lab session. The cadaver rotation system has several important benefits. 1) Students review material in lab more frequently, as a brief review is required to orient to the new specimen before proceeding each day. 2) The quality of the dissections is not adversely affected and may improve somewhat. Less skilled dissectors strive to improve their skills to match that of their peers, and students try to be more careful with shared material. 3) Students develop a much better understanding of normal anatomical variation. 4) The system helps foster a sense of collaborative work, as the cadavers are viewed as a collective resource. It is important that students appreciate the contribution of the cadavers to their education. The rotation system has not led to a devaluing of the cadavers; on the contrary, the students' perception is broadened to an appreciation that all of the cadavers make an essential contribution not just to their own education, but that of their colleagues as well. The system is simple to implement, costs nothing, and has been perceived as highly valuable by all faculty and instructional staff and an overwhelming majority of students.

Presentation: Poster

Student Competition: No

Presenting Author: Leslie Sprunger

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