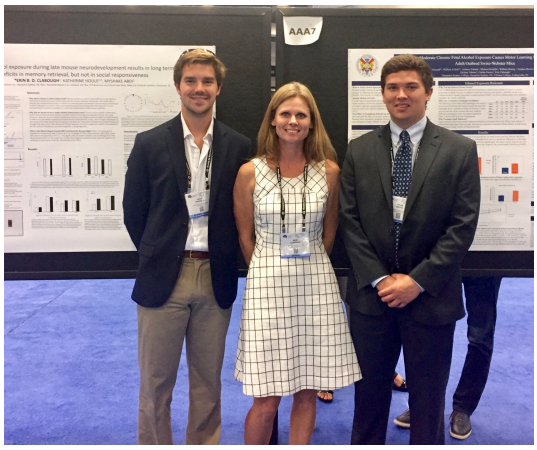
News from the Hampden-Sydney Sciences 2016-17

Biology—*by Kristin M. Fischer*

The 2016-2017 year has found the H-SC Biology department engaged in a number of interesting endeavors. In 2016, **Dr. Kristin Fischer** joined the department as a visiting professor. She earned her B.S in Biology at Virginia Tech and her interest in the medical field led her to pursue her graduate degrees from the Virginia Tech-Wake Forest School of Biomedical Engineering and Sciences. She focused on skeletal muscle tissue engineering with the goal to replace or repair vastly damaged skeletal muscle in the body. Dr. Fische,r along with **Tyler McGaughey '18**, will focus on continuing her skeletal muscle tissue engineering research this summer. This past year, Dr. Fischer collaborated with **Dr. Trey Thurman** in the Physics and Astronomy department and **Cody Smith '18** to investigate concussions in baseball pitchers with his research to continue this summer. This past fall, **Dr. Erin Clabough** and Dr. Fischer collaborated on a project with **Tyler Reekes '17** on the neural response to ethanol. The new interactive Anatomage table, a life-size, digital anatomy table, exposed students to human and animal cadavers during Anatomy and Physiology classes taught this past year by Dr. Fischer and **Dr. Alex Werth**. H-SC students utilized the touch screen platform to cut the cadavers, view specific systems in the body, and zoom in on specific structures repeatedly. The Anatomage table enables each student to experience working with a cadaver similar to the environment available at a larger school while maintaining the small student:professor ratio that H-SC is known for. Drs. Fisher and Werth also received a grant from the Virginia Foundation for Independent Colleges (VFIC) to purchase a digital platform document camera that allows high resolution, real-time images to projected in the classroom. It is especially useful in our visually rich anatomy courses, where we frequently demonstrate and lead students through a display of models, specimens, dissections, etc. It can also record the demo for students to study from later.

Dr. Kristin Fischer

Dr. Erin Clabough was awarded a 2016 Mednick fellowship from the VFIC to support her work with **Josh Chamberlin '17** investigating loggerhead sea turtle emergence patterns on Hatteras Island. This project was done in collaboration with the National Park Service and the Hatteras Island Ocean Center, a nonprofit organization located on Hatteras Island. This Turtle Sense work will continue into summer 2017. Dr. Clabough has also been investigating the morphological and molecular mechanisms beneath the neural response to ethanol with Reekes and **James Ingersoll '18**. Three posters describing this Fetal Alcohol Spectrum Disorder research were presented at the Society for Neuroscience 2016 annual meeting in San Diego, where both students presented first author posters. Dr. Clabough's vertebrate physiology class published a peer reviewed paper at the website for Faculty of 1000 investigating the effects of gestational ethanol in an outbred strain of mice. Dr. Clabough published a paper in the journal Brain and Behavior in 2017 with **Myshake Abdi '16** describing the long-term effects of a single developmental binge drinking episode on learning and memory in mice. Dr. Clabough also continued her pedagogical research investigating the most effective way to teach writing using a rubric-based approach in introductory science classes. This work was published in fall 2016



Jamie Ingersoll '18, Dr. Clabough, and Tyler Reekes '17 in San Diego at the Society for Neuroscience meeting

in the Journal of Undergraduate Neuroscience Education.

Dr. Rachel Goodman's Wildlife Biology class took a weekend field trip this past October for the Eastern Shore Birding & Wildlife Festival. They camped for 2 nights in Kiptopeke State park and attended workshops on bird identification and bird watching. They saw and heard 40 species of birds (and some bottle-nosed dolphins). Dr. Goodman and **Joey Tyler, '17** continued working on her research on the spread of ranavirus among central Virginia reptiles**. Dakota Reinartz '18, Traylor Nichols '17, David Bushhouse '19,** Joey Tyler**,** and Dr. Goodman attended the Sigma Xi student research conference in Atlanta, GA in November 2016. Nichols won the Best Poster award for Environmental Science for his work on developing optimal growing practices for hops.

In 2016-2017, **Dr. Kristian Hargadon** received a $100,000 grant from the Jeffress Trust Awards Program in Interdisciplinary Research to continue jo research on melanoma-associated immune suppression and factors that regulate melanoma metastasis. In addition to experimental work supported by this grant, Dr. Hargadon published an invited review article in the *Journal of Clinical Medicine* entitled "Dysregulation of TGFbeta1 Activity in Cancer and Its Influence on the Quality of Anti-Tumor Immunity." He is thrilled to involve two outstanding students in his research program this past year, **James Lau '17** and **Brant Boucher '17**, both of whom have already presented their work at the Virginia Branch Meeting of the American Society for Microbiology. James, Brant, and Dr. Hargadon will also present their work in April 2017 along with 19,000 other cancer researchers from around the world at the American Association for Cancer Research Annual Meeting in Washington, D.C. This past year, Dr. Hargadon was proud to have received the John Peter Mettauer Award for Excellence in Research at Hampden-Sydney College and to have been nominated for Membership in the European Academy of Tumor Immunology.

Dr. Alex Werth conducted research with **Shemar Blakeney '18** and **Adrian Cothren '19** on the baleen of bowhead and right whales. Baleen is a unique tissue, found only in the mouth of large whales that consists of hundreds of parallel keratin plates that filter traps small fish, plankton, or other food items. This past fall, they investigated the effects of different oils on baleen and how well the various oils (and other substances including fresh and salt water and detergent) interacted—or did not interact at all—to see how whales might be affected by oil spills or other similar situations. Currently, the study has expanded to look at baleen's material properties including how strong the hair-like baleen fringes are when pulled (i.e., in tension), and how the baleen plates and fringes respond to currents of water. This work involves a circulating flow tank in Werth's research lab. **Robert Harris '16** and Dr. Werth published a research article in the peer-reviewed journal Royal Society Open Science on the hydration properties of baleen, based on their presentation at the 2015 Marine Mammal Conference. Dr. Werth continues to conduct research on several aspects of whale feeding and would welcome additional students to work in his lab. He returned to Alaska in November 2016 to speak at the annual Whale Fest, where he also led naturalist whale watches and held workshops and sessions with students and the general public, while also working with other whale biologists. He returns to New Zealand in April 2017 to collaborate with researchers studying a special feeding behavior in Bryde's whales, plus a visit to work on the evolution of dolphin tooth enamel with a Brazilian colleague now in NZ. Werth is collaborating with researchers around the world to study many other aspects of whale biology, including 3D printing of baleen models, the anatomy of the whale tongue, and the evolution of baleen filtration in whales.

Whale siahtina bv Dr. Werth near Sitka. Alaska

Dr. Mike Wolyniak is starting a new 3-year $120,000 National Science Foundation Grant this year. The project is a collaboration between Hampden-Sydney, Adams State University of Colorado, Embry-Riddle Aeronautical University of Florida, and Bethune-Cookman University of Florida and will establish a network of institutions dedicated to expanding opportunities for computational science research across several STEM disciplines. He also organized a network meeting for the 12 institutions in the Undergraduates Phenotyping Arabidopsis Knockouts (unPAK) research group, a National Science Foundation-supported enterprise of which Hampden-Sydney is a charter member. The meeting brought 40 undergraduates and faculty from across the country to the University of Texas-Austin for discussions about the research being done at each institution and ways to continue productive collaborative work going forward. Traylor Nichols '17, Dakota Reinartz '18, and **Drew**

Elliott ’18 accompanied Dr. Wolyniak to this meeting. In April 2017, Dr. Wolyniak and **Michael Willis ’17** will attend the 31st Annual National Conference on Undergraduate Research in Memphis. Later that month, Dr. Wolyniak, **Sean Walden ’18**, and Brant Boucher '17 will present at the American Society for Biochemistry and Molecular Biology in Chicago.

William Echols ’17, **Thomas Vinyard ’17**, Tyler Reekes ’17, and **Luke Bloodworth ’18** attended the Southeastern Medical Symposium at the University of Alabama-Birmingham this past fall. Echols, Vinyard, and Reekes presented a poster on their work done in Dr. Erin Clabough’s Neuroscience lab. Bloodworth presented a poster on his Hampden-Sydney supported summer research experience involving zebrafish.

Thomas Vinyard '17, Tyler Reekes '17, and Will Echols '17 in Birmingham, Alabama at the Southeastern Medical Symposium

Finally, we worked with the Chemistry Department to create a new major in Biochemistry and Molecular Biology. The new major has already attracted 8 majors in its first year and will provide an exciting new opportunity for students to study and research at the interface of Biology and Chemistry.

Chemistry*—by Rupak Dua*

Year 2016-17 has been very productive for the Department of Chemistry at H-SC. In 2016, the Chemistry department worked with several students on summer research projects. **Dr. Herbert Sipe**, Spalding professor of Chemistry worked with **Reed Mingione’19** on a study of Artemisinin’s ability to generate radicals using electron spin resonance spectroscopy. **Dr. Paul Muller** worked with **Ron Davis ’17** and **Andres Garcia ’18** on the synthesis of new ligands and coordination complexes of transition metals that might act as catalysts. They made several new ligands and coordinated them with metals. **Dr. William Anderson** worked with **Tyler McGaughey ’19** on the renovation of Spectronic-20 by integrating a Raspberry Pi computing system.

Dr. Rupak Dua

In 2016, there was an addition in the Chemistry Department. **Dr. Rupak Dua** joined the Department as a visiting assistant professor following his completion of post-doctoral fellowship from the Institute of Orthopedic Research and Education, located at Texas Medical Center. Dr. Dua along with our chemistry alum Jefferson Thomson’16 wrote a book chapter, titled “Nanogels for Tissue Engineering” that will be published by the Royal Society of Chemistry in the book titled, “Nanogels for Biomedical Applications”. Dr. Rupak Dua also received a mini grant from the Virginia Foundation for Independent Colleges for his proposed idea for bringing a more 21st Century “digital” feel to the teaching. **Dr. Rupak Dua** is working on functionalizing of implant surfaces for enhanced antibacterial activity and osteointegration using biomimetics and chemical approaches. Dr. Dua also presented his research on ex-vivo bone bioreactor for bone ingrowth culturing in the Biomedical Engineering Society Annual Meeting in 2016. One of his students **Brant Boucher ’17** will be presenting his research on the topic “Biomimetic Nano-Patterned Design on the Surface of the Implants to Prevent Bacterial

Infections" in the upcoming annual meeting of the American Society for Biochemistry and Molecular Biology in April 2017 at Chicago, IL.

Dr. Nicholas Deifel and three Hampden-Sydney chemistry students have continued a partnership with Prince Edward County High School teacher Dr. Gary Lutz. This work provides a six-week laboratory experience for eight students in his AP Chemistry class. The three teaching assistants are chemistry majors **Reed Mingione '19**, **Robery Kerby '17**, and **Ben Lam '17**. The project involves synthesis and characterization of an organic ligand and will provide the High School students with real chemical instrumentation experience. Dr. Nicholas Deifel is a co-author on a publication titled, Thermochemical Properties of U(VI) Hybrid Materials containing Uranyl Tetrachloride Anions, which is currently in review. This work is a collaborative effort between D. Deifel and colleagues at the George Washington University and University of California at Davis.

Ben Lam '17 working with freshmen

Dr. Kevin Dunn has been very active in research and productive during the 2016-17 academic year. He contributed several articles to the *Handmade Magazine*.

Dr. Paul Muller continued to work with students, studying questions in three area of interest: preparation and characterization on new Mauveine dyes; determination of how much barium leaches from barium-copper blue glazes; and synthesis of new ligands and coordination complexes of transition metals that might act as bifunctional catalysts.

The Chemistry department is happy to announce that the instrument endowment is more than a quarter of the way to the goal of $2M through gifts and pledges from alumni and friends. The Department of Chemistry has also started two additional development projects – a student research fund and a student travel fund, and we are excited to have them running.

The Chemistry and Biology Department collaborated to provide two admissions programs for incoming students in the month of February 2017. **Persus Akowuah**, **Ben Lam '17**, **Chance Hastings '18**, **Reed Mingione '19**, **Jamie Ingersoll '17**, **Jason Pough '19**, **Grayson Cogan '18** were some of the tour guides during these events.

Mathematics and Computer Science*—by Brian C. Lins*

This summer **Reuben Retnam '17** and **Dr. Brian Lins** worked on a research project related to the boundary curves of the numerical range of a matrix. They worked on trying to understand the number of possible crossings and patterns of crossings of these curves. The numerical range of a matrix is a useful tool in linear algebra that has applications in quantum information theory and other areas.

In addition, Dr. Lins, along with co-authors Dr. Bas Lemmens and Dr. Roger Nussbaum, completed a paper "Detecting fixed points of nonexpansive maps by illuminating the unit ball" which has now been accepted to appear in the Israel Journal of Mathematics.

Dr. Paul Hemler continued his collaboration with **Dr. Patrick Martin '02** by managing the progress of two Computer Science juniors, **Keith Kangas '18** and **Ben Hackney '18**. These students picked up the work started by two other Computer Science students during the previous summer. This particular project was part of an NSF grant Dr. Martin had received while he was a professor at York College of Pennsylvania. Our particular task was to develop protocols and experimental code to allow different devices on the Internet to communicate. The novel aspect of this work was to develop a unified language with which many different devices could communicate and cooperate to achieve a general goal. Keith and Ben completed a prototype system by the time the funding ran out.

Dr. Hemler also continued his work on the Energy Research Laboratory with two other students, **Travis Newcomb '18** and **Wes Kuegler '18**. This summer they investigated a variety of software systems for determining a temperature model of the building, and then began to develop our own thermal model of the building from basic heat transfer models and coupled that with parameters associated with the building materials in ERL. They continued the development of a computational model that was started in Dr. Hemler's senior level parallel programming course. Their approach modeled the building with difference equations, a discrete approximation to the governing differential equations of heat transfer. By the end of the summer they had found a one-dimensional computational result that gave similar results to the observed measurements. They hope to continue this work

during the next summer and extend the model to three-dimensions.

Dr. Rebecca Jayne, together with coauthor Kailash C. Misra, had a paper "Lattice Paths, Young Tableaux, and Weight Multiplicities" accepted for publication in Annals of Combinatorics.

Finally, **Dr. Marcus Pendergrass** is on sabbatical for the Spring 2017 semester. One of his sabbatical projects addresses an issue that came up in the 2016 presidential election. Prior to the election, organizations such as Nate Silver's 538.com and Sam Wang's Princeton Election Consortium gave odds on who would win the election based on poll results. Most of these groups predicted that Clinton would win the election, but the published odds varied wildly, from a 65-70 percent chance of a Clinton win from 538.com, to an over 99 percent probability of a Clinton win from the Princeton Election Consortium. Needless to say, all these predictions turned out to be wrong. Why? Dr. Pendergrass' work examines the mathematics behind predicting election returns from poll results, and identifies optimal methods for making these predictions. One preliminary result of his work is that, when the poll results are close, as they were in the 2016 election, predicting the winner is extremely difficult.

The other strand of Professor Pendergrass' sabbatical research is focused on using mathematics to both analyze and compose music. This work involves taking standard musical operations such as transposition and inversion, and placing them in an algebraic context so they can be analyzed and manipulated. The result is a set of mathematical operations that produce melodies, rhythms, and accompaniments. The algebraic context also opens up the possibility of "factoring" melodies into "products" of simpler motifs. This raises interesting questions. For instance, do famous melodies from classical and popular music tend to have nice factorizations? Or are they more like prime numbers, which have no factorizations? Dr. Pendergrass is pursuing this work with **Carlo Anselmo '18**, as part of his senior honors project.

Physics and Astronomy*—by Mitchell H. Thomas '17*

Currently the physics department has eight students conducting research in various aspects of the field. **Alex Greer '17** is working on classifying stars by analyzing their spectra using a telescope and CCD, a diffraction grating. His work will be helpful in teaching Introductory Astronomy labs and has the potential to become an ongoing research project. **Pasquale Graziosi '17** is studying various materials and electronics with a goal to improve the capabilities of wireless charging. **Jonathan Miller '17** is researching the analytical, computational, and experimental evaluation of the Fermi-Dirac integral, an important integral in statistical mechanics. **Zach Shermer '18** is measuring the spectral reflectance and transmittance from different plant leaves. His overall goal is to understand how much the absorbance of sunlight by plants influences global climate. **Jacob Gray '18** is studying the Faraday effect. The research explores how magnetic fields affect the polarization of light through an atomic vapor. His research could lead to an active light filter and light polarizer. **Jake Burns '18** is exploring how capillary waves on the surface of fluids can be used to measure the surface tension of the fluid. **Cody Smith '18** is computationally modeling the human brain as a nonlinear oscillator to better understand how the brain reacts to impacts that can result in concussions. **Cecil Tiblin '18** is attempting to use a standing wave technique to measure the speed of sound at the bubble resonance. Such research could lead to development of technologies that utilize bubbles to dampen sound from underwater construction, which has been shown to harm underwater ecosystems.

Psychology*—by Daniel G. Mossler*

Jake Duncan ‘17, Lee Hamlet ‘18, Emmalee Klein ‘17, and **Jonathan Van Dyke ’17** will be traveling with me to Boston. They have been working with me this past year and are co-authors on a research report that we will present at the annual meeting of the Eastern Psychological Association March 16-19 in Boston, MA. Our findings are briefly summarized below.

Mossler, D.G., Van Dyke, J., Klein, E., Hamlet, L., Duncan, J., & Mossler, L. (2017, March). *Third through eighth grader’s use of computers, cell phones, and social media.* Research report accepted for presentation at the annual meeting of the Eastern Psychological Association: Boston, MA.

We surveyed 452 students and found significant increases between third and eighth grades in time spent listening to music, using cell phones, and on social media. Girls spent significantly more time than boys using social media and more time on their cell phones. While cell phone and social media use increased over grade level, it increased significantly more for girls than for boys. Most interestingly, the hours that girls spent on computers decreased between third and eighth grades, while the time that boys spent on computers increased over those grade levels.

We also found that grades in school were positively correlated with self-esteem, well-being, and knowledge about using the Internet, but negatively correlated with time spent using cell phones and hours spent on social

media. Psychological well-being was positively correlated with grades and self-esteem, but negatively correlated with hours spent on cell phones and social media.

These results help chart the developmental trajectories of digital media use by younger school aged children and demonstrate that the daily use of technology, particularly cells phones and social media, increases significantly over the elementary and middle school years. Children who use these technologies daily, and for the most time each day, have lower grades and poorer psychological well-being. It appears that these young children are already showing precursors of some of the well documented adverse consequences associated with excessive use of these digital media technologies by high school and college students.