REGIONAL MEETING
NOVEMBER 4, 2017 – DUQUESNE UNIVERSITY, PITTSBURGH, PA

ABSTRACTS – POSTER PRESENTATIONS
SORTED BY POSTER BOARD

Implications of Nerve and Vessel Anastomosis in Wrist and Palmar Injury
Derek W. Altema, Janine M. Ziermann; Dept. of Anatomy, Howard University College of Medicine, Washington, DC

Distal arteries and nerves on the upper extremity often form connecting arching structures, which are called anastomoses. In the hand, the superficial palmar arch supplies blood to most of the palmar aspect of the hand, and commonly forms an anastomosis of the ulnar artery with the radial artery. Communications also occur with nerves. The median and deep ulnar nerves innervate the lateral and medial palmar hand muscles, respectively. In the thenar compartment, a few muscles were reported to be innervated by both of those nerves and a nerve fiber exchange was reported near the carpal tunnel. Connections between major arteries and nerves may ensure dual blood supply and/or innervation of different muscles of the hand. We aim to quantify common variations in vascular anastomosis or innervation patterns that may be important for surgical procedures after hand injuries. Gross dissections are performed on fixed cadaver hands, and the courses of major arteries and nerves are carefully followed into the palmar aspect of the hands. Common variations include the superficial palmar arch, which may present as an incomplete arch formed by the ulnar artery, or a complete arch with a contribution from the radial artery near the second digit. Furthermore, the median nerve may receive a contribution from the deep ulnar nerve just distal to the flexor retinaculum. A better understanding of the variability in blood supply and innervation of the palmar aspect of the hand can lead to improvement of surgical techniques and better outcomes following injury.
Level of First Author: Graduate/Medical Student **Topic Category: Anatomy Education**
Poster Board # 1

Use of Ultrasound to Teach Living Anatomy to Graduate Students
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Ultrasound technology is used to reinforce gross anatomy instruction in many medical sciences programs. However, this technology has not transferred into common practice for anatomy instruction in non-medical graduate courses. Ultrasound sessions could help students transfer anatomy from didactic content onto a living body to assist with spatial understanding, knowledge retention, and student engagement. Our main objective of this study was to determine the efficacy of ultrasound sessions in order to achieve better comprehension and retention of gross anatomy.
We tested our hypothesis with two cohorts of students (n=48) in a graduate gross anatomy course. During the course, students participated in three interactive, two hour long ultrasound sessions. At the end of the course, they took a final exam to evaluate their content mastery, and filled out a survey to assess their learning experience and interest level in the sessions. The survey results were analyzed and the words and phrases used most frequently to describe the sessions were collected.
Results from the final exam showed an appropriate level of comprehension for a graduate anatomy course. Survey analysis demonstrated that there was an overwhelmingly positive response to how well the sessions aided anatomy comprehension. The students unanimously “agreed/strongly agreed” that ultrasound technology should be used

for anatomical instruction for graduate students. Free response data showed that while students found the sessions to be helpful, they sought more and longer sessions, and smaller group sizes. This study supports the idea that using ultrasound technology to reinforce gross anatomy to graduate students could be an effective and engaging method of instruction.

Level of First Author: Graduate/Medical Student **Topic Category: Anatomy Education**
Poster Board # 2

A Prosection Technique Preserving and Displaying both External Musculature and Visceral Organs

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As health-related career opportunities are in demand and relevant educational tracks continue to diversify, the demand for anatomy instruction is outstripping the ability of many institutions to provide meaningful laboratory experiences. For example, the University of Indianapolis offers full or partial cadaver dissection for more than 100 students per year in four doctoral and masters programs while also teaching anatomy courses to several hundred students per year ranging from freshman to graduate level. Dissection of common animals has some value, but specimens are becoming increasingly more expensive and sometimes difficult to obtain, while full cadaver dissection exceeds both the instructional time available and our physical facilities.

Cadaver prosection provides a compromise for time investment by students and expense and laboratory facilities for the institution. However, dissection is inherently destructive. It is often impossible to display both superficial and deep structures on a single cadaver. We describe a procedure that preserves a prosection of the musculature of the body wall while also providing access to the visceral cavities in anterior approach. We suggest this is a particularly useful approach for students in sports medicine fields that emphasize musculoskeletal anatomy but still desire an introduction to major internal organs.

Level of First Author: Graduate/Medical Student **Topic Category: Anatomy Education**
Poster Board # 3

Prospective Utilization of 3D Skull Scans in and out of the Anatomy Laboratory

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The anatomy of the skull (i.e., cranium and mandible) is relatively complex compared to other skeletal structures and often is a challenge for the anatomy student to learn. Aside from the inherent complexity of the skull, other factors may influence the ability of the anatomy student to learn the skull including limited laboratory access to skulls, damage to skulls, anatomical variations, and the lack of depth perception from textbook images. Therefore, this research makes note of potential pitfalls and benefits of "traditional" methods used to learn the anatomy of the skull and compares them with potential pitfalls and benefits of the incorporation of three-dimensional (3D) scanned skull images into the curriculum. Examples of 3D scans are presented to illustrate potential utilization of 3D scanned skulls into the curriculum. Based upon the observations of this research, we hypothesize that the incorporation of 3D skull scans into the curriculum would provide more learning benefits for the student when compared to "traditional" methods alone. Further quantitative study is needed to test the hypothesis.

Level of First Author: Undergraduate Student **Topic Category: Anatomy Education**
Poster Board # 4

Was It Worth It? The Value of Undergraduate Human Gross Anatomy Lecture and Laboratory Courses as Preparation for Medical School: The Perspective of First and Second Year Medical Students

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Gannon University offers undergraduate human gross anatomy lecture and laboratory courses every semester. These courses are often taken by students planning to matriculate to medical schools. While these courses are rigorous and therefore stressful at times, anecdotal evidence over the years has suggested that our students greatly

appreciate having taken these courses once they take their professional gross anatomy courses. In an effort to gauge student-perceived value of our courses, as well as compare the content covered in our courses against what is taught in medical schools, we collected data from first and second year medical students who had previously taken these courses at our institution via an IRB-approved Survey Monkey survey. Data revealed that the alumni felt better prepared for medical school having taken these courses, and that the depth of the material we cover in many sections of our courses is comparable to that covered in their initial medical school human gross anatomy courses. All respondents indicated that they would recommend these courses to future pre-medical students at Gannon. This information provides concrete evidence that our courses equip our students for success in medical school. Research support for this study was provided by a Gannon University Faculty Research Award
Level of First Author: Faculty **Topic Category: Anatomy Education**
Poster Board # 5

Early Human Fetal Period: Dissection and Photographic Atlas
Mary Richarmé McGinn, Ph.D., Daniel Olson, Ed.D, Moira Jenkins, M.S., D.C., Karen Samonds, Ph.D.; Dept. of Biology, Northern Illinois University, DeKalb, IL

Although Embryology is usually part of a core curriculum in Human Anatomy programs, most visuals used for Embryology are drawings, as photographs of cadavers in early stages of development are rare. The purpose of this project was to create a photographic atlas of the early fetal period for use in a graduate Embryology curriculum as supplemental material. Three male human cadavers, aged 12, 15 and 18 weeks post-conception, were dissected and photographed. The primary focus was the viscera of the thorax and abdomen, with a secondary focus on the bones and nervous systems. Tools used included a #10 scalpel, micro-forceps, household scissors, and straight pins; a D-500 digital camera with 16x macro-lens allowing for extreme close-ups; and an Acculab V-600 scientific scale to weigh viscera and compare them to published normal values. The range in subjects' ages allowed for comparisons of the development of specific structures through time, and was particularly informative for displaying the rapid and differential growth that are characteristic of this period. This atlas, currently in use at Northern Illinois University, has helped students make connections between the Embryology they learn in the classroom and the hands-on engaged learning in the cadaver lab.
Financial support was provided by the Dept. of Biology at Northern Illinois University, DeKalb, IL.
Level of First Author: Faculty **Topic Category: Anatomy Education**
Poster Board # 6

Exposing Our Roots: A Graduate Level Course in the History of Anatomy
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The chronology, global context, and impact of anatomy throughout history can provide context and foundational knowledge to anatomists in training. Courses that expose anatomists to their roots however, are few. A search of course catalogs for known graduate anatomy programs (n = 41) revealed only five with a course in the history anatomy (n = 1) or medicine (n = 4). In preparing a new graduate level course on the history of anatomy, several articles and texts were reviewed for content related to the evolution of education, illustration, research, and ethics in anatomical sciences. Classroom and online dialogue, debates, and written assignments were selected to help students develop their communication skills as well as a deeper understanding of anatomy history. The course syllabus includes examination of prehistoric anatomical knowledge, to anatomy in Ancient Rome through anatomy in the modern era, as well as the future of anatomy, including the use of novel imaging modalities and advancing technology. Ultimately, this course is designed to review the roles education, illustration, research, and ethics played in the historical development of the field of anatomy while facilitating the development of professional communication skills. The past truly can help one appreciate the present, and work to develop the future.
Level of First Author: Graduate/Medical Student **Topic Category: Anatomy Education**
Poster Board # 7

Using Virtual Dissection Approach to Teach Post-traumatic Stress Students

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Human gross anatomy, generally the central course in the curriculum of first-year Allied health students, comprises lecture material and laboratory dissection of the cadaver. This abstract is a case report where an Occupational therapist (OT) student was suffering from *post-traumatic stress disorder* (PTSD). One of the OT students was honorably discharged from the Army and rated as a 40% disabled veteran due to tinnitus and an adjustment disorder that was mixed with anxiety and depression, these problems starting becoming apparent after his deployment from Afghanistan where he did experience seeing casualties and soldiers who did die. War and environmental tragedies have been the prototypic stresses leading to PTSD. He began to have more problems once the abdominal dissections were started as his loved one died of colon cancer so this warranted some unwanted memories, the noise of over 100 students was unbearable as he couldn't comprehend what his faculties would say. Some days, the cadavers also brought back memories of his time in the Army. As the anatomy component was a requirement, an alternate virtual approach was given to this student as he was very determined to finish his coursework. Exam quiz for structure identification was created as presets and the student was allowed ample time to identify and answer the structures. The main learning goal of introducing cadaver-specific virtual dissection scans is to improve the students' 3D spatial understanding of general gross anatomy. We believe that those teaching Anatomy teaching modernizations should identify this process of adjustment, and view it as a prospect to begin the expansion of a sensitive and mature professional approach toward this most difficult problem.

Level of First Author: Faculty **Topic Category: Anatomy Education**
Poster Board # 8

Using 3D Printing to Increase Critical Thinking in Pre-Medical Students

Lis K. Regula, Dept. of Biology, University of Akron, Kent, OH

I have been working with students in my Human Anatomy for Biology Majors lab to 3D print anatomical models. These models are used as learning tools in the class, similar to the models produced by manufacturers like 3M Scientific. As part of the lab, students choose a structure in the body that their group would like to learn in greater detail, or that they feel the need to study more in depth (often because of the complexity of the structure). The students then work in their groups to determine what parts of the structures they want to address, and how they want to describe the parts and the whole of their structure. While the content of these models are important in the Human Anatomy class, the process is also critical. Learning something well enough to teach it to someone else assures that students learn that topic inside and out, and improves retention of the material considerably. Creating a model is not the same as teaching, which is why each group is tasked with producing a key or worksheet to go along with the model. This gets us closer to having peer teaching experiences and not quite all the way there, but this is a work in progress at the moment. Additionally, encouraging students to actively think about how to depict anatomy- what parts to include or leave out, how they fit together, how to draw attention to key features and distinguish one part from another- helps them understand the human body in better detail than any text book image or pre-made model could hope to do.

Support for this project came from the University of Akron Biology Dept. and Bierce Library.

Level of First Author: Faculty **Topic Category: Anatomy Education**
Poster Board # 9

First Forays: Incorporating 3D Technology into Undergraduate-Level, Allied Health Gross Anatomy Courses

Claire Werner, Alexandra Bono, Kimberly Szucs; Dept. of Physical Therapy and Dept. of Occupational Therapy, Duquesne University, Pittsburgh, PA

Recently, the gross anatomy faculty at Duquesne University implemented the inclusion of Z-Space, a 3D anatomy application, as a supplement to cadaver-based gross anatomy courses for students enrolled in allied health departments, all of whom are at the undergraduate level. Because technology can be expensive to procure, maintain, and update, an accurate understanding of how 1) it is implemented and 2) used by students is important. As the students use this new technology, our research will examine how implementation in our undergraduate-level, allied health gross anatomy courses compares to implementation in medical and dental schools. In addition, we are interested in our students' willingness to use technology to augment traditional cadaveric dissection. Long term, this research could reveal whether anatomy courses have a strong need or use for technology in the anatomy lab setting. In order to address comparative implementation, the first author collected responses to a set of questions posed to course directors of medical school, dental school, and allied health gross anatomy courses. These questions were designed to ascertain how much technology was incorporated into cadaver-based gross anatomy courses. Preliminary results reveal that technology is not the primary focus in any of the questioned programs, but there was great variation in use of supplementary technology. Overall, technology appears to be more of an optional supplement to the dissection portion of the courses as opposed to becoming a replacement for cadaveric-based instruction. The next phase of our research is to survey students in these courses to ascertain their attitudes on using supplementary technology and whether they in fact use it on a regular basis.

Level of First Author: Graduate/Medical Student **Topic Category: Anatomy Education**
Poster Board # 10

The Incidence of Fibularis Digiti Quinti Tendon in a Cadaveric Cohort with Anthropological and Clinical Considerations

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From a cohort of 26 cadavers dissected by podiatric-medical students for a lower-extremity anatomy course, we observed bilateral and robust fibularis digiti quinti (FDQ) tendons in a 99-year-old female. Here, we describe the case, the incidence of the FDQ tendons in the cohort, and discuss the anthropological and clinical significance of our findings. In both feet of our case, the FDQ tendon arose from the fibularis brevis tendon proximal to the lateral malleolus, but did not separate completely from the fibularis brevis tendon until passing through the inferior fibular retinaculum. On the lateral dorsum of the foot, the FDQ passed through a third fibular retinaculum formed by the fibularis tertius tendon, and inserted onto the extensor sling of the fifth digit. Our case is considered fully present FDQ. Of the 52 limbs dissected in the cohort, 17 limbs (33%) showed a fully present FDQ, 20 limbs (38%) exhibited an FDQ in a rudimentary form, and 15 limbs (29%) lacked an observable FDQ. Human bipedality requires less dexterity than that of nonhuman primates in the routine use of hindlimbs. Therefore, we interpret the high variability of the FDQ, including its absence in many feet, as a relaxation of natural selection maintaining this trait since the divergence of human ancestors from African apes. The clinical significance of our findings suggests that the presence of a fully developed FDQ anomaly could result in irritations of the 5th toe due to excess abduction. In addition, physician awareness of the FDQ would be important during surgery.

Research supported by Kent State University College of Podiatric Medicine.

Level of First Author: Podiatric Medical Student **Topic Category: Gross Anatomy**
Poster Board # 11

Third Molar Agenesis: Prevalence and Asymmetry in Northern Chinese Archaeological Populations

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Eruption of the third molars (M3) is often used in anthropological studies to assess adult versus subadult age; however, incidences of M3 agenesis vary among modern human populations. Samples of Asian ancestry, for example, tend to have higher frequencies of M3 agenesis. Here, we present frequencies for mandibular and

maxillary M3 congenital-agenesis in archaeological samples from Northeast China (n=148). Agenesis was determined where no third molar, alveolar sockets, and/or resorption were apparent, as independently assessed by two researchers (LB, MK); cases that could not be resolved were not included in counts. Overall, 48 individuals (32.34%) were congenitally missing at least one M3; three individuals (3.57% of 84 individuals where all four could be assessed) were missing all four M3s. Comparing the upper and lower jaws, agenesis of the maxillary M3 (34.12%) was slightly higher than mandibular (24.35%) agenesis (X^2=10.797, p=0.001); comparing right and left sides, 7.45% (n=94) were missing both left M3s, while 8.70% (n=92) were missing both right M3s. Right and left asymmetry were also noted in that the right maxillary M3s presented highest the frequencies of agenesis (21.37%), followed by the right mandibular M3 (19.17%). Chi-Square tests indicate dependency in right and left agenesis (X^2=43.338, p<0.0001). Qualitative assessment of internal structures with associated computed tomographic scans, as well as structural-functional implications of M3 agenesis, are also discussed.

Level of First Author: Faculty **Topic Category: Gross Anatomy**
Poster Board # 12

Hepatic Morphology: Variations and Its Clinical Importance

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Emergent technologies and advances in the fields of diagnostic radiology and gastroenterology have created a need to better understand the morphological features of the liver. Variations in these features are a potential source for diagnostic errors, which can lead to costly follow-up testing and detrimental health outcomes. In the present study, the morphological features of human cadaveric liver specimens were evaluated via macroscopic examination and measurements to asses for variations in accessory fissures/sulci, accessory lobes, and the pons hepatis. The study was conducted on 33 specimens obtained from cadavers utilized for routine dissection for first year medical students in the 2016-2017 academic year in the Department of Clinical Anatomy and Embryology at the Touro College of Osteopathic Medicine. Out of 33 specimens, 12 were considered normal without any accessory fissures, lobes, or presence of a pons hepatis. 21 livers had 1 or more morphological variation, which included but not limited to: multiple accessory fissures, Riedel's lobe, and varying degrees of pons hepatis. The study aims to bring greater light to the field of hepatic morphology and its variations.

Research support was given by Touro College of Osteopathic Medicine, New York, NY.

Level of First Author: Graduate/Medical Student **Topic Category: Gross Anatomy**
Poster Board # 13

The Development & Evolution of the Multi-Chambered Heart in Vertebrates

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The human heart is a complex four chambered structure derived developmentally and evolutionarily from a simple tube-like structure. Its complexity of development makes the heart vulnerable to a number of morphological and functional defects that can effect each of its four chambers, the outflow and inflow vessels, and the septa in between atria and ventricles. Here we have dissected a multitude of vertebrate hearts, each containing chambers differing in number and structure. Our study supports previous views that the vertebrate heart evolves from a simple tube with contractile regions in lampreys, through different chamber types and forms in fishes, to the three chambered heart in amphibians to the four chambered heart in mammals. The mammal heart develops from an extremely simple tubular structure through folding, fusion, and separation of its parts into a four chambered mammalian heart, paralleling in its ontogeny its phylogeny. This shows us that as vertebrates evolve from respiration in water to that in air the heart adapts to shunt that oxygenated and deoxygenated blood properly and pump it more efficiently throughout the body. Understanding the evolution of the vertebrate heart provides insights into developmental mechanisms. This will also help to understand many congenital anomalies, such as Tetralogy of Fallot, Ventricular Septal Defects, etc. Our research may therefore contribute to understanding such

defects and to developing diagnostics, treatments, or therapy suggestions.
Source of research support provided by Howard University College of Medicine.
Level of First Author: Graduate/Medical Student **Topic Category: Gross Anatomy**
Poster Board # 14

Anatomical Analysis of Musculoskeletal Anomalies in a Trisomy 13 Fetus Due to Delayed Development
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Patau syndrome (Trisomy 13, T13) is a chromosomal polyploidy that occurs in about 1 in 16,000 newborns. Studies on the anomalies of individuals with T13 focus on polydactyly and cleft palate, however, there is scarce information regarding soft tissues. Here we compare musculoskeletal anomalies found in a T13 male fetus to those of other fetuses with congenital abnormalities, particularly T18 and T21. The fetus died at ~19w gestation with a deep cleft palate, hypertelorism, polydactyly and clinodactyly. Dissections revealed further anomalies, including the absence and fusion of muscles. Moreover, many of the anomalies/variations found were similar to those found in the karyotypically normal population and other trisomic specimens. Palmaris longus and plantaris, which are often absent in the normal population, were bilaterally missing in the T13 fetus, as often observed in T18 and T21 fetuses as well. In addition, some of the anomalies found support previous reports on general developmental delay in individuals with trisomy. These findings include poor differentiation of individual facial muscles such as zygomaticus and non-differentiation of the risorius. A delay may explain the non-differentiation of many muscles in the upper limbs including non-separation of the biceps brachii heads. Apart from anomalies associated with such a delay, abnormal fusions between muscles that derive from completely different primordia, such as in the deltopectoral complex, were noted. Although this fetus has polydactyly, there were no tendons inserting onto the extra digit in either hands or feet, contradicting the 'nearest neighbor' model from Evo-Devo studies. The major evolutionary and medical implications of these findings will be discussed.
Level of First Author: Graduate/Medical Student **Topic Category: Gross Anatomy**
Poster Board # 15

The Location of the Infraorbital Foramen Relative to the Inferolateral Piriform Aperture and the Inferolateral Orbit
Lauren E. Hartnell[1], Layne S. Hartnell[1], Sarah E. Bodnar[1], Aaron W. Koons[1], Matthew J. Zdilla[1,2]; [1]Dept. of Natural Sciences and Mathematics, West Liberty University, West Liberty, WV; [2]Dept. of Graduate Health Sciences, West Liberty University, West Liberty, WV

The location of the infraorbital foramen (IOF) is important for infraorbital nerve block procedures. Oftentimes, the teeth are used as reference points for infraorbital nerve block procedures; however, there is variation in IOF location relative to teeth. Therefore, other methods of identifying the IOF location may be of benefit to infraorbital nerve block procedures. This report assessed the location of the IOF relative to the inferolateral piriform aperture and the inferolateral orbit in 456 adult (3rd decade and older) crania. A total of 844 sides (416 left and 428 right) were analyzed. The average distance of the IOF from a midpoint between the piriform aperture and orbit was 3.35±1.79mm (Mean±SD) among all sides (Left: 3.27±1.79mm; Right: 3.43±1.79mm). A paired t-test revealed statistically significant difference between left- and right-sided IOF locations relative to the midpoint ($t(387)=-2.02$; $p=0.04$). The difference in means was 0.19mm. These findings suggest that, the utilization of landmarks on the piriform aperture and the orbit to determine the location of the IOF my serve as a useful adjuvant method for locating the IOF.
Supported by the WV Research Challenge Fund [HEPC.dsr.17.06]
Level of First Author: Undergraduate Student **Topic Category: Gross Anatomy**
Poster Board # 16

Estimating Masticatory Muscle Mechanical Efficiency Using Northern Chinese Archaeological Samples

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Estimating overall masticatory efficiency in human skeletal populations has far-reaching implications for the fields of anthropology, bioarchaeology, and paleopathology. It is hypothesized that changes in dietary patterns result in measurable craniofacial variation among these populations, with certain diets (i.e., agriculture) resulting in decreased masticatory demands, thus leading to reduced craniofacial robusticity. This study uses skeletal remains from seven Northern Chinese and Mongolian archaeological samples (n=121 individuals) of varying subsistence patterns (agriculture, hunting-gathering, nomadic pastoralism) to estimate masticatory muscle efficiency using traditional craniometrics and novel models to estimate masticatory efficiency and bite force. One-way ANOVA tests show significant differences between the three subsistence patterns in mean cross-sectional area (CSA) of the temporalis muscle ($F=4.23$, $p< 0.01$), and no significant differences between CSA of the masseter ($F=2.14$, $p= 0.110$) or medial pterygoid ($F= 2.20$, $p= 0.124$). However, by including novel estimates of masticatory muscle efficiency, such as bite-force lever arms, muscle physiological cross sectional area, bite stress, and effective mechanical advantage, this study found significant differences ($F=4.02$, $p= 0.013$) between groups practicing agriculture and those practicing hunting-gathering and/or pastoralism. These results suggest that models that incorporate physiological and bite force modeling better estimate overall masticatory efficiency than traditional craniometrics alone, and demonstrate the need for novel techniques in estimating overall masticatory function in past populations.

Level of First Author: Postdoctoral Researcher **Topic Category: Gross Anatomy**
Poster Board # 17

Costal Cartilage Harvesting and Grafting for Use in Facial Reconstructive Surgery: A Comparison between Females and Males

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Facial reconstruction surgeries often require the harvesting and grafting of costal cartilage. However, little information exists regarding the optimal cartilage for use in the various reconstructions. The most commonly harvested cartilages are the fifth, sixth, and seventh. Because grafts, by their nature, have a requisite size that must be compatible with the size of the grafting site, the question of which cartilage is optimal to harvest may be one answered by assessing the size differences among costal cartilages. Therefore, this study assessed 312 fifth, sixth, and seventh cartilages from 20 female and 32 male cadaveric ribcages for anatomical comparison. The fifth costal cartilage offers the smallest measurements in terms of area and length (Mean±SD) for both females (1119±248.8mm2 and 69.48±10.29mm) and males (1525±353.1mm2 and 79.67±14.62mm). The seventh costal cartilage offers the largest surface area and total length measurements among both sexes (Females: 1836±271.1mm2 and 123.4±14.62mm; Males: 2390±409.3mm2 and 137.5±20.49mm, respectively). Males consistently provided greater measurements in nearly all parameters studied. However, there was no significant difference between the sternum-to-curve length of the 5th cartilage ($t(50)=1.579$; $p=0.1205$) or the rib-to-curve length of the 7th cartilage between sexes ($t(50)= 0.9609$; $p=0.3412$). Therefore, females can afford, on average, less cartilage to harvest than males. The information provided in this study will aid surgeons in making informed decisions in their pre-surgical planning of costal cartilage harvesting and grafting.

Level of First Author: Undergraduate Student **Topic Category: Gross Anatomy**
Poster Board # 18

The Width of the Marginal Tubercle: Implications for Neurosurgery

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The processus marginalis or marginal tubercle occurs in most crania along the posterior aspect of the frontal process of the zygomatic bone. The marginal tubercle can be drilled in standard mini pterional craniotomy to enhance exposure. Surgical difficulty is encountered with tubercles greater than 13mm in width, in which case drilling of the tubercle is required for adequate surgical exposure. However, little information exists regarding the average width of the marginal tubercle. Therefore, this study analyzed a total of 813 tubercles (461 left-sided; 352 right-sided; 351 females; 437 males). The left-sided tubercles had an average width of 12.56±0.11mm (mean±SEM) and the right side with an average length of 12.07±0.13mm. There was no significant difference found in the left and right side ($t(811)= 2.809$; $p=0.5127$). The average length of the female tubercle was 11.68±0.13mm. The average length of the male tubercle was 12.91±0.12mm. The widths of the female and male tubercles were found to be significantly different ($t(786)= 7.133$; $p<0.0001$). In regard to width, 191 of 437 males (43.7%) had a tubercle greater than 13 mm and 83 of 351 females (23.6%) had a tubercle greater than 13 mm. Overall, males are more likely to have the marginal tubercle drilled in the mini pterional craniotomy.

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Level of First Author: Undergraduate Student **Topic Category: Gross Anatomy**
Poster Board # 19

The Location of the Infraorbital Foramen between Nasospinale and Jugale: Considerations for Infraorbital Nerve Block and Maxillofacial Surgery in Adult and Pediatric Populations

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Identification of the infraorbital foramen is important in infraorbital nerve block and the prevention of iatrogenic injury of the infraorbital nerve in maxillofacial surgeries. This study assessed the location of 887 adult infraorbital foramina, and 152 pediatric foramina of varied sex and population. The study assessed the midpoint of a line segment spanning from nasospinale to jugale (NS-J) relative to the infraorbital foramen. For adults, the mean distance of the NS-J midpoint from the infraorbital foramen was 2.1±1.9mm with a mode of 0mm. The NS-J midpoint was in the same plane or inferior to the infraorbital foramen in 98.4% of sides. For the pediatric group, the midpoint was typically located 1.2±0.17mm from the IOF. Overall, there were no significant differences between sexes, populations, or sides regarding the NS-J midpoint to infraorbital foramen distance. The NS-J midpoint can be used to locate the infraorbital foramen in both females and males of varied populations regardless of craniofacial diversity. The results of this study will aid in infraorbital nerve block procedures and maxillofacial surgery.

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Level of First Author: Undergraduate Student **Topic Category: Gross Anatomy**
Poster Board # 20

Internal Iliac Artery: Branching Deviations

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The internal iliac artery supplies the pelvic viscera and thigh and hip musculature. Variations in blood supply in this region carry postpartum surgical implications. We dissected the internal iliac artery and its branches in two different adult human cadavers. One cadaver was a 64 year old male dissected by one investigator. The other cadaver was a 92 year old female dissected by two of the investigators. We screened articles to be reviewed on the variations of the internal iliac artery and surgical implications. One cadaver had many variations of this artery while the other conformed to typical depictions per the literature. A literature survey indicates more variations in the anterior division, compared to the posterior division. Numerous of these variations concern the obturator artery. The literature states that there is a 4.7% chance that the obturator artery could come off of the inferior gluteal

artery. In our dissection, this variation was observed in one body; however, both departed from the posterior division. In this variant, the prolonged course of the obturator artery crosses adjacent to the uterine body. We suggest this proximity or novel anastomotic communications created with this variant route may render the obturator artery vulnerable to postpartum trauma.

Level of First Author: Graduate/Medical Student **Topic Category: Gross Anatomy**
Poster Board # 21

The Orientation of the Foramen Ovale According to Cephalic Index

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The foramen ovale (FO) of the sphenoid is often cannulated for the treatment of trigeminal neuralgia. To cannulate the FO, the angle of surgical approach may partly depend on the orientation of the FO. Because cranial base development is related to the growth of the cranial vault, in general, this research tested the hypothesis that the FO and cephalic index would be correlated. A total of 465 foramen ovale angles were measured relative to the sagittal plane and formed an average angle of 48.36±6.98° (Mean±SD). No statistically significant difference was found between paired left and right sides ($t(228)=1.5$; $p=0.14$). Neither the left- nor right-sided FO orientation was correlated to biparietal distance, occipitofrontal distance, or the cephalic index. Therefore, the shape of the head, in general (e.g. brachycephalic, dolichocephalic, etc.) should not influence the surgical approach to cannulating the foramen ovale. This research provides important descriptive statistical data that may aid in the approach to the FO.

Level of First Author: Graduate/Medical Student **Topic Category: Gross Anatomy**
Poster Board # 22

The Evolution of Magnitudes of Phenotypic Integration in the Primate Cranium

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Although patterns of phenotypic integration in the cranium are highly conserved across mammals, the strength of integration varies. Shifts in magnitudes of integration may facilitate the evolution of divergent morphologies, so it is important to understand how these magnitudes of integration evolve. Previous work has shown important interactions between the face, cranial base, and the brain, suggesting that some of these interactions may be driving the strength of integration in the cranium. To test this, I assessed integration in the cranium of 11 primate genera (1009 individuals) and compared these values to variables quantifying overall size, brain size, size and shape of the face and cranial vault, and locomotor behavior. My results show that the relative size of the face is consistently linked to magnitude of integration in primates, so that taxa with larger faces tend to have stronger integration. This may reflect a constraint linked to diet or other selection pressures acting on the function of the jaws. My results also show that larger taxa have a reduced ability to evolve in response to selection pressures compared to smaller taxa. This may be because larger taxa tend to have much longer periods of growth and development. Overall, these results suggest that dietary or body size changes could have an important role in spurring not just morphological evolution, but the ability of morphology to evolve.

This research was funded by the Wenner-Gren Foundation and New York University.

Level of First Author: Faculty **Topic Category: Gross Anatomy**
Poster Board # 23

The Contour of the Zygomatic Bone from the Zygomaticofrontal Suture to the Zygomaticotemporal Suture

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The zygomatic bone possesses a tubercle along its posterior-aspect referred to as the processus marginalis or marginal tubercle. Based on the observation that some crania exhibit a pronounced tubercle, whereas others do not, this study assessed the contour of the zygomatic bone hypothesizing that female and male crania would

exhibit different contours. The study included 784 norma lateralis images of a mixed sample of female (n=343) and male (n=416) crania. Twenty five images were from crania of questionable sex and were, therefore excluded from analysis. Procrustes superimposition was performed to demonstrate the average contour. Principle component analysis revealed variation in the sigmoidal shape of the countour. Discriminant function analysis revealed no significant difference between male and female contours (Procrustes distance between groups=0.012; p=0.3029). The results demonstrate noteworthy shape variation in the contour; however, the variation in the shape is not explained by differences among sexes.

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Level of First Author: Undergraduate Student **Topic Category: Gross Anatomy**
Poster Board # 24

Polychrome Sequential Labeling Techniques to Analyzed Craniofacial Bone Growth in Juvenile Swine

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Fluorochrome sequential labeling is a commonly used technique to study bone growth where apposition rates are calculated as the distance between fluorochromes over labeling intervals. The aim of this study is to determine if fluorochrome sequential labeling could be useful in the study of rapidly growing craniofacial bones in piglets younger than 14 weeks. The fast-pace of these growing bones may yield diffuse labels or lost labels due to high turn-over rates. To determine adequate labeling interval, 3 week-old weaned piglets were injected with calcein, alizarin and oxytetracyclin solutions at 5, 7 or 10 days intervals. Bone samples were taken bilaterally along the maxilla, zygomatic arch, hard palate and the lingual and labial surfaces of the mandible for analysis under fluorescence microscopy. Samples from long bone (humerus and femur) were analyzed to compare endochondral and intramembranous ossification. Optimal interval of fluorochromes administration will then be applied to our surgical alveolar cleft model to compare normal and post-surgical maxillary growth in young piglets. These experiments will facilitate discovery of the mechanisms involved in surgical-induced growth restriction common to pediatric patients with skeletal defects.

Funding: Cincinnati Children's Hospital Medical Center

Level of First Author: Postdoctoral Researcher **Topic Category: Histology**
Poster Board # 25

Identifying Ultrastructures of Spermatids in Process of Spermiogenesis in *Masticophis flagellum*

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Presently, little is still known about spermatid development during spermiogenesis within the snake testis. There are only two complete ultrastructural studies on ophidians that detail spermatid ultrastructure within the Cottonmouth and Sea Snake. Therefore, this research was carried out with the goal of expanding our knowledge of the ontogenic steps of spermiogenesis within snakes by studying spermatid maturation in *Masticophis flagellum* via transmission electron microscopy. *M. flagellum* were collected in Arkansas in the fall of 2013. The testes were removed and fixed in Trumps fixative and tissues were processed for standard electron microscopy. Many of the ultrastructural details of spermatids in the sea snake are similar to what has been described for squamates and ophidians. There are a few notable differences in the spermatids of *M. flagellum* compared to the previously studied viperids. There is not a well-developed lacuna within the nucleus, the dense collar is underdeveloped, and the epinuclear lucent zone in the acrosome is longer and more conspicuous in *M. flagellum* spermatids. Other features of chromatin condensation and morphology of the acrosome complex are similar to what has been observed in the Cottonmouth and Sea Snake. Though the spermatids in *M. flagellum* appear to be highly conserved, there were differences in subcellular details from previously studied snakes. The importance of such character differences during spermiogenesis in snakes is still unknown. Presently the number of species investigated is too small to unravel the phylogenetic implications of such key character differences during spermiogenesis in Ophidia.

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Level of First Author: Undergraduate Student **Topic Category: Histology**
Poster Board # 26

Spermiogenesis in Testes of the Bunchgrass Lizard (*Sceloporus aeneus*)
Alanna Mayberry[1], **Joel Gintzler[1],** Kevin Gribbins[2]; [1]Dept. of Human Biology; [2]Dept. of Biology; University of Indianapolis, Indianapolis, IN

Ultrastructural data on spermatid characters during spermiogenesis are starting to increase in reptiles, but are still relatively limited within saurians. A recent study compared *Sceloporus bicanthalis* to *S. variabilis* and found 8 character differences between these species that reside in the same genus. This study focuses on the events of spermiogenesis within an oviparous and seasonal lizard, *Sceloporus aeneus*. This lizard is the sister taxon to *S. bicanthali*s and we want to explore the question do sibling species within a genus show differences in the ontogeny of spermiogenesis. Five lizards were collected in April 2012 from Toluca, Mexico. The testicular tissues were processed normally for TEM and analyzed to access the ultrastructural spermatid changes occurring during spermiogenesis. The present data were compared to the spermiogenic information available on the viviparous *Sceloporus bicanthalis*. Interestingly, few differences are observed between *S. bicanthalis* and *S. aeneus*. Degrading and coiled myelin figures were visible within the developing acrosome, which are likely remnants of transport vesicles of the Golgi complex. Acrosome and subacrosome granules are present during early spermiogenesis. During late spermiogenesis, an acrosome lucent ridge is seen between the subacrosomal space and the acrosomal medulla was observed in *S. aeneus* spermatids. Our study suggests that spermiogenesis may be more conserved in sibling taxa within a genus. The significance of these findings is not known as too few lizards with the same genus and across taxa have been studied to date.
Research support was provided by the University of Indianapolis biology department
Level of First Author: Graduate Student **Topic Category: Histology**
Level of Presenting Author: Undergraduate Student
Poster Board # 27

Spermiogenesis in Testes of the Texas Horned Lizard (*Phrynosoma cornutum*)
Alanna Mayberry[1], Samantha Holmes[1], Kevin Gribbins[2]; [1]Dept. of Human Biology; [2]Dept. of Biology; University of Indianapolis, Indianapolis, IN

Testicular information is presently limited for spermatid structure during spermiogenesis in squamates. Only a small number of lizards have complete ultrastructural data for spermiogenesis, including several species of *Sceloporus*. These data show that differences can be seen between spermatids within lizards of the same genus. We wanted to further test the hypothesis that spermatid architecture differences exist between species within the same family. Thus, testicular tissues were extracted and examined using standard TEM for four *Phrynosoma cornutum* males collected from Arizona in 2014. Many of the characteristics of spermiogenesis within *P. cornutum* are conserved and very similar to that of sceloporine lizards. These include the development of the acrosome, perforatorium, subacrosome cone, nuclear rostrum, and epinuclear lucent zone. However, there were several differences observed in *P. cornutum* spermatids that are different from other lizards. Their perforatorium is wider and more robust and the epinuclear lucent zone is thin and elongated compared to other saurians. Mitochondria/dense bodies do surround the midpiece axoneme, but *P. cornutum* has an elongated distal centriole with 17 longitudinal tiers of mitochondria, the longest midpiece presently known in lizards. The shoulders of the flagellar nuclear fossa also have a unique shape compared to all lizards studied to date. The present results corroborate previous studies and show that even though there is morphological conservation within lizard spermatids, character differences between species can be recognized. Further studies on spermiogenesis are required in order to judge the relevance of these ontogenetic changes in terms of amniotic spermatid/spermatozoal phylogeny.

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Level of First Author: Graduate/Medical Student **Topic Category: Histology**
Poster Board # 28

Inhibiting IGF1 Activity in the Proximal Tibial Growth Plate Attenuates the Bone-Lengthening Effects of Temperature in Hindlimbs of Growing Mice

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Limb length inequality in children can lead to painful musculoskeletal disorders. Treatments to minimize limb length discrepancy are needed. Targeted heat exposure is a noninvasive way to increase limb length in growing mice. We examined the role of insulin like growth factor 1 (IGF1) in this heat-mediated growth response. We HYPOTHESIZE that heat-enhanced bone elongation in growth plates is IGF1 dependent. To test this, 3-week old female C57BL/6 mice (N=6 per group) were injected with saline, IGF1 (2.5mg/kg SQ), or the IGF1 blocking drug JB1 (Sigma, 2.5mg/kg) one-hour prior to unilateral heat-treatment (40C for 40 min/day). To assess IGF1 activation, proximal tibial growth plates were stained with antibodies against PCNA, IGF1 receptor (IGF1R), and phosphorylated IGF1 receptor (pIGF1-R). Statistical significance ($p<0.05$) was determined using one-way ANOVA and paired t-tests. Histological analyses revealed JB1-injected mice had significantly shorter growth plates relative to saline and IGF1 groups. PCNA expression increased nearly 10% on heat-treated sides of saline- and IGF1-injected mice, but decreased over 10% on the heat-treated side of JB1-injected mice, suggesting an IGF1-driven increase in growth rate. Relative to non-treated sides, expression of IGF1-R and pIGF1-R increased on the heat-treated sides of saline-injected mice, but decreased in the JB1-injected mice. Blocking IGF1 activity in the proximal tibial growth plate attenuates bone lengthening effects of temperature in hindlimbs of growing mice. Results are relevant for elucidating mechanisms of heat-enhanced bone elongation and for developing strategies to combat a range of limb lengthening disorders.
Supported by the NIAMS of the NIH (1R15AR067451-01)
Level of First Author: Graduate/Medical Student **Topic Category: Histology**
Poster Board # 29

A Procedure for Comparing the Articular Discs in the Jaw from Human Cadavers with Dentures versus Natural Teeth

Ashley Turner, Dept. of Biology and Mathematics, D'Youville College, Buffalo, NY

Frequent jaw pain and discomforts are a reality for many. Temporomandibular disorders (TMD) can range from issues with the bony structures of the jaw, articular discs, facial musculature, and several nerves of the face. Research does not suggest one specific cause over another; however, individuals that have jaw articular disc shrinking or degeneration often experience symptoms of TMD. Edentulous patients that wear partial or full dentures can suffer with TMD (Alzarea, 2015). This research outlines a procedure for the comparison of the articular discs of the jaw in cadavers with dentures versus those with natural teeth in an attempt to determine if the use of dentures affects articular disc degeneration. Current research suggests that dentures are not a solution for temporomandibular joint disorders; however, there is nothing that definitively suggests a negative or positive affect on the articular discs in the jaw. The study thoroughly examined two cadavers. The samples were obtained from the cadavers at D'Youville College gross laboratory. All bodies were donated for research and study to the University at Buffalo anatomical gift program. Preliminary observations of dissected discs show degeneration in both cadavers with natural teeth and dentures in the posterior central and lateral regions.
Level of First Author: Graduate/Medical Student **Topic Category: Histology**
Poster Board # 30

A Mathematical Model that Describes the Spatial Interrelationship between the Anatomy of the Foramen Ovale and a Cannulating Stylet

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Cannulation of the foramen ovale is often performed for treatment of trigeminal neuralgia. However, despite advances in resolution and visualization, even fluoroscopy and CT paired with navigation technology have proven unsuccessful in cannulating the foramen. Moreover, adverse events due to miscannulation may be life-threatening. The interface between foramina and the surgical tools which are transmitted through the foramina has not been explicitly examined and, therefore, warrants consideration. This study applies a geometric model to analyze the region of a foramen occupied by a cylindrical surgical tool (e.g., cannula / stylet / catheter / needle) inserted at an angle ϕ to the plane of the foramen. As the tool passes through the plane of the foramen, its cross-section is an ellipse with a major axis depending on ϕ. Accordingly, the area of the region depends on ϕ, as well as on r—the radius of the surgical tool. Knowing the area of the region provides an elementary means of comparing a candidate surgical tool to the foramen it will cannulate when the area of the foramen is known (e.g., from imaging). After accounting for irregularities in the boundary of the foramen, the angle of approach ϕ, and relative orientations of the foramen and the elliptical region occupied by the tool, the geometric model proceeds to describe two new regions: one which guarantees successful cannulation and one which guarantees the tool will not cannulate. In consequence, the model predicts from preoperative imaging studies when cannulation of a foramen ovale will likely be impossible. Therefore, this method may prevent adverse surgical events and improve the surgical approach and outcomes in the treatment of trigeminal neuralgia.

Level of First Author: Faculty **Topic Category: Imaging**
Poster Board # 31

What is the Mechanism Underlying Electroejaculation? Evidence from a Porcine Model

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Objective: To examine for the first time whether electroejaculation (EEJ) functions either by mimicking a neurophysiological response, or by directly activating local pelvic musculature.
Methods: We developed a novel large animal model and monitored EEJ-induced contractility of the internal urethral sphincter (IUS) before and after lesioning its sympathetic innervation with a combination of progressively-worsening surgical and pharmacological insults in three anesthetized boars (46.1 ± 7.4kg).
Results: Surprisingly, IUS contractility, as measured with a pressure-sensing balloon (mmHg), was fully preserved following each progressive insult ($p>0.05$). In contrast, these same insults resulted in complete IUS paralysis when its sympathetic innervation was directly stimulated with bipolar electrodes ($p<0.05$).
Conclusions: Collectively, our results provide the first empirical evidence to suggest that EEJ does not initiate ejaculation through neural mechanisms, but rather activates pelvic musculature independently. Importantly, this discoordinated muscle activation may underlie the reduced viability and motility of sperm commonly associated with standard EEJ protocols

Level of First Author: Graduate/Medical Student **Topic Category: Neurobiology**
Poster Board # 32

Bone Biomechanics of the Wing Bones of Bats Compared to Terrestrial Mammals

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The wing bones of bats function in deformation, resulting in the bones twisting and bending during flight. Structural innovations driving this unusual performance remain unclear. This study characterized the differences in bone performance at the tissue and whole-bone levels of organization in small-bodied bats (n=5) and terrestrial mammals of similar body size [rodents (n=4), insectivores (n=3)]. Microindentation tests performed on sectioned bone cortices revealed bats and terrestrial mammals displayed overlapping hardness and elasticity values at the

tissue-level. Whole bone experiments on a universal testing machine loaded bones in three-point as well as cantilevered bending. The resulting flexural rigidity and resilience data suggest overlap among bat and terrestrial species. When adjusting for bone length, bat limb elements appear relatively rigid and potentially less resilient compared to terrestrial animals suggesting a key role of bone elongation in wing flexibility observed in flight. Taken together, these tissue-level and whole-bone tests suggest that the flexible phenotype of bat wing bones is influenced by morphological innovations in bone length as nanostructural innovations in bone composition will require further analyses.

This research was supported by NSF-CMMI 1537745 to LNC

Level of First Author: Graduate/Medical Student **Topic Category: Physiology**
Poster Board # 33

Sensory Motor Integration and Task Specific Control of Shared Anatomical Substrates of Swallowing and Respiration in Mammals

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The anatomical relationship between the trachea and the esophagus present a unique functional challenge for mammalian swallowing and respiration. Muscles shared by different functions must be appropriately coordinated for each, but sensorimotor interactions are poorly understood. Six infant pigs were implanted with radio opaque oropharyngeal markers and chronic indwelling electrodes in hyoid muscles. Pigs were recorded feeding on milk mixed with barium using high speed videofluoroscopy and simultaneous EMG before and after surgical lesion of the right recurrent laryngeal nerve. Measurements included (1) assessment of airway protection (2) tongue, hyoid, and epiglottal kinematics, and (3) duration and relative timing of EMG signals. We tested the hypothesis that the relationship among kinematics, EMG, and airway protection changed with RLN lesion. Following lesion, the relationship between tongue kinematics and airway protection changed for safe swallows ($p<0.001$). Unsafe swallows did not change. Duration of firing of the thyrohyoid muscle in safe swallows also changed post lesion ($p<0.001$), with no changes in unsafe swallows ($p=0.05$). The generation of the motor patterns that produce the kinematics that result in safe swallows is compromised by lesion of nerves supplying the larynx. Sensory signals from the upper airway are necessary for the appropriate neuromotor control of the shared anatomical structures of swallowing and respiration.

Research was funded by NIH.

Level of First Author: Postdoctoral Researcher **Topic Category: Physiology**
Poster Board # 34

Micron-scale Strain Estimates of the Juvenile Swine Cranial Skeleton for Use in Surgical Models of Alveolar Cleft Repair

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Craniofacial skeletal growth is a coordinated process sensitive to mechanical forces that dictate the spatial distribution of recruitment, proliferation and differentiation of bone cells. This is important because perturbations early in growth can propagate, producing smaller and/or malformed bones. In order to understand normal physiology and tissue response to surgical interventions, injury, or other growth insults, a careful description of trabecular-scale estimates of bone material properties is needed. To provide this, the skull of a 5-week-old cadaveric standard farm pig was skeletonized, disarticulated, and CT scanned (52.06 µm resolution). Grey scale values for each pixel in DICOM files were automatically processed to capture bone complexity. Three dimensional reconstructions of each bone piece were assembled, maintaining trabecular architecture. These digital pieces were compiled into a full skull. Processed grey scale values were experimentally correlated to Young's Modulus values to produce a detailed bone model. FE models were constructed with literature-derived loading vectors. The result is a novel computerized representation of a full swine skull to µm resolution, complete with internal structural elements including trabeculae. This intricate replica of the control condition was modified to illustrate stress/strain

differences among three test conditions: growth restricted, maxillary alveolar cleft, and scaffold-repaired.
Funding support: NIDCR K08 DE023124
Level of First Author: Faculty **Topic Category: Physiology**
Poster Board # 35

Pharmacological Exposures Effect Cranial Suture Stem Cells
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The CDC National Birth Defects Study has published data suggesting that "environmental" exposures including maternal thyroid diseases, use of selective serotonin reuptake inhibitors (SSRIs), and maternal nicotine use may exacerbate incidence and or severity of craniofacial anomalies including craniosynostosis. Craniosynostosis is defined as the premature fusion of the suture(s) of the skull occurring in 1:1800-2500 births. A proposed mechanism of craniosynostosis is the disruption of proliferation and differentiation of stem cells in the perisutural area. To determine if *in utero* pharmacological exposures deplete stem cells within the calvarial sutures, we exposed pregnant wild-type mice to levothyroxine, citalopram (SSRI), and nicotine and investigated suture fusion and the presence of stem cell markers *ex vivo*. Additionally, we exposed primary suture cells to clinically relevant doses levothyroxine, citalopram, and nicotine *in vitro* and assessed the presence of stem markers via flow cytometry. Micro-CT assessment of coronal and posterior interfrontal suture fusion revealed that *in utero* exposure to nicotine and citalopram increased the risk of premature posterior interfrontal suture fusion and exposure to citalopram resulted increased likelihood for coronal suture fusion at post-natal day 15. Further, we confirmed a reduction in Gli1+ cells *ex vivo* in correlation with *in utero* teratogen exposure. Our *in vitro* analysis also indicates a depletion of stem cell populations with teratogen exposure via flow cytometry. Investigating the newly defined stem cell niche of the calvarial sutures and its relationship to suture maintenance will provide insight into future manipulation of these cells for therapeutic benefit.
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Level of First Author: Graduate/Medical Student **Topic Category: Cell & Molecular Biology**
Poster Board # 36

The Development of the Fetal, Neonatal, and Infant Basiocciput
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The anatomy of the basiocciput is particularly important with regard to the developing cranium. Despite its importance, a paucity of information exists with regard to its ontogeny from fetal age through infancy. Therefore, this study assessed 98 basioccipital bones ranging in age from 5 months intrauterine development to 5 months post-natal development. Dry bone mass and distances of all articulating surfaces, the margin of the foramen magnum, and maximum length, midsagittal length, and width were measured to determine descriptive statistics (e.g. Mean+SD) in each developmental month. Regression equations were also developed. The parameter with the best-fit regression was that of width (Distance=0.6486(age) + 6.651; R^2= 0.60). Further, the midsagittal length is longer than the width until the 6th month of development (10.24±0.58mm vs 9.67±0.92mm) (Mean±SD); however, the opposite is true in the 7th month of development— in which case the width becomes longer than the midsagittal length (11.17±1.11mm vs 10.56±1.06mm) and remains so throughout infancy. Canonical variate analysis revealed shape change from a relatively narrow/long with mild concavity at the foramen magnum in the 5th and 6th intrauterine months to relatively broad/short with more pronounced concavity in the 5th postnatal month. In addition to adding context for the development of the human cranial base, this research has implications for

anthropology and forensic osteology, especially since the durable nature of the endochondral-derived basiocciput, relative to the fragile nature of the myriad intramembranous bones of the fetal and infant cranium, makes the bone an excellent candidate for determining age-at-death from fetal/infant remains.

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Level of First Author: Undergraduate Student **Topic Category: Development & Growth**
Poster Board # 37

Craniofacial Growth in a Mouse Model of Osteogenesis Imperfecta

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Osteogenesis imperfecta (OI), a genetic disorder of type I collagen (COL1A1/1A2), is characterized by increased skeletal fragility and fracture risk, low bone mineral density (BMD), and shortened stature. OI type III patients also exhibit midface hypoplasia, dental malocclusions, and sometimes dentinogenesis imperfect (DI). While the postcrania has been extensively studied experimentally, little is known about the craniofacial phenotypes in mouse models.

Here we use the OI murine (oim), a strain with a nonlethal recessively inherited mutation of COL1A2. Homozygous ($oim^{-/-}$) mice are a model for OI type III and exhibit increased skeletal fragility, low BMD, and shortened limbs. DI is present in $oim^{-/-}$, but the craniofacial phenotype is unknown.

Methods: $oim^{-/-}$ and WT littermates (n=20/genotype) were weaned at 21d and raised until adult (16 weeks). Growth of the craniofacial skeleton was document by serial in-vivo µCT scans. Digital 3D landmarks were used to generate craniomandibular centroid sizes and morphometric distances, and the genotypes compared via Krusal-Wallis ANOVAs.

Results: Relative to WT mice, adult $oim^{-/-}$ mice have smaller craniomandibular centroid sizes; decreased cranial lengths and bizygomatic widths; decreased mandibular lengths, corpus heights, and reduced coronoid and angular processes; and shorter postdiastemal toothrows.

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Level of First Author: Faculty **Topic Category: Development & Growth**
Poster Board # 38

Development of the Snout in American Alligators

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Crocodilians have variable superficial snout morphology. Despite numerous studies describing snout skeletal morphology, little is known regarding the details of snout ontogeny in terms of soft tissue anatomy. This study objective is to describe American alligator snout ontogeny, specifically the nasolacrimal duct (NLD), nasal glands, and the vomeronasal organ (VNO). A total of 89 embryonic, fetal and hatchling specimens were examined, measured and 16 heads were histologically serially sectioned and prepared for 3D analysis. There is no evidence of a VNO. Heterochronic shifts in the growth of snout and brain are suggested by ratios of rostrum to braincase volume. These are high in hatchling and in the earliest embryonic stages, but relatively low at intermediate stages 18 – 20 (S 18-20). At S 15, the cranial growth outpaces the snout growth, the olfactory epithelium volume is five-fold of the non-olfactory epithelium, and the nasolacrimal duct originates from the lateral nasal wall. By S 17, a cranial narial gland develops and the NLD connects to the base of the nostril, bifurcating to form the rostral nasolacrimal gland. By S 19, the nasal epithelial volumes have a three-fold difference. The rostrum is growing at a faster pace at S 20. By S 23, there is only a two-fold volume difference between the nasal epithelia and the NLD opens into the posterior aspect of the nasal cavity. Additionally, growth and tissue differentiation continues into the hatchling stage. Similar growth patterns are observed in both mammals (fetal snout growth) and birds

(dissociation of NLD and naris). The absence of the VNO during ontogeny is consistent with small birds, but inconsistent with findings of an embryonic VNO-like structure in both crocodiles and albatrosses.

Level of First Author: Faculty **Topic Category: Development & Growth**
Poster Board # 39

Tooth Crown Volume of Subadult Primates: Methodology for Measuring Age-related Changes

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The availability of micro-computed tomography (μ-CT) has significantly enhanced our ability to document the morphology of subadult specimens, but challenges remain relating to the minute size and tissue composition of immature teeth and bones. We studied a mixed-age sample of twelve species of primates (n= 33) to assess the ability of μ-CT to faithfully discriminate between dentin and enamel across age using the last deciduous premolar (dp4) and first permanent molar (M1) from each jaw. Thickness of the buccal cusps and marginal ridges was compared between histological sections and CT slices prepared from the same specimen and aligned to the same viewing plane. Enamel was frequently fragmented in histology of deciduous (but not permanent) teeth. However, the dentin was pristinely preserved in histological sections, allowing a direct comparison to CT slices in several cross-sectional planes. Measurements of dentin thickness using the two methods, obtained using ImageJ software, were highly correlated (R = 0.99) with no significant differences between CT and histology data based on a paired t-test. Our findings suggest some failure of μ-CT to detect isolated predentin, which tended to measure in thicknesses too small for our resolution to detect (20 to 25 μm voxels). However, the resulting deficit in crown volume was minimal (e.g., to the cervical region). This suggests μ-CT can be used to reliably reconstruct crown morphology in subadult primates. Preliminary findings indicate *Propithecus coquereli* stands apart from all other primates studied. Newborn *Propithecus* have the most fully formed dp4 and M1 crowns, measuring 80% or more of the volume observed in older infants (~one-month-old), and > 40% of the crown volume in weanlings.

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Level of First Author: Faculty **Topic Category: Development & Growth**
Poster Board # 40

Developmental Abnormalities in an Adult Male Skull: Challenges for Forensic Facial Approximation

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All previous attempts to identify an adult male homicide victim have failed. This man's remains were found in Cleveland, 1969. Attempts to hide the homicide included dismemberment and immersion in a caustic fluid, inside a barrel, so most skeletal elements are very poorly preserved, except for the skull. The skull exhibits premature closure of most cranial sutures, impressions of brain gyri on the inner table, a deep sella turcica, partially ossified stylohyoid ligaments and other signs of Crouzon's Syndrome. But it does not have shallow orbits, and the shape is markedly dolichocephalic, not brachycephalic. Forensic art is created and made public in an effort to generate new investigative leads, but how should the artist approximate this man's features? Although overall facial proportions are most important in facial approximation, the drawing should include exophthalmos if it was likely present in life. If it was not present, including it in the art work would be very distracting and inhibit recognition of the person's identity. The artist chose to render the eyes very wide open, with an anxious expression, but not exophthalmic.

Level of First Author: Faculty **Topic Category: Development & Growth**
Poster Board # 41

The Size and Shape of the Oval Window: A Micro-CT Anatomical Study with Considerations for Stapes Surgery
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The oval window an important structure with regard to stapes surgery, including stapedotomy in the treatment of otosclerosis. Recent study of perioperative imaging of the oval window has revealed that the oval window niche height can indicate both operative difficulty and subjective discomfort during otosclerosis surgery. Despite the clinical importance of the oval window, there is little information regarding its size and shape. Therefore, this study assessed the size and shape of the oval window via micro-CT paired with modern morphometric methodology in the fetal, infant, child, and adult populations. Additionally, the study compared the oval window size and shape both side-to-side and between sexes. No differences were found among traditional morphometric parameters among age groups, sides, or sexes. Geometric morphometric methods provided the average oval window shape and most-likely shape variance. Likewise, geometric morphometric methods revealed shape differences between age groups. In addition to assisting with visualization, the results of this report will aid in preoperative assessment and planning.

Level of First Author: Faculty **Topic Category: Development & Growth**
Poster Board # 42

Nasal Asymmetry as a Potential Risk Marker for Non-syndromic Cleft Lip with or without Palate (NSCL/P)
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The unaffected parents and siblings of individuals with NSCL/P have been shown to exhibit a number of distinct morphological features, which are hypothesized as underlying, but incompletely expressed, genetic risk factors. This analysis applies 3D facial imaging and shape analysis for determining the type and extent of soft-tissue nasal asymmetry in a sample of unaffected parents and controls. A geometric morphometric approach was used to analyze coordinates of fifteen nasal landmarks collected from 3D facial images of 164 unaffected parents and 243 controls with no family history of clefting. Following generalized Procrustes analysis, Procrustes ANOVA was used to determine the type and magnitude of nasal asymmetry present in each group. Group differences in mean nasal asymmetry were also assessed via permutation testing. Directional asymmetry (left-right differences that show systematic directional bias) was the predominant form of nasal asymmetry observed in both parents and controls, although the magnitude of the asymmetry was greater in parents. This was confirmed with permutation testing, where the mean nasal asymmetry was significantly different ($p < 0.0001$) between parents and controls. The asymmetry was greatest for midline structures and the nostrils. When subsets of parents were subsequently analyzed and compared (parents with bilateral vs unilateral offspring; parents with left vs right unilateral offspring), each group showed a similar pattern of asymmetry and could not be distinguished statistically.

Level of First Author: Graduate/Medical Student **Topic Category: Development & Growth**
Poster Board # 43

Exploring the Role of Nkx2.5 & Islet1 during Development of Cardiopharyngeal Mesoderm
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Nkx2.5, a homeodomain protein, is important for the proper differentiation of cardiogenic mesoderm from the cardiopharyngeal field into the functional heart musculature. Furthermore, Nkx2.5 has been shown to interact with transcription factors such as GATA4 to regulate cardiomyocyte development. Due to this involvement, mutations in Nkx2.5 have been implicated in many congenital heart malformations, e.g., Tetralogy of Fallot. To better understand the role of Nkx2.5 in normal development and to gather insights into malformations observed, we observed Nkx2.5 expression in whole-mount *in-situ* hybridization embryos of *Xenopus laevis*. We analyzed the expression in stages 18 to 45, and compared the results to those of Islet1, which is another important marker of cardiopharyngeal mesoderm differentiation. Furthermore, we compared our data with published studies in

Xenopus and other model organisms in developmental biology (e.g., mice, chickens). Most embryos showed a Nkx2.5 expression pattern limited to the heart region, which was to be expected. Further expression was observed in the head, which supports the findings in mice that Nkx2.5 plays an important role in pharyngeal mesoderm differentiation. The comparison with Islet1 provides information about the differential role of both investigated genes during cardiac and craniofacial muscle development.

Level of First Author: Graduate/Medical Student **Topic Category: Developmental Biology/Embryology**
Poster Board # 44

Point Mutation of *Prickle1* Cause Cleft Palate and Craniofacial Bone Defects

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The *Bj* mice *(Prickle1$^{Bj/Bj}$)* have a point mutation in the Prickle1 protein (C161F). Prickle1 is a core component of planar cell polarity (PCP) signal pathway and is expressed in the mesenchyme and epithelium in and surrounding both the cranial base and skull vault. The *Prickle1$^{Bj/Bj}$* mutants develop various defect in neural crest derived craniofacial bones, including frontal bone, presphenoid and basisphenoid, without affecting mesoderm derived parietal bone and basioccipital bone. Meanwhile, the *Prickle1$^{Bj/Bj}$* mutants also develop a median cleft lip and cleft palate. In the *Prickle1$^{Bj/Bj}$* mutants, frontal bone, formed by intramembranous ossification, is much smaller and the interfrontal suture is enlarged. Interestingly, the smaller frontal bones do not result from defects in cell proliferation or death, but rather from a delayed differentiation, and significantly decreased migration of osteoblast precursors. Surprisingly, presphenoid and basisphenoid, formed through endochondral ossification, has disorganized synchondroses. Further investigation show that the entire mutant synchondroses lack well defined chondrocyte zones but contain round-to-oval chondrocytes instead. Moreover, the cell orientation of the chondrocyte is disrupted and chondrogenesis is accelerated in the *Prickle1$^{Bj/Bj}$* mutants. Finally, we observe decreased Wnt/β-catenin and Hedgehog (HH) signaling in the frontal bone primordium at E12.5. *Prickle1* regulates migration and differentiation of osteoblast progenitors as well as polarity and differentiation of chondrocyte, partly through modulate Wnt/β-catenin and Hedgehog (HH) signaling pathway.

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Level of First Author: Postdoctoral Researcher **Topic Category: Developmental Biology/Embryology**
Poster Board # 45