Nava Rijal, MS candidate from Biomedical Engineering presented his research work entitled, "Magnesium Incorporated Polycaprolactone-Chitosan- Based Nanofibers for Biomedical Engineering Applications".

The ability to produce composite nanofibers from synthetic and natural polymers represents a significant advancement in development of composite materials with structural and material properties that will support biomedical applications such as tissue engineering, drug delivery and wound healing. In this research composite nanofiber membranes of magnesium oxide (MgO), poly (ε-caprolactone) (PCL) and chitosan (CS) was fabricated by electrospinning. A blend solution of MgO, PCL and CS was first prepared with different compositions and then the solution was transformed into nanofibrous membranes. Toward the potential use of this nanofibrous membrane in tissue engineering, its physicochemical properties, such as morphology, mechanical strength, and integrity in aqueous medium were studied and its cellular compatibility was determined.

Udhab Adhikari, PhD candidate from Mechanical Engineering presented his research work entitled, "Magnesium Incorporated Chitosan Based Scaffolds for Tissue Engineering Applications".

Bone substitutes, including autografts, allografts, and synthetic materials, are among the widest applications of bio-implant materials. Tissue-engineered scaffold materials help restore bone tissue functions during the bone regeneration process. The scaffolds subsequently resorb into the body while the body generates new bone tissue. This paper presents a study of the fabrication and characterization of porous, bioactive

scaffolds made of natural materials: chitosan (CS), carboxymethyl chitosan (CMC) and magnesium gulconate (MgG). Scaffolds were fabricated by subsequent freezing-induced phase separation and lyophilization process of polyelectrolyte complexes of CS, CMC and MgG.

Mr. Paul McGhee, PhD student from Mechanical Engineering presented his research work titled, "The Effect of Grain Size, Extrusion Ratio and Extrusion Temperature on Texture Development in Mg-Zr Alloys.

Magnesium and its alloys have been found to potential candidates for biodegradable implant applications. However, magnesium and its alloys are broadly known to have poor tribological properties, but detailed specifics on wear performance are scarce. This research investigates the tribological characteristics on Mg-Zn-Ca-RE alloys and pure magnesium under as-cast and extruded conditions. Pure magnesium and Mg-Zn-Ca-RE alloys were hot extruded at 350°C and 400°C. Magnesium and Mg-Zn-Ca-Re alloy were also cast at 350°C and heat treated at 510°C. Directional wear properties were investigated using a CETR-UMT 2 microtribometer under unlubricated conditions in a reciprocating configuration for 120 cycles, with normal loads ranging from 0.5N-2.5N. Wear tests were conducted in directions: cross-sectional, longitudinal (along the extrusion direction) and transverse direction (perpendicular to the extrusion direction). Wear properties and friction properties were analyzed using a microtribometer, a mechanical stylus profiler, and microindentation. Surface morphology and microstructure were characterized using optical microscopy, scanning electron microscopy, and optical profilometry. The results show a lower wear rate in the transverse and crosssectional direction compared to the longitudinal direction.

Lumei Liu, PhD student from Mechanical Engineering presented her research work titled, "The Study of Biodegradable Magnesium-Based Stents Using ex vivo Aorta Bioreactor and Microfluidics Systems".

Magnesium (Mg)-based stents are expanded to treat atherosclerosis due to its biodegradability and biocompatibility. However, the discrepant outcomes of Mg-based alloys between in vivo and in vitro tests made the corrosion behavior unpredictable. To better evaluate Mg-based alloys, it's necessary to improve relevant factors of in vitro models that mimic as closely as possible the in vivo microenvironment. In this study, we investigated biodegradation and biological response of Mg-based alloys at the interface in simulated physiological environment using aorta bioreactor and microfluidics system. Our results indicate that the aorta bioreactor can predict degradation behavior of Mg under factors of flow, tissue construction. The microfluidics system can evaluate degradation behavior of Mg-based alloys in the interface microenvironment by mimicking shear stress of in vivo. Intricate cellular and molecular factors need to be isolated and supplemented to further simulate in vivo environment. (997<1000).

Ashley Jackson, MS student of Bioengineering presented her research work entitled, "Exploring the Accuracy of micro-CT Guided FEA".

Finite element analysis (FEA) has become an essential tool for orthopedic applications including use in prosthetic design and failure prediction as well as analysis of the mechanical properties of bone; however, the validity of this method has been questioned; more so calling into question the ability of an empirical mathematical model,

such as those derived from Wolff's law, to accurately portray the cellular and mechanical micro-environment. One of the most challenging aspects of creating a feasible model is correct model geometry. The use of micro-computed tomography (μ-CT) has greatly influenced the accuracy of predictive modeling; allowing the researcher to obtain high resolution slices that can be reconstructed to create a 3-dimensional surface model.

Sample data for this study was obtained prior to the current research by an Institutional Animal Care and Use Committee (IACUC)-approved animal study conducted by research personnel in the NSF Engineering Research Center for Revolutionizing Metallic Biomaterials (NSF ERC-RMB). For this study, explant data from Rabbit 9 at 2 weeks explantation was used. Rabbit 9 had a right transcortical press-fit implantation. Micro-CT data was obtained using the Nanotom-M^{TM} Computed Tomography System (GE Phoenix Nanoton-M 180, GE Sensing & Inspection Technologies GmbH, Germany). The volume was processed as a volume graphics file in VG Studio Max 2.1 (Volume Graphics GmbH, Germany) and translated into a DICOM (.dcm) file. After thresholding, the magnesium label map was manually edited to remove excess values that were included in the volume, as is a common case when thresholding since it is an approximate process. The label maps were then merged and a model built in the model maker module.

The label map statistics module was used to calculate the volumes for the background, region 14 (screw) and the bone which were 0.2042, 0.0327, and 0.8752 cm^3, respectively. While surface geometries represented the press-fit design of the 2-dimensional micro-CT scans, statistical analysis and measurement must be done to assess whether the geometry is accurate. This will be done by comparing the volumes of the created labels to the estimated volumes measured using the grayscale data. The

original size of the screw was 3mm in width and 5mm in depth, making this volume estimation seem logical. Further analysis of entire volume to include the Ti-K guide wires will also need to be done. The surface models from this work will be used to create an adaptive finite element model of bone remodeling around the magnesium-based screw.

Shalil Khanal, PhD candidate from Energy and Environmental System presented his research work titled, "PLGA/Chitosan Based Nanoparticles as Drug Delivery System".

Poly(lactic-co-glycolic acid) (PLGA) based nanoparticles have gained increasing attention in delivery applications due to their capability for controlled drug release characteristics, biocompatibility, and tunable mechanical, as well as degradation, properties. However, thorough study is always required while evaluating potential toxicity of the particles from dose dumping, inconsistent release and drug-polymer interactions. In this research, we developed PLGA nanoparticles modified by chitosan (CS), a cationic and pH responsive polysaccharide that bears repetitive amine groups in its backbone. We used a model drug, diclofenac sodium (DS), a nonsteroidal anti-inflammatory drug (NSAID), to study the drug loading and release characteristics. PLGA nanoparticles were synthesized by double-emulsion solvent evaporation technique. The nanoparticles were evaluated based on their particle size, surface charge, entrapment efficacy, and effect of pH in drug release profile. About 390–420 nm of average diameters and uniform morphology of the particles were confirmed by scanning electron microscope (SEM) imaging and dynamic light scattering (DLS) measurement. Chitosan coating over PLGA surface was confirmed by FTIR and DLS. Drug entrapment efficacy was up to 52%. Chitosan coated PLGA showed a pH responsive drug release in in vitro. The release was

about 45% more at pH 5.5 than at pH 7.4. The results of our study indicated the development of chitosan coating over PLGA nanoparticle for pH dependent controlled release DS drug for therapeutic applications.

Erika Johnson, MS student of Bioengineering presented her research work titled, "Improving Post Cryopreservation Hepatocyte Viability through Manipulation of the Pre-Cryo Suspension Solution".

The primary challenge in hepatic micro-tissue engineering is the fast dedifferentiation of primary hepatocyte aggregates in vitro. For practical application, hepatocyte aggregates must be cryopreserved for prolonged hepatic functions. Hepatocytes are significantly weakened once removed from their donor and cell viability after cryopreservation has been found to be significantly decreased. Because the liver plays an essential role in most human metabolic processes, a need has arisen for improved toxicity analysis techniques to screen for drug toxicity in clinical testing. For practical use of microtissues engineered from encapsulates, an optimized cryopreservation protocol is needed. It can then go on to be used in the production of 2D & 3D microtissue research within NC A&T's bioengineering program.

Rohit Ranabhat, PhD student from Animal Science presented his research work titled, "Swine Production Systems Cause Differential Expression of Superoxide Dismutase in Tracheobronchial Tissues of Pigs".

Swine production facilities harbor dusts, gases and chemicals that have been associated with diminished respiratory health in facility workers. Chronic exposure to

indoor swine production environments cause inflammation and oxidative stress, an imbalance between oxidants and antioxidants in favor of oxidants, which damages cells and tissues by reacting with macromolecules. However, the respiratory system is capable of mounting a response to protect the delicate epithelium from damage. For instance, the respiratory system uses superoxide dismutase (SOD), an endogenous enzymatic antioxidant, as a main line of defense against the oxidants. The goal of this study was to evaluate SOD expression in porcine airway tissues to determine the impact of swine facility dust exposure on respiratory health. Histopathological and immunohistochemical analysis of tracheas from adult pigs reared within indoor and outdoor facilities was performed to evaluate airway epithelial anatomy and physiology. Protein expression and activity of SOD was performed via western blot and enzymatic assays, respectively. Results showed that tracheal epithelia of pigs reared indoors were thicker and more densely packed with goblet cells (p-value = 0.0001) compared to outdoor-reared pigs. While the tracheas of outdoor-reared pigs had higher SOD2 protein expression than tracheas of indoor-reared pigs (p-value = 0.0001) as determined by immunohistochemistry and western blot. These observations demonstrate that goblet cell density, epithelium thickness and SOD expression within the airway mucosa of pigs is linked to swine production system type. In conclusion, these findings indicate that long-term exposure to indoor swine production environments, including inhalation exposure to bioaerosols therein, affect tracheal epithelium morphology and enzymatic antioxidant signaling dynamics. The findings summarized here provide insight for understanding the impact of swine production environments on animal, worker and public health.

M. Paulette Foster, MS student of Bioengineering presented her research work titled, "In Vitro Cardio-Active Drug Screening Using a Stretchable MicroElectrode Array".

Evaluating pharmaceutical drug efficacy in vitro is hindered by the poor prognostic techniques of existing cardiovascular screening methods. Existing multi electrode arrays (MEAs) are able to screen cardiomyocyte drug response through electrode-integrated well plates; however, the mechano-electrical characteristics of cardiomyocytes, including mechano-sensitive and stretch activated ion channel expression, are inextricably linked. Therefore, the electrical activity of static cultured cells does not accurately reflect that of cardiomyocytes in a mechanically dynamic in vivo environment. Recording electrical response in a mechanically active cellular environment may improve in vitro drug screening accuracy.

We have developed a linear stretching system on which a MEA containing adhered cardiomyocytes will provide mechanical stretch to emulate the in vivo environment. We will monitor cardiomyocyte cellular behavior with the Electric Cell-substrate Impedance Sensing System (ECIS) to provide real-time, impedance-based metrics, measuring the electrical behavior while providing mechanical stress to the MEA. We believe there will be a noted change in cellular beating behavior previously undiscovered with existing drug monitoring methods. This behavior change will reveal pertinent information that may protect stakeholders involved in the pharmaceutical drug development process.

The aims of this research include microfabrication of single well units and demonstration of mechanical, electrical and fluidic integrity under mechanical stretch,

followed by a proof-of-concept measurement of cellular beat rate and drug response from a stretched cardiomyocyte cell line. The ultimate goal of this technology is to provide a cost-effective method to improve accuracy in predicting adverse cardiac drug effects through a sophisticated multiplexed assay mirroring tissue-level functionalities. This technology has the potential to translate into a novel functional screening tool for drug development with improved predictivity of significant adverse affects.

Zain Bhatti, MS student of Bioengineering presented his research work titled, "Improvement in Stability of Phase Change Contrast Agent (PCC) Upon Using an Albumin Shell For Ultrasonic Imaging".

Over the past two decades, phase-change contrast agents have been widely investigated by researchers for biomedical applications. An ongoing challenge exists to formulate an agent that simultaneously exhibits a low-pressure threshold for activation and a long circulation halflife. To address this challenge, we have formulated a droplet emulsion with a liquid octafluoropropane core and albumin shell by condensing pre-existing, gas-filled microbubbles with the equivalent constitutive components. Upon activation with ultrasound, the liquid core is vaporized into a gas, and the droplets transform back into microbubbles. The size and the concentration over time of the albumin droplets were determined and compared to a previously developed formulation with a lipid shell. With these measurements, the acoustic signature from emitted during the conversion from droplet to microbubble was measured to quantify the number of detected vaporization events over time. Compared to the lipid formulation, the stability of albumin-coated droplets was significantly increased (e.g., the half-life was 2.7 times than for albumin-shelled at 22ºC) while their ability to be vaporized using low acoustic pressure

(mechanical index < 0.1) was preserved. The results of this study demonstrate that the droplet encapsulation may greatly improve the persistence of contrast agents in the vascular network or their accumulation into tumors, offering new opportunities for therapeutic applications and perfusion measurements using late-phase imaging.