

STEM at Middlebury College Annual Report for 2014-2015

Introduction

The faculty of the math and science departments and interdepartmental programs here at Middlebury College are justifiably proud of our accomplishments during this past year, as teachers, scholars, and advocates for the STEM (Science, Technology, Engineering, and Mathematics) disciplines to the wider community. We represent a diverse group of disciplines – including the life and physical sciences, mathematics, and departments that bridge both natural and social domains – but we are united by a shared commitment to science and math as a way of knowing and as a foundational component to a literate, free, and progressive society. Our work during this past year, summarized below as publications, external grant support, major curricular changes, student research, and public outreach, exemplifies both the breadth and depth of this commitment.

All of this, of course, is in addition to each member of the faculty's on-going work in teaching courses, advising and mentoring students, and service both to the college and our wider professional communities. By any measure, STEM at Middlebury College sets – and achieves – high standards in education and scholarship, and our accomplishments during the 2014-2015 academic year were no exception.

Publications (CY 2014)

Abbott, S. (2014). Simon McBurney's ambitious pursuit of the pure maths play. *Interdisciplinary Science Reviews*, 39(3), 224–237. <http://doi.org/10.1179/0308018814Z.00000000086>

Allen, D., & Tenenbaum, K. (2014). A theoretical blueprint for improving MLEs. Pages 374–384 in *The Hardball Times Baseball Annual 2015*. CreateSpace Publishers.

Backus, V., Nurok, A., & the Middlebury College Students of BIOL 140. (2014). Long-term patterns in density of stream invertebrate families in Addison County streams. Poster presentation for Vermont Monitoring Cooperative Annual Meeting. Davis Center, University of Vermont.

- Beato, M., & **Arndt, J.** (2014). False recognition production indexes in forward associative strength (FAS) lists with three critical words. *Psicothema*, 26, 457-463.
- Bernhardt, H. S., & **Sandwick, R. K.** (2014). Purine Biosynthetic Intermediate-Containing Ribose-Phosphate Polymers as Evolutionary Precursors to RNA. *Journal of Molecular Evolution*, 79(3-4), 91-104. <http://doi.org/10.1007/s00239-014-9640-1>
- Bockheim, J. G., & **Munroe, J. S.** (2014). Organic carbon pools and genesis of alpine soils with permafrost: A review. *Arctic, Antarctic, and Alpine Research*, 46(4), 987-1006. <http://doi.org/10.1657/1938-4246-46.4.987>
- Boyd, D., Patterson, J., Allen, W., Bolt, G., Bonnardeau, M., Campbell, T., Campbell, J., Cejudo, D., Cook, M., de Miguel, E., Ding, C., Dvorak, S., Foote, J., Fried, R., Hambsch, F., **Kemp, J.**, Krajci, T., Monard, B., Ogmen, Y., Rea, R., Roberts, G., Skillman, D., Starkey, D., Ulowetz, J., Uthas, H., & Walker, S. (2014). A crowd-sourced light curve for SN 2014G. *The Journal of the American Association of Variable Star Observers*, (402)2, 474.
- Boyd, D., Patterson, J., Allen, W., Bolt, G., Bonnardeau, M., Campbell, T., Campbell, J., Cejudo, D., Cook, M., de Miguel, E., Ding, C., Dvorak, S., Foote, J., Fried, R., Hambsch, F., **Kemp, J.**, Krajci, T., Monard, B., Ogmen, Y., Rea, R., Roberts, G., Skillman, D., Starkey, D., Ulowetz, J., Uthas, H., & Walker, S. (2014). The asynchronous polar V1432 Aquilae and its path back to synchronism. *Proceedings for the 33rd Annual Conference of the Society for Astronomical Sciences*, 163.
- Brym, Z., **Allen, D.**, & Ibáñez, I. 2015. Community control on growth and survival of an exotic shrub. *Biological Invasions*, 16, 2529-2541.
- Carbonetto, P., Cheng, R., Gyekis, J.P., **Parker, C.C.**, Blizard, D.A., Palmer, A.A., & Lionikas, A. (2014). Discovery and refinement of muscle weight QTLs in B6 x D2 advanced intercross mice. *Physiological Genomics* 46(16), 671-582.
- Chakrabarti, A., Xiong, Y., Sun, B., Darrell, T., **Scharstein, D.**, Zickler, T., & Saenko, K. (2014). Modeling radiometric uncertainty for vision with tone-mapped color images. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 36(11), 2185-2198. <http://dx.doi.org/10.1109/TPAMI.2014.2318713>
- Christman, A.**, & Forcier, W. (2014). *Maximizing revenues for on-line dial-a-ride* (Vol. 8881). Retrieved from <http://www.scopus.com/inward/record.url?eid=2-s2.0-84921340456&partnerID...>
- Chung, H., **Andrews, C.**, & North, C. (2014). A survey of software frameworks for cluster-based large high-resolution displays. *IEEE Transactions on Visualization and Computer Graphics*, 20(8), 1158-1177. <http://dx.doi.org/10.1109/TVCG.2013.272>
- Cooper, A. S., Pikhurko, O., **Schmitt, J. R.**, & Warrington, G. S. (2014). Martin Gardner's minimum no-3-in-a-line problem. *American Mathematical Monthly*, 121(3), 213-221. <http://dx.doi.org/10.4169/amer.math.monthly.121.03.213>
- Costanza-Robinson, M. S.** (2014). *Oil & Water Mix*. Middlebury Magazine, Winter.
- Coyner, J., McGuire, J.L., **Parker, C.C.**, Ursano, R.R., Palmer, A.A., & Johnson, L.R. (2014). Mice selectively bred for High and Low fear behavior show differences in the number of pMAPK (p44/42 ERK) expressing neurons in lateral amygdala following Pavlovian fear conditioning. *Neurobiology of Learning and Memory* 112, 195-203.

- Daumann, L. J., **Larrabee, J. A.**, Ollis, D., Schenk, G., & Gahan, L. R. (2014). Immobilization of the enzyme GpdQ on magnetite nanoparticles for organophosphate pesticide bioremediation. *Journal of Inorganic Biochemistry*, 131, 1–7. <http://dx.doi.org/10.1016/j.jinorgbio.2013.10.007>
- Downey, J. S., Mashburn-Warren, L., Ayala, E. A., Senadheera, D. B., Hendrickson, W. K., McCall, L. W., ... **Spatafora, G. A.**, Goodman, S. D. (2014). In vitro manganese-dependent cross-talk between *Streptococcus mutans* *vicK* and *gcrR*: Implications for overlapping stress response pathways. *PLoS ONE*, 9(12). <http://dx.doi.org/10.1371/journal.pone.0115975>
- Erdert, A., Hossain, M. S., Ramakrishnan, N., North, C., Fiaux, P., & **Andrews, C.** (2014). The human is the loop: new directions for visual analytics. *Journal of Intelligent Information Systems*, 43(3), 411–435. <http://dx.doi.org/10.1007/s10844-014-0304-9>
- Farsi, C., **Proctor, E.**, & Seaton, C. (2014). Gamma-extensions of the spectrum of an orbifold. *Transactions of the American Mathematical Society*, 366 (2014), 3881–3905.
- Gleiser, M., and **Graham, N.** (2014). Transition to order after hilltop inflation, arXiv:1401.6225, *Physical Review D* **89**, 083502.
- Graham, M. J., Djorgovski, S. G., Drake, A. J., Mahabal, A. A., Chang, M., Stern, D., ... **Glikman, E.** (2014). A novel variability-based method for quasar selection: Evidence for a rest-frame ~54 d characteristic time-scale. *Monthly Notices of the Royal Astronomical Society*, 439(1), 703–718. <http://dx.doi.org/10.1093/mnras/stt2499>
- Graham, N.** (2014). Casimir energies of periodic dielectric gratings. *Physical Review A - Atomic, Molecular, and Optical Physics*, 90(3). <http://dx.doi.org/10.1103/PhysRevA.90.032507>
- Graham, N.**, Quandt, M., & Weigel, H. (2014). Casimir energy of frequency dependent interactions. *Physical Review D - Particles, Fields, Gravitation and Cosmology*, 90(8). <http://dx.doi.org/10.1103/PhysRevD.90.085004>
- Grogan, J., **Landis, R. M.**, Free, C. M., Schulze, M. D., Lentini, M., & Ashton, M. S. (2014). Big-leaf mahogany *Swietenia macrophylla* population dynamics and implications for sustainable management. *Journal of Applied Ecology*, 51(3), 664–674. <http://dx.doi.org/10.1111/1365-2664.12210>
- Grover, T.W., & **West, D.P., Jr.** (2014). Bedrock geology of the East Pittston 7.5' quadrangle, Maine: *Maine Geological Survey Map 14-30*, Scale = 1:24,000.
- Horn, C., Manduca, C., & **Kauchak, D.** (2014). Learning a lexical simplifier using Wikipedia (Vol. 2, pp. 458–463). Presented at the 52nd Annual Meeting of the Association for Computational Linguistics, ACL 2014 - Proceedings of the Conference. Retrieved from <http://www.scopus.com/inward/record.url?eid=2-s2.0-84906932883&partnerID...>
- Jackson, D., **Allen, D.**, Perfecto, I., & Vandermeer, J. (2014). Self-organization of background habitat determines the nature of population spatial structure. *Oikos*, 123(6), 751–761. <http://dx.doi.org/10.1111/j.1600-0706.2013.00827.x>
- Johnson, J. E., **West, D. P., Jr.**, Condit, C. B., & Mahan, K. H. (2014). Strain localization in the Spanish Creek mylonite, Northern Madison Range, southwest Montana, U.S.A. *Rocky Mountain Geology*, 49(2), 91–114.
- Kazmier, K.**, Sharma, S., Islam, S. M., Roux, B., Mchaourab, H. S., & Wright, E. M. (2014). Conformational cycle and ion-coupling mechanism of the Na⁺/hydantoin transporter

- Mhp1. *Proceedings of the National Academy of Sciences of the United States of America*, 111(41), 14752–14757. <http>
- Kazmier, K.**, Sharma, S., Quick, M., Islam, S. M., Roux, B., Weinstein, H., ... McHaourab, H. S. (2014). Conformational dynamics of ligand-dependent alternating access in LeuT. *Nature Structural and Molecular Biology*, 21(5), 472–479. [http10.1038/nsmb.2816](http://dx.doi.org/10.1038/nsmb.2816)
- Kim, J., **Ryan, P.**, Klepeis, K., Gleeson, T., North, K., Bean, J., ... Filoon, J. (2014). Tectonic evolution of a Paleozoic thrust fault influences the hydrogeology of a fractured rock aquifer, northeastern Appalachian foreland. *Geofluids*, 14(3), 266–290. [http10.1111/gfl.12076](http://dx.doi.org/10.1111/gfl.12076)
- Kuhn, A., H. Mayer, H. Hirschmüller, and **D. Scharstein.** (2014). A TV prior for high-quality local multi-view stereo reconstruction. In International Conference on 3D Vision (3DV 2014), Tokyo, Japan, 2014.
- Macdonald, F. A., Ryan-Davis, J., **Coish, R. A.**, Crowley, J. L., & Karabinos, P. (2014). A newly identified Gondwanan terrane in the northern Appalachian Mountains: Implications for the Taconic orogeny and closure of the Iapetus Ocean. *Geology*, 42(6), 539–542. [http10.1130/G35659.1](http://dx.doi.org/10.1130/G35659.1)
- Majerczyk, C., Brittnacher, M., Jacobs, M., Armour, C. D., **Bunt, R.**, Radey, M., ... Peter Greenberg, E. (2014). Global analysis of the *Burkholderia thailandensis* quorum sensing-controlled regulon. *Journal of Bacteriology*, 196(7), 1412–1424. [http10.1128/JB.01405-13](http://dx.doi.org/10.1128/JB.01405-13)
- Majerczyk, C. D., Brittnacher, M. J., Jacobs, M. A., Armour, C. D., Radey, M. C., **Bunt, R.**, ... Greenberg, E. P. (2014). Cross-species comparison of the *Burkholderia pseudomallei*, *Burkholderia thailandensis*, and *Burkholderia mallei* quorum-sensing regulons. *Journal of Bacteriology*, 196(22), 3862–3871. [http10.1128/JB.01974-14](http://dx.doi.org/10.1128/JB.01974-14)
- McHone, J. G., Hussey II, A. M., **West Jr., D. P.**, & Bailey, D. G. (2014). The Christmas Cove Dyke of coastal Maine, USA, and regional sources for Early Mesozoic flood basalts in northeastern North America. *Atlantic Geology*, 50, 66–90. <http>
- Merchant, A. T., & **Spatafora, G. A.** (2014). A role for the DtxR family of metalloregulators in gram-positive pathogenesis. *Molecular Oral Microbiology*, 29(1), 1–10. [http10.1111/omi.12039](http://dx.doi.org/10.1111/omi.12039)
- Munroe, J. S.**, Attwood, E. C., O'Keefe, S. S., & Quackenbush, P. J. M. (2015). Eolian deposition in the alpine zone of the Uinta Mountains, Utah, USA. *Catena*, 124, 119–129. [http10.1016/j.catena.2014.09.008](http://dx.doi.org/10.1016/j.catena.2014.09.008)
- Newman, D. J., & **Giddings, L.-A.** (2014). Natural products as leads to antitumor drugs. *Phytochemistry Reviews*, 13(1), 123–137. [http10.1007/s11101-013-9292-6](http://dx.doi.org/10.1007/s11101-013-9292-6)
- Parker, C.C.**, Carbonetto, P., Sokoloff, G., Park, Y.J., Abney, M., & Palmer, A.A. (2014). High-resolution genetic mapping of complex traits in a combined analysis of an F₂ intercross and an advanced intercross. *Genetics* 198(1), 103–116.
- Parker, C.C.**, Chen, H., Flagel, S.B., Geurts, A.M., Richards, J.B., Robinson, T.E., Solberg Woods, L.C., & Palmer, A.A. (2014). Rats are the smart choice: Rationale for a renewed focus on rats in behavioral genetics. *Neuropharmacology* 76B, 250–258.
- Patterson, J., Oksanen, A., Monard, B., Rea, R., Hamsch, F., McCormick, J., Nelson, P., **Kemp, J.**, Allen, W., Krajci, T., Lowther, S., Dvorak, S., Richards, T., Myers, G., & Bolt, G. (2014). The death spiral of *T. Pyxidis*. *Proceedings of Stella Novae: Past and Future Decades*, ASP

Conference Series, 490, 35.

Prozument, K., Barratt Park, G., Shaver, R. G., **Vasiliou, A. K.**, Oldham, J. M., David, D. E., ... Field, R. W. (2014). Chirped-pulse millimeter-wave spectroscopy for dynamics and kinetics studies of pyrolysis reactions. *Physical Chemistry Chemical Physics*, 16(30), 15739–15751. [http10.1039/c3cp55352c](http://dx.doi.org/10.1039/c3cp55352c)

Qiao, H., Prasada Rao, H. B. D., Yang, Y., Fong, J. H., Cloutier, J. M., Deacon, D. C., ... **Ward, J.** (2014). Antagonistic roles of ubiquitin ligase HEI10 and SUMO ligase RNF212 regulate meiotic recombination. *Nature Genetics*, 46(2), 194–199. [http10.1038/ng.2858](http://dx.doi.org/10.1038/ng.2858)

Ryan, P.C., (2014). *Environmental and Low-Temperature Geochemistry*. Wiley-Blackwell. ISBN: 978-1-4051-8612-4. 416 pages.

Scharstein, D., Hirschmüller, H., Kitajima, Y., Krathwohl, G., Nestic, N., Wang, X., & Westling, P. (2014). High-resolution stereo datasets with subpixel-accurate ground truth. In German Conference on Pattern Recognition (GCPR 2014), Münster, Germany, 2014.



Shulman, L. M., & **Spritzer, M. D.** (2014). Changes in the sexual behavior and testosterone levels of male rats in response to daily interactions with estrus females. *Physiology and Behavior*, 133, 8–13. [http10.1016/j.physbeh.2014.05.001](http://dx.doi.org/10.1016/j.physbeh.2014.05.001)

Sinha, S., **Scharstein, D.**, and Szeliski, R. Efficient high-resolution stereo matching using local plane sweeps. (2014). IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR 2014), Columbus, OH, 2014.

Tewksbury, J. J., Anderson, J. G. T., Bakker, J. D., Billo, T. J., Dunwiddie, P. W., Groom, M. J., ... **Trombulak, S.C.**, & Wheeler, T. A. (2014). Natural history's place in science and society. *BioScience*, 64(4), 300–310. [http10.1093/biosci/biu032](http://dx.doi.org/10.1093/biosci/biu032)

West Jr., D. P., Abbott Jr., R. N., Bandy, B. R., & Kunk, M. J. (2014). Protolith provenance and thermotectonic history of metamorphic rocks in eastern Jamaica: Evolution of a transform plate boundary. *Bulletin of the Geological Society of America*, 126(3-4), 600–614. [http10.1130/B30704.1](http://dx.doi.org/10.1130/B30704.1)

West, D.P., Jr., (2014). Bedrock geology of the Brooks West 7.5' quadrangle, Maine: Maine Geological Survey Map 14-4, Scale = 1:24,000.

Wolfson, R. (2014). *Essential University Physics*, 3rd edition, Volumes 1 & 2, Pearson Education.

Research Grants

Will Amidon (Geology) has received a grant from the National Geographic Society for a project titled *Finding Early Martian Landscapes in Idaho*. The goal of

this research is to understand the role of glacial outburst floods in forming amphitheater-headed canyons on the Snake River Plain of Idaho. This work should provide useful clues to how similar canyons formed on the surface of Mars. Two Middlebury undergraduates will be working with Will on this project.

Catherine Combelles (Biology) has received a Sabbatical grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture to support her 2015-16 academic leave. The grant will cover leave salary and expenses related to research that she will conduct at the French National Institute for Agricultural Research (INRA) in Toulouse, France. This grant will enable Catherine to acquire advanced metabolic approaches for use in studies on the microenvironment of the developing follicle in cow ovaries.

John Emerson (Mathematics) received a modest grant through the Yale University Provost's Fund for support of a project titled *Advances in Statistical Software Environments*, on which he is working while on academic leave this year. The project grows out of an interest in changing the way statistics is taught, and it will develop educational materials and supporting illustrations suited for guiding students in undergraduate courses in using modern statistical computation.

Glen Ernstrom (Biology and Neuroscience) Project grant for work on *Genetic Analysis of Neurotransmitter Release in C. elegans*. The grant provides funding for summer and academic-year effort from June 2014-May 2015 and includes summer stipends for two undergraduate summer research students.

Eilat Glikman (Physics) was awarded a Cottrell College Science Award from the Research Corporation for Science Advancement to study the co-evolution of galaxies and their supermassive black holes. The grant supports summer research student stipends, as well as purchasing of telescope time and support for travel to telescopes to conduct observations. Eilat was also awarded 26 kiloseconds of observing time with the *XMM-Newton* Space Telescope, which detects X-rays from astrophysical objects. The award will be accompanied by a grant from *NASA* – Goddard Space Flight Center.

Guntram Herb (Geography) was awarded a grant to participate in a National Endowment for the Humanities Summer Institute titled *On Native Grounds: Studies of Native American Histories and the Land*, which was sponsored by the Community College Humanities Association and was in residence at the Library of Congress in Washington, DC for three weeks this summer. This institute provided college and university faculty participants with the opportunity to engage in dialogue with leading scholars in Native American history and scholarship. While at the Institute, Guntram conceptualized a new research project on Native American tribes astride the US-Canada border.

Jeff Howarth (Geography) and a colleague at University of California-Santa Barbara have been awarded a grant from the National Science Foundation's IUSE program (Improvement in Undergraduate STEM Education) for an interdisciplinary project titled *Multimedia Learning Principles for Design-it Yourself Online Instruction of GIS Concepts*. The theoretical goal of the project is to evaluate the generalizability of multimedia learning theory to the domain of solving spatial problems with computer-based geographic information systems. The practical goal of the project is to provide STEM educators with evidence-based guidance for presenting instruction online that can help them develop blended learning environments as an alternative to traditional lecture and lab classrooms. At least three undergraduate students will be involved with this project.

Matthew Kimble (Psychology) has been awarded a research grant from the National Institute of Mental Health through NIH's R15 AREA program. The grant provides three years of funding to support a project titled Neurophysiological and Behavioral Studies of Expectancy Bias in Trauma Survivors, which will use electroencephalography and eye tracking technology to better understand how psychological trauma affects how individuals look at the world. The project will involve multiple students through the life of the grant as independent study students, thesis students, and summer and regular semester research assistants. This grant represents Matt Kimble's third NIMH funded project in this research area.

Anne Kelly Knowles (Geography) has been awarded a fellowship from the Guggenheim Foundation for a project called *Telling the Spatial Story of the Holocaust*. This project grew from her ongoing work with the Holocaust Geographies Collaborative, an international group of geographers and historians exploring the geographical dimensions of the Holocaust with spatial methods, notably GIS (geographic information systems). Knowles' new project will incorporate corpus and computational linguistics as well as GIS, video, and manual methods of geovisualization to represent victims' experiences of place and time during the Holocaust. Her research will take her to Poland, Lancaster University in the UK, Stanford, USC, and UCLA.

Tom & Pat Manley (Geology) have received a grant from the Lintilhac Foundation for a project titled High-Resolution Bottom Mapping of Lake Champlain. This grant provides funding to begin a long-term effort to update the 2005 bottom bathymetric map of Lake Champlain using multibeam technology which Middlebury acquired with a 2011 grant from the National Science Foundation.



When completed, this new bottom map will provide a significant increase in the resolution of the lake bottom that is important to the recreation, research and management communities.

Jeff Munroe (Geology) has been awarded a Franklin Grant from the American Philosophical Society for a project titled *Developing a Record of Holocene Environmental Change from an Idaho Ice Cave*. The grant will cover field research expenses for Jeff and a Middlebury undergraduate to collect samples from the ice cave as well as the expense of acquiring radiocarbon dates for organic matter within the ice deposit. The goal of the project is to develop a record of winter snowfall and atmospheric dust deposition spanning the past several centuries.

Peter Nelson (Geography) and a colleague at Point Park University have received a three year grant from the National Science Foundation for a project titled *International Rural Gentrification*; research teams from the United Kingdom and France are also funded via their own respective national funding agencies. The entire project is part of the Open Research Area funding scheme for international social science research that now involves agencies in four European countries as well as the NSF. The objective of this multi-national collaborative project is to undertake the first in-depth cross-national integrated comparative study of the theory, forms and dynamics of rural gentrification encompassing France, UK and USA. The US team will compile a comprehensive database of rural gentrification indicators for each of the three countries, and then identify a set of communities in the US in which to carry out in depth case study analysis focusing on the different forms of rural gentrification and the various actors involved in the process. Scholars from the UK and France will do similar case study analyses in their respective countries. In addition to funding all the costs of the research in the US, the grant will also fund trips to Europe to meet with the entire research team; this research will be the focus of Pete's academic leave in 2015-16. Three undergraduate students will be involved in this research.

Clarissa Parker (Psychology and Neuroscience) received pilot support for a new project titled *Genome-wide Association for Ethanol Sensitivity in the DO Mouse Population*. The grant provides funding for 2014 summer effort and travel to present a paper at a conference in Uppsala, Sweden. Clarissa also applied for and was awarded funds to support an undergraduate summer research student.

John Schmitt (Mathematics) received a grant from the NSF-sponsored Institute of Mathematics and Its Applications, located on the campus of the University of Minnesota, to attend a workshop entitled *Probabilistic and Extremal Combinatorics* this fall. While there he presented a poster highlighting his work with two collaborators, one from the University of Georgia and the other a College alumnus.

John Schmitt (Mathematics) and colleagues from Dartmouth College, Bard College, Smith College, St. Michael's College, SUNY Albany, Wesleyan University, and Worcester Polytechnic Institute have received funding from the National Security Agency for two conferences this year on discrete mathematics. The first was hosted by Middlebury College at Bread Loaf during September. The main purposes of these conferences are to enhance the national infrastructure for research and education in discrete mathematics by creating and strengthening a regional network of interacting researchers and to facilitate the dissemination of cutting-edge research ideas, methods and results.

An-Gayle Vasiliou (Chemistry & Biochemistry) received a grant to support research into *Thermal Composition of Biomass: Molecular Pathways for Sulfur Chemistry*. The grant provides funding for summer effort during 2014 and includes funds for two summer research students.

David West (Geology) has been awarded a fellowship from the Marion and Jasper Whiting Foundation for a project titled *Exploring Iceland's Active Geology*. The grant will support ten days of field investigation in Iceland that will enrich his teaching of structural geology, tectonics, and volcanic hazards in both introductory and upper-level geology courses. The experience will also provide a springboard for organizing an Iceland field course for students during Middlebury College's recently established Summer Term.

Frank Winkler (Physics) has been awarded funding from the NASA-funded Space Telescope Science Institute for his role in a collaborative research project involving researchers at STScI and University of Toronto. This project entails observations from the Hubble Space Telescope and is titled *To be or not to be the Progenitor: The Question about Tycho-B*. The goal of the observations is a better understanding of the star that exploded as a supernova in 1572, commonly known as Tycho's Supernova, after the 16th-century Danish astronomer Tycho Brahe who made careful records of it at the time.

Major Curricular Developments

Dave Allen (Biology) offered a new first-year seminar called *Lyme Disease*.

Vickie Backus and **Alison Nurok** (Biology) established two long-term research forests on campus for use in Ecology and Evolution (BIOL 140).

Rick Bunt and **Jeff Byers** (Chemistry & Biochemistry) offered two new organic chemistry courses (*Organic Structure and Reactivity* and *Organic Synthesis and Spectroscopy*) as part of a revamped organic chemistry curriculum to better

address class size, student needs, and the new, 2015 MCAT / Medical School Admissions requirements.

Jeff Byers (Chemistry & Biochemistry) “flipped” the classroom in the new Organic Chemistry sequence (CHEM 203 and 204) this past year. This format involves students watching videos of previously recorded classes prior to their class time, freeing class time for active problem solving in small groups, rather than passively collecting notes in the standard lecture format. His Advanced Organic Chemistry class (CHEM 442) created or significantly upgraded existing Wikipedia pages on organic chemistry topics in lieu of writing final papers. This class has been doing this for the last 10 years, and many frequently accessed Wikipedia entries have been created.

Kim Cronise (Psychology) offered a new course titled *Mindfulness and Psychology* (co-taught with Bill Waldron, Religion Department).

Mike Dash (Psychology) developed a new course titled *Sensation and Perception*.

Allison DiBianca (Psychology) developed and taught *Introductory Psychology for Juniors and Seniors* in response to altered pre-med requirements that now recommend a course in psychology for students wishing to apply to medical school. She also modified (from Winter term) and taught a new course on the *Psychology of Morality*.

Eilat Glikman (Physics) introduced a new Winter Term course called *Ancient Astronomy*, geared toward non-STEM majors. The course takes a cultural examination of ancient cultures and their relationship to the sky.

Peter Johnson (Computer Science) developed and offered a new winter-term course called *Crash Course in Systems Security*.

Robert Moeller (Psychology) offered a new course entitled *Social and Emotional Development* and implemented a new research component utilizing Mechanical Turk with students in his senior seminar *Health Psychology*.

Jeff Munroe (Geology) and **Peter Ryan** (Geology and Environmental Studies) team-taught a completely redesigned, entirely field-based *Soils and the Environment* course in the fall semester of 2014.

Clarissa Parker (Psychology and Neuroscience) offered a new senior seminar titled *Genes, Brain, and Behavior*.

Emily Proctor (Mathematics) offered a new first-year seminar titled *The Story of Geometry*.

Tom Root (Biology) and **Glen Ernstrom** (Biology and Neuroscience) offered a revised course called *Introduction to Neuroscience*.

Tom Root (Biology) offered a new course called *Neural Disorders*.

Mark Spritzer (Biology) developed a new laboratory exercise for Animal Physiology (BIOL 370) that involved collecting electrophysiological recordings from crayfish muscle fibers using newly acquired equipment. The experiment gave students hands-on experience with electrophysiology and demonstrated some basic concepts that are central to neurobiology. He also offered a new first year seminar called *Biology of Attraction*.

Steve Trombulak (Biology and Environmental Studies) offered a new seminar/project course called *Conserving Endangered Species* (co-taught with Chris McGrory Klyza, Political Science and Environmental Studies)

Carlos Vélez-Blasini (Psychology) developed a new course on *Social Psychology*.

Jeremy Ward (Biology) redesigned Cell and Genetic (BIOL 145) using a simple but very different approach to science education when compared to most introductory science pedagogies. The re-design involved a combination of the “backwards planned course” where the entire course learning goals are set *first* during planning and the concept that all students should leave the course with an identical high level of competency. Most science courses stratify the course participants by grades in what is historically referred to as a “weed out” process. He reasoned that, at the introductory level, it is inappropriate to “weed” anyone out because the assumption that they all come in with similar educational backgrounds (and hence have an equal chance from the outset) is likely to be false. Rather, the class was re-designed so that many students with very diverse backgrounds could be successful by using mastery of material as the main criteria for moving on to the next topic as opposed to more traditional approaches, which would move students on regardless of evidence that they do not truly understand the previous topic. Primarily, the goals were accomplished by allowing the students to retake evaluations after correcting their previous work until they demonstrated mastery. For most students this occurred after a second evaluation and overall was a very successful way to increase learning.

Richard Wolfson (Physics) developed two new graduate-level workshop courses and taught them during Winter Term at the Middlebury Institute of International Studies at Monterey. He taught *Power, Plutonium, and Proliferation* to students in the Program in Nonproliferation and Terrorism Studies, and *Climate Change: Assessing the Risks* to students in the International Environmental Policy Program.

Helen Young (Biology) offered *Ecology and Evolution* (BIOL 140) in a new way in the spring of 2015, with many in-class exams, each of which had to be corrected and came with an opportunity to take each exam again. This was an attempt to make exams tools for learning, not just to assess knowledge.



Student Research

Nick Bachman (Geology major) worked with Pete Ryan (Geology and ES) during the academic year on a senior thesis that used micron-scale scanning electron microscopy and chemical analysis to determine the mineralogical source of uranium in a bedrock aquifer in northeast Vermont.

J.D. Ballard (Physics major) worked with Michael E. Durst (Physics) during the academic year on his senior project, applying the Microsoft Kinect sensor's depth imaging capability to the measurement of instant 3D profiles of microscopic objects.

Elyse Barnard (Psychology major) worked with Mike Dash (Psychology) during the academic year on an independent project which focused on the role of slow-wave activity in regulating sleep need.

Connor Bentivoglio (Neuroscience major) worked with Mike Dash (Psychology) during the academic year on an independent project which focused on characterizing behavioral strategies of rats performing a dual-solution maze task.

Aaron Birnbaum (Biochemistry major) worked with Roger Sandwick (Chemistry and Biochemistry) during the summer and academic year on his senior thesis, which focused on the effect of glycation on cytochrome c's ability to initiate programmed cell death.

Elizabeth Noelle Blose, Biswash Ghimire, and Jeremy Stratton-Smith (Physics and Mathematics majors) worked with Noah Graham (Physics) on a project to write a general-purpose software package to compute Mathieu functions. While this project was motivated by research on the applications of quantum mechanical Casimir forces in nanotechnology, these functions also arise in a variety of situations involving the reflection of waves in elliptical geometries. The completed package, now publicly available online,

is the only one currently available that is capable of computing integer-order Mathieu functions of both the first and second kind for complex argument and parameter.

Steven Bodine (Biochemistry major) worked with Roger Sandwick (Chemistry and Biochemistry) during the academic year on research work to determine the up-regulation of a series of enzymes in response of *E. coli* to the rare sugar allose.

Maddie Bruns, Anna Paritsky, and Timothy Ogle (Neuroscience majors) worked with Kim Cronise (Psychology and Neuroscience) during the academic year on projects exploring the effects of meditation practice on EEG brain activity and on behavioral measures of self-referencing and emotional regulation.

Cecelia Burkey (Biochemistry major) worked with Roger Sandwick (Chemistry and Biochemistry) during the summer and academic year on her senior thesis, which focused on the characterization of a bacterial transcription regulator, AlsR, and its role in the metabolism of a rare sugar, allose, by a select group of bacteria.

Linnea Burnham (History and French double major) worked on a senior independent study project with Molly Costanza-Robinson (Environmental Studies and Chemistry) on the chemistry, flavor, and texture of cheese. This independent work supported Linnea's senior thesis on the culture and terroir of French cheesemaking and her subsequent Watson Fellowship on artisanal cheesemaking in Italy.

Nicholas Caminiti (Biochemistry major) worked with Rick Bunt (Chemistry & Biochemistry) during the summer and academic year on a senior thesis project investigating the impact of different chiral ligands and added bases on the on the reversibility and enantioselectivity of palladium-catalyzed, allylic-amination reactions.

Ann Carpenter (Biology major) worked with Tom Root (Biology and NSCI) on a thesis studying age and stabling impacts upon parasites in Morgan horses.

Lydia Carpenter (Biology major) worked with Tom Root (Biology and NSCI) on a thesis studying anthelmintic products and internal parasites burden in dairy cows.

Luke Carpinello (Economics major) worked with Tom Root (Biology and NSCI) on a study of game theory and economic decision making.

Andrew Catomeris (Neuroscience major) worked with Tom Root (Biology

and NSCI) on a study of reading comprehension in humans using the Spritz method.

Vera Chan and **Ethan Strayer** (Biology and ES/Conservation Biology joint majors) worked with **Dave Allen** (Biology) during Summer 2014 on a forest mapping and demography project at a research plot in the Edwin S. George Reserve (Pinckney, MI). A major aim of the study is to document and understand oak decline in a mid-successional forest. Data from this forest census are now included in the Smithsonian Institute's Forest Global Earth Observatories network of research plots (<http://www.forestgeo.si.edu/>).

Vera Chan (Biology major) worked with Helen Young in summer and fall of 2015 on research to determine the effects of growing buckwheat on soil fungal communities at the Middlebury College Organic Farm.

Cynthia Connard (Geology major) worked with Ray Coish (Geology) during the academic year on her senior thesis, which focused on a field and laboratory study to understand the ancient plate tectonic history of Vermont, using U-Pb ages of zircon - a small, nearly indestructible mineral whose growth in rocks chronicles the movement of tectonic plates.

John Corbett (Molecular Biology and Biochemistry major) worked with Grace Spatafora (Biology) during the summer and academic year on his senior thesis, which elucidated the interaction between an important metalloregulatory protein called SloR and its binding targets on the *Streptococcus mutans* chromosome. John used electrophoretic mobility shift assays to define SloR binding that is nucleotide sequence-specific.

Eleanor Crawford (Neuroscience major) worked with Tom Root (Biology and NSCI) on a review of the effects of a gluten-free diet versus treatment & non-compliance and depression

Sarah Crepps (Molecular Biology and Biochemistry major) worked with Grace Spatafora (Biology) during the summer and academic year on her senior thesis, which focused on the SloR metalloregulator and its involvement in the *Streptococcus mutans* oxidative stress response.

Brendan Cullen, Isabella Stallworthy, and Emma McGuirk (Neuroscience majors) worked with Kim Cronise (Psychology) during the Summer 2014 on a project funded by the Academic Outreach Enhancement Award (Middlebury College), which focused on the effects of meditation practice on stress hormones, competitive performance and compassionate responses.

Brendan Cullen (Neuroscience major) worked with Kim Cronise (Psychology) during the academic year on his senior thesis project evaluating the effects of meditation experience on narrative self-concept and on

associated electroencephalographic (EEG) neural activity.

Will Daly (Molecular Biology and Biochemistry major) worked with Grace Spatafora (Biology) during the summer and academic year on his senior thesis, which applied a DNase I footprinting approach to reveal the details of an interaction involving an important SloR metalloregulator and its binding target that is promoter proximal to the *sloABC* locus on the *Streptococcus mutans* chromosome.

Elaine Dellinger (Biochemistry major) for her senior honors thesis and **John (Connor) Stoll** (Biochemistry major) both worked during summer and academic terms with Molly Costanza-Robinson (Environmental Studies and Chemistry) on a wastewater remediation project, in which the chemistry governing the ability of chemically modified clay minerals to act as adsorbents for organic contaminants was investigated.

Jack Desmarais (Molecular Biology and Biochemistry major), working with Jeremy Ward (Biology) during Fall 2014, investigated the mechanism governing the interaction of an important DNA synthesis enzyme, DNA Pol Beta and the gene HEI10. This relationship will have important implications for not only meiotic and fertility biology but also for cancer biology as well.

Courtney Devoid (Biology and ES/Conservation Biology joint major) worked during Fall 2014 with Dave Allen (Biology) on a senior research project, begun the previous spring, studying post-agricultural forest succession on abandoned pastures in a Lincoln, Vermont, farm.

Marina DiMarco (Molecular Biology and Biochemistry major) worked with Grace Spatafora during the summer and academic year on her senior thesis, which centered on defining the sites on the *Streptococcus mutans* genome to which a SloR metalloregulatory protein binds. To this end she used a chromatin immunoprecipitation (ChIP) approach.

Jacob Dixon (not declared) worked with Rich Bunt (Chemistry & Biochemistry) and Sallie Sheldon (Biology) during Summer and Fall 2014 on a project to study polycyclic aromatic hydrocarbons deposition associated with motorboat traffic in bays near Friday Harbor (WA).

Tom Dobrow and **Shrerif Nada** (Mathematics majors) were involved in a UCRF-sponsored research project entitled "Distinct Partial Sums in Cyclic Groups." The project is part of on-going work of John R. Schmitt (Mathematics), who is seeking to develop tools within the polynomial method for problems in combinatorics and graph theory.

Terri Duncan (Biology major) worked with Sallie Sheldon (Biology) during Summer and Fall 2014 on a comparison of zooplankton caught in vertical and

horizontal tows in oligotrophic Ontario lakes.

Riley Ebel (Geology major) completed a year-long senior thesis with Jeff Munroe (Geology) investigating the origin and significance of submicron-sized sediment that is prevalent in many lake sediment cores from the Uinta Mountains, Utah. Results indicate that this material formed as a product of long-term weathering in alpine soils, and was eroded into the lakes during a period of landscape instability associated with the last deglaciation.

Alyssa Fassett-Carman (Biology major) worked with Tom Root (Biology) on a study of puzzle learning in the California Two Spot octopus.

Jason Feinman (Physics major) worked on his senior project with Rich Wolfson (Physics) during the fall semester. Jason used computer modeling to compare the energy performance of a conventional Vermont house versus an “Earthship” house built by Middlebury economics professor Amitava Biswas. Feinman also explored implications of global warming for energy use in both houses.

Eleanor Fisk (Psychology major) worked with Robert Moeller (Psychology) in the spring semester on a project exploring forms and sources of social support among emergent adults.

Jade Forsberg (Neuroscience major) worked with Mike Dash (Psychology) during the academic year on an independent project that focused on characterizing the effects of reduced synaptic strength on the need for sleep.

Jacob Fox (Biochemistry major) worked with Rick Bunt (Chemistry & Biochemistry) during the academic year on a project using ^{31}P NMR to investigate the structure of the catalytic intermediates of palladium-catalyzed, allylic-amination reactions.

Gaby Fuentes, Zoe Kaslow, Kaitlyn Kovalanka & Sara Rosenband (Psychology majors) worked with Robert Moeller (Psychology) during the fall semester on a pilot project exploring social support among emergent adults.

Evan Gallagher (Neuroscience major) worked with Marcia Collaer (Psychology) during the academic year on his senior thesis, which investigated how exposure to an experimentally-induced stressor altered human moral judgments as well as cardiovascular and hormonal responses.

Madison Goodstein (Chemistry major) worked with Rick Bunt (Chemistry & Biochemistry) during the summer and academic year on project investigating the impact of different chiral ligands and added bases on the reversibility and enantioselectivity of palladium-catalyzed, allylic-amination

reactions.

Andrew Goulet (Molecular Biology and Biochemistry major) continued his research from the previous spring and worked with Jeremy Ward (Biology/MBB) during Summer and Fall 2014 to develop and implement protocols using antibodies to localize the protein HEI10, and important DNA repair protein, within the cell as a function of the cell cycle. To work on this project Andrew learned to culture several human cancer cell lines including breast and leukemia cancers.

Ilana Gratch (Psychology major) worked with Robert Moeller (Psychology) during the academic year on a project exploring social support and life satisfaction among young adults. Ilana and Prof. Moeller presented their work in May at the Western Psychological Association Convention.

Sarah Guth (Biology - ES-Conservation Biology joint major) worked with Helen Young (Biology) and Tom Root (Biology) during the winter and spring semesters on her senior thesis to evaluate the effects of sub-lethal levels of neonicotinoids on bumble bee learning.

Adela Habib (Physics major) completed a senior thesis with Eilat Glikman (Physics) in which she analyzed optical and near-infrared spectra of dust-reddened quasars to determine the masses of their supermassive black holes and total energy output, to quantify their growth rates.

Courtney Haron (Biochemistry major) worked with Roger Sandwick (Chemistry & Biochemistry) during the academic year on senior research work to develop two new laboratory exercises for CHEM 104 laboratories.

Will Henriques (Independent Scholar) worked with Jeremy Ward (Biology) and Clarissa Parker (Psychology and Neuroscience) during Spring 2014 to begin an ambitious project to characterize the entire expressed genome of the mouse hippocampus in one of the mouse lines we carry called Akap9. Akap9 mutant animals have severely impaired cell signaling and communication and appear to have significant cognitive difficulty. During Summer 2014, Will travelled to Switzerland to learn the brain dissection and processing necessary to complete the project.

Lauren Honican (Neuroscience major) worked with Mark Spritzer (Biology) during the academic year on her senior thesis entitled *Potential memory restorative effects of an ependymin mimetic in an aged, transgenic mouse model of Alzheimer's disease*.

Sam Horn (Molecular Biology and Biochemistry major) worked with Jeremy Ward (Biology) during Fall 2014 to use a system called yeast two-hybrid to

identify proteins that interact with the protein RNF212. RNF212 is essential for meiosis and likely plays an important role in DNA repair.

Jack Hunsicker (Physics major) completed a senior project with Eilat Glikman (Physics) in fall 2014 in which he analyzed the energy-emitting mechanisms in high-redshift quasars whose light was emitted when the universe was only 15% of its current age.

Asa Julien (Biology major) worked with Sallie Sheldon (Biology) during Winter and Spring 2015 on algal species composition under ice in five Vermont lakes.

Drew Kreuzman (Neuroscience major), **Mary Thomas** (Neuroscience major), **Kayvon Sharif** (Neuroscience major) and **Steven Kasperek** (Psychology major) worked with Clarissa Parker (Psychology and Neuroscience) during the academic year conducting behavioral and neural genetic research.

Sydney Larkin (Neuroscience major) worked with Tom Root (Biology) on a thesis studying polarized light and chemosensitivity in the California Two Spot octopus.

Duncan Levear (Mathematics major) worked during the summer and the academic year with Daniel Scharstein (Computer Science) on a new version of the Middlebury Stereo Evaluation, a widely-used computer vision benchmark evaluating 3D reconstruction results from images.

Benjamin Mansky (Neuroscience major) worked with Clarissa Parker (Psychology and Neuroscience) during the summer and academic year on his senior thesis, which examined variation in ethanol sensitivity in the Diversity Outbred mouse population and its implications for genome-wide association mapping.

Mackenzie Martin (Psychology major) worked with Suzanne Gurland (Psychology) during the academic on her senior thesis, which investigated feedback as a possible mechanism for the effects of self-affirmation on students' academic performance.

Michael Martini (Molecular Biology & Biochemistry major) worked with Rick Bunt (Chemistry & Biochemistry) during the academic year on a senior thesis project investigating the effect of achiral ligand chelate size on the reversibility of palladium-catalyzed, allylic-amination reactions.

Alison Maxwell (Biochemistry major) worked with Roger Sandwick (Chemistry and Biochemistry) during the academic year on her senior thesis,

which investigated the potency of a rare sugar, allose, as a potential inhibitor of cancer cell growth.

Emma McGuirk (Neuroscience major) worked with Kim Cronise (Psychology) during the academic year on her senior project evaluating the effects of meditation practice on cognitive strategies of emotional control.

Colin McIntyre (Physics major) worked with Michael E. Durst (Physics) during the academic year on his senior thesis, in which he created a laser-scanning multiphoton fluorescence microscope from scratch. His work will allow for collaborative 3D biomedical imaging projects with biology and neuroscience faculty this summer.

Edgar Meija (Psychology major) worked with Robert Moeller (Psychology) during the academic year on a project exploring benevolent and hostile sexism among racial and ethnic minorities. Edgar and Prof. Moeller presented their work in May at the Western Psychological Association Convention.

Charlotte Michaelcheck and Leslie Panella (Neuroscience majors) both worked with Mark Spritzer (Biology) during the academic year on NSCI 700 projects. They worked on different aspects of a project testing the effects of estradiol on stages of neurogenesis in adult male rats.

Logan Miller (Geology major) worked with Ray Coish and Dave West (both Geology) during the academic year on his senior thesis, a field-based study of a copper and zinc mineral deposit in southeastern Alaska.

Laura Nelson (Neuroscience major) worked with Mark Spritzer (Biology) during the summer on multiple research projects. Her primary project involved comparing neurogenesis levels in wild meadow voles captured during different seasons.

Claire Nishioka (Psychology major) worked with Carlos Vélez-Blasini (Psychology) during the academic year on her senior thesis examining the effects of emotional states on the presence of own race bias in emotion recognition.

Brent Nixon (Geology major) worked with Pete Ryan (Geology and Environmental Studies) during the academic year on a senior thesis that examined the mineralogy and hydrology of elevated sodium sulfate in surface water in eastern Montana.

Marcela Olvera (Biochemistry major) worked with Roger Sandwick (Chemistry & Biochemistry) during the academic year on senior research

work, which focused on the inhibition of an enzyme in the purine synthesis pathway.

David Park (Mathematics major) completed his senior thesis in mathematics under the direction of John R. Schmitt (Mathematics). In his thesis he investigated use of an algebraic method applied to a problem in finite geometry.

Zach Perzan (Geology major) completed an independent study with Jeff Munroe (Geology) during Winter 2015 focused on interpreting the sedimentary record in the deepest accessible level of the Weybridge Cave, Vermont. Results indicate that these sediments washed into the cave from an ice-free surface environment before the last glaciation.

Rita Pfeiffer (Neuroscience major) worked with Tom Root (Biology) on a study of the role and implications of rhythmic production in speech in children.

Lauren Pincus (Chemistry – Geology double major) worked with Molly Costanza-Robinson (Environmental Studies and Chemistry), Pete Ryan (Geology and Environmental Studies), and collaborators in Spain on a winter term project to visualize the interlayer expansion of clay minerals in response to chemical modification. Lauren's high-resolution transmission electron microscopy data provided useful insights into the use of engineered clays for remediation of organic contaminants from wastewater.

Rahul Rakshit (Chemistry major) completed a thesis in the laboratory of Jeff Byers (Chemistry & Biochemistry), attempting to carry out Suzuki coupling reactions of arene-Chromium organometallic complexes. Rahul pioneered the use of new equipment aimed at running multiple parallel reactions, which should have a long-term effect of improving laboratory throughput.

Shannon Reinert (Biochemistry major) worked with Roger Sandwick (Chemistry & Biochemistry) during the summer and academic year on her senior thesis, which focused on the characterization of cytochrome c's ability to activate downstream caspase activity in the process of apoptosis.

Mary Richards and **John (Jack) Kerby-Miller** (Environmental Studies – Chemistry joint majors) worked during summer and academic terms, for Jack forming the basis of his senior honors thesis in Environmental Studies, while **Kristina Conroy** (Psychology major) (academic year) and **Emily Auran** (Environmental Studies – Chemistry joint major) worked only during the academic year, all on an ongoing project with Molly Costanza-Robinson (Environmental Studies and Chemistry) to develop novel bioindicators for detecting environmental endocrine disruption in humans at the population level.

Ethan Roy (Neuroscience major) worked with Mark Spritzer (Biology) during the summer and academic year on his senior thesis entitled *Effects of dihydrotestosterone on stages of adult neurogenesis in male rats*.

Rob Shaw (Neuroscience major) worked with Mike Dash (Psychology) during the academic year on an independent project that focused on the relationships between brain anatomy and the formation of distinct neuronal assemblies.

Hayden Shea (Biology and Environmental Studies - Conservation Biology joint major) worked with Steve Trombulak (Biology and Environmental Studies) during the academic on her senior thesis, which is exploring the precision of habitat suitability models to predict the distribution of rare plants in New York State.

Dana Silver (Computer Science major) worked during the summer with Christopher Andrews (Computer Science) on MiddGuard, a new visual analytics platform that supports collaborative analytics, specifically targeting intelligence analysis.

Christine Skeffington (Biochemistry major) worked with Roger Sandwick (Chemistry & Biochemistry) during the academic year on senior research work that analyzed the presence of a quorum sensor in bacterial cell media.

Stephanie Smith (Independent Scholar) worked with Helen Young (Biology) in the Fall 2014 semester on her thesis: *Soil fertility and the abundance of soil microorganisms in conventional and organic agricultural systems*.

Alexandra Spencer-Wong (Neuroscience major) worked with Tom Root (Biology) on a study of tactile discrimination in the California Two Spot octopus.

Isabella Stallworthy (Neuroscience major) worked with Jason Arndt (Psychology) during the academic year on her independent senior research project exploring the effects of emotional arousal and valence on memory.

Noah Stone (Geology major) completed an independent study with Jeff Munroe (Geology) during the Fall 2014 that involved generating optically stimulated luminescence ages for samples they collected from a field of sand dunes in northeastern Nevada. Results indicate that the dunes formed as recently as 100 years ago, raising the possibility that dune activation was related to upstream diversions of water for irrigation.

Ethan Strayer (Biology major) worked with Roger Sandwick (Chemistry & Biochemistry) during the academic year on senior research work that characterized the glycation of human hemoglobin by ribose 5-phosphate.

Chloe Super (Neuroscience major) worked with Mark Spritzer (Biology) during the summer and academic year on her senior thesis entitled *Effect of testosterone and age on spatial memory and BDNF in male rats*.

Kristen Taft (Physics major) worked on her senior project with Rich Wolfson (Physics) during the fall semester, studying the differential response of Middlebury's 143-kW solar farm to direct and diffuse solar radiation. She confirmed a theoretical prediction that solar photovoltaic systems should actually be more efficient (although producing less energy) under cloudy as opposed to clear conditions.

Mika Tan (Biology major) worked with Sallie Sheldon (Biology) and Grace Spatafora (Biology) during the academic year on a metagenomic analysis of microbial biofilms that form on various materials in lakes by biofilms.

Dominik Tattera (Neuroscience major) worked with Clarissa Parker (Psychology and Neuroscience) during the summer conducting behavioral genetic research.

Walter Taylor (Neuroscience major) worked with Clarissa Parker (Psychology and Neuroscience) during the academic year on his senior thesis, which examined variation in conditioned fear in the Diversity Outbred mouse population and its implications for genome-wide association mapping.

Hannah Tiberend (Mathematics major) completed her senior thesis in mathematics under the direction of John R. Schmitt (Mathematics). In her thesis she investigated the graph theoretic topic of list coloring, which included use of the Alon-Tarsi Theorem.

Dorosi Valle Flores (Psychology major), **Julie Goodfriend** (Neuroscience major), **Erin Rea** (Neuroscience major), and **Ashley Leung** (Psychology major) worked with Jason Arndt (Psychology) during the academic year as research assistants on projects examining how testing influences memory and different encoding strategies influence memory errors.

Huaiju Wang and **Mark Isbell** (Chemistry majors) completed theses with Jeff Byers (Chemistry & Biochemistry) on the synthesis of organometallic molecular wires. Their work led to the synthesis of poorly conducting polymers, and future work incorporating metals may lead to improved conductivity.

Amanda Werrell (Biology and Environmental Studies - Conservation Biology joint major) worked with Steve Trombulak (Biology and Environmental Studies) during the academic on her senior thesis, which focused on a field study to quantify the bias introduced by the use of bird feeders on the number of individuals and species of birds surveyed during Christmas Bird Counts.

Klaudia Wojciechowska (Molecular Biology & Biochemistry major) worked with Roger Sandwick (Chemistry & Biochemistry) during the academic year on research work to identify the potential of microorganisms to uptake and convert alloose to a phosphorylated form.

Community Outreach Activities

Dave Allen (Biology) offered a three-class short course titled *The forests of Vermont and their future* during the Spring 2015 semester at Elderly Services Inc. College.

Rick Bunt (Chemistry & Biochemistry) worked with the Aurora Middle School on a laboratory experiment using red cabbage to detect the acid-base properties of common household items.

Ray Coish (Geology) taught a course entitled *Volcanoes: the Blood of the Earth* to an *Elder College* class in Middlebury during Winter 2015 and also gave a public lecture on *Vermont Geology: A Tale of Ancient Oceans and Volcanoes* to 75 enthusiastic learners at the *Green Mountain Academy for Lifelong Learning* in Manchester, Vermont in Spring 2015.

Jonathan Kemp (Science Technical Support Services) managed an outreach program at the astronomical observatory that welcomed local schoolchildren, the College community, and the general public. He also worked with and trained College students and a local high school student as part of the astronomical observatory's outreach program.



Emily Proctor (Mathematics) offered two classes on *Geometry and the Shape of Space* at the 2014 Governor's Institute of Mathematical Sciences.

Tom Root (Biology) worked with Lisa Bernardin of the Vermont Brain Bee to

provide opportunities for Neuroscience majors to assist local high school students learn brain facts and concepts.

John R. Schmitt (Mathematics) gave a lecture at the Governor's Institute in Mathematical Sciences, held at the University of Vermont in summer of 2014. He introduced the students to a topic in combinatorial game theory.

Sallie Sheldon (Biology) taught high school teams from Vermont, New York, Delaware, and Puerto Rico how to sample streams, work with samples, and analyze data as part of the VT-EPSCoR program.

Grace Spatafora (Biology) organized two science fairs at each of two local middle schools in Spring 2015. Student projects were on display during a Science Fair night that she hosted at the College's McCardell Bicentennial Great Hall in March 2015. She also hosted a Science Day at the McCardell Bicentennial Hall in Spring 2015 for local 7th graders.

Mark Spritzer (Biology) hosted a one-hour visit by the Human Biology class from Middlebury Union High School. Students were given a demonstration of electrophysiology equipment and a tour of the Spritzer research laboratory.

Jeremy Ward and **Nancy Graham** (Biology) offered multiple workshops and visits for public school students in Addison County in biology through the NSF CAREER grant funded program – The Gene Wagon.

Department/program Statements *(submitted by department chairs and program directors)*

Biology (Dr. Jeremy Ward, chair)

There were four major events in the Biology department this year (CY 2014) that stand out: (1) the recruitment and hiring of Dr. Jill Mikucki, polar ecologist and microbiologist, (2) hosting of Nobel laureate, Dr. Martin Chalfie, (3) the announcement and planning (by co-head biology faculty member Dr. Susan DeSimone) of the first STEM Posse, and (4) a strong level of student-faculty collaborative scholarship.

Dr. Jill Mikucki.—Dr. Mikucki is an internationally known polar microbial ecologist whose work has been published in excellent journals such as *Science* and *Nature* and funded by the



National Science Foundation and NASA. Dr. Mikucki describes her work as the study of interactions between microbes and their environment and how the impact of microbial metabolism is detectable on an ecosystem scale. In particular she focuses on sub-glacial environments as a "model" ecosystem because their isolation and relatively simple food-webs allow for the study of microbially-mediated processes, which can be difficult to identify in more complex ecosystems.

Dr. Mikucki conducted her graduate work at Montana State University and her post-doctoral studies at Harvard University and Dartmouth College. She most recently was a faculty member at the University of Tennessee where she taught and worked closely with many undergraduates including several who travelled to Antarctica with her. She will join us this fall (2015) and begin teaching an Molecular Microbial Ecology course that bridges the molecular genetics side of biology with the ecology side. She will also teach in our genomics course and introductory ecology and evolution. We are very much looking forward to having her at Middlebury.

Dr. Martin Chalfie.—Dr. Chalfie is the co-recipient of the 2008 Nobel Prize in Chemistry, awarded for his work discovering and using the fluorescent protein called GFP. Dr. Chalfie was invited by Biology faculty member Dr. Ernstrom (also faculty in the Program in Neuroscience). Dr. Chalfie met with many students during his visit and emphasized the value of persistence in laboratory work and appreciation of results you were not expecting. Dr. Chalfie was awarded an honorary degree at the 2015 Commencement.

STEM Posse.—In January 2014, President Ron Liebowitz announced that Middlebury will host its first STEM POSSE group of 10 urban students selected by the POSSE foundation from Los Angeles. Middlebury Biology faculty member Dr. Susan DeSimone is co-head of the planning group (with Dr. Roger Sandwick in Molecular Biology and Biochemistry) that is organizing the STEM POSSE student's pre-matriculation visit to Middlebury in the summer of 2015.

Student and Faculty Scholarship.—Biology students and faculty were very productive collaborative scholars in 2014. Six students were collaborative authors with three Biology faculty members in peer-reviewed publications. Further, in CY 2014 there were five active or new national level grants and one regional level grant with Biology faculty as principle investigators. The value of these grants dedicated to student independent work was over \$200,000.

Chemistry & Biochemistry (Dr. Rick Bunt, chair)

After more than two years of planning and preparation, we unveiled our new organic chemistry curriculum this fall. The first semester course, CHEM 203, and its follow-up, CHEM 204, represent a major shift how we approach organic chemistry at Middlebury.

This change was undertaken to address changing medical school admissions requirements, the new MCAT-2015 exam, and to improve flow across our curriculum for all students, including our chemistry and biochemistry majors. Students from CHEM 203 can now continue directly on to



biochemistry (CHEM 322) without taking the second semester of organic chemistry, which is no longer part of the standard “premed” track. As CHEM 203, CHEM 204, and CHEM 322 are now offered both fall and spring semesters, premedical students and majors alike have many more options for how they complete the courses and balance their other academic interests, other majors / minors, and activities such as study abroad.

To support this new curriculum and increased number of course offerings (fall and spring) the department hired a dynamic new biochemist, Lesley-Ann Giddings, who started in January. Originally from Jamaica, Dr. Giddings grew up in New York City before graduating from Smith College, getting her Ph.D. from MIT, and doing a post-doc at the National Cancer Institute. We are all very excited that she has joined us and is getting her research lab up and running this summer.

Computer Science (Dr. Daniel Scharstein, chair)

The Department of Computer Science had a busy and productive year, with enrollments continuing to climb to new record levels. We taught more than 750 students this year - a three-fold increase over the last 4 years - and graduated 24 seniors.

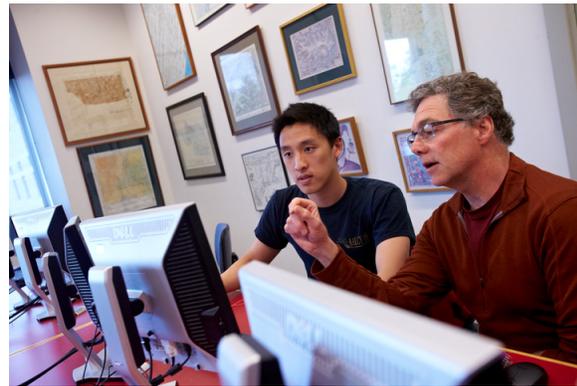
We welcomed a new colleague, Peter Johnson, into a visiting position, and hired our colleague Christopher Andrews into a tenure-track line. We also expanded our curriculum by offering a new interdisciplinary track with scientific computation focus to the computer science major.

Several colleagues collaborated on research problems with Middlebury students during the summer, and one paper co-authored with 5 Middlebury students won the best paper award at the German Conference for Pattern Recognition.

Geography (Dr. Pete Nelson, chair)

The GIS Teaching Fellows program has now completed its second full year under the direction of Jeff Howarth and assisted by Bill Hegman. Over the past two years, three Post-Docs have completed teaching fellowships from the fields of Geography and Archeology. This program now allows us to serve a larger number of students in our introductory GIS course and expand the offerings of GIS courses at more advanced levels. The Department is excited to welcome a Conservation Biologist and Urban Geographer as fellows during the 2015-16 academic year.

The Geography Department has now become one of the core 'hubs' of the Digital Liberal Arts initiatives supporting colleagues from across campus as they incorporate geo-spatial technologies into their teaching and research programs. Caitlin Myers of the Economics department will be one of the first fellows with an explicitly geo-spatial focus as she seeks ways to better assess the effects of abortion policy on demographic and social outcomes for women and children.



In the Fall 2014, Joshua Rodd joined our department for the first year of a two year position. Josh brings expertise in Health and Medical Geography to our curriculum as well as regional expertise in Africa. Josh's position now allows the Department to consistently offer our Research Methods course.

Geology (Dr. Jeff Munroe, chair)

The Geology Department graduated 12 students in the 2014–15 academic year. As always, each of these students completed a year-long senior thesis on topics as close as identifying the source of uranium in Champlain Valley groundwater, and as far away as investigating the petrology of igneous rocks on the Banks Peninsula in New Zealand. Logan Miller '15 received the Charles G. Doll award from the Vermont Geological Society for his senior-thesis work on a volcanogenic massive sulfide deposit in southeastern Alaska. Zach Perzan '14.5 was one of just 60 students nationwide invited to present his research at the Council on Undergraduate Research "Posters on the Hill" event in Washington, DC. Using the Department's Luminescence laboratory, Zach determined that sediments in the Weybridge Cave, just a few miles from Middlebury, predate the last glaciation, making this one of the only locations in New England where pre-glacial sediments are preserved. Perhaps the biggest change in the Department was acquisition of

a new Inductively Coupled Argon Plasma – Mass Spectrometer (ICAP-MS) that will be used for geochemical investigations. The ICAP-MS can measure trace element abundances in rock, soil, and water samples at concentrations as low as parts per billion. The Department also acquired a new X-ray Fluorescence (XRF) analyzer for measuring the concentrations of major elements in powdered rock samples. The two new instruments were installed in January, 2015, and Ray Coish, Pete Ryan, and Jody Smith worked extensively through the spring semester designing protocols that will allow Geology students, as well as students from other departments, to use these analyzers in their classes and research.

Molecular Biology & Biochemistry (Dr. Roger Sandwick, director)

In 2015, the program has continued to thrive with increased numbers of majors and the addition of two new faculty members, Dr. Glen Ernstrom of the Biology Department/Neuroscience Program and Dr. Lesley-Ann Giddings of the Department of Chemistry & Biochemistry. The research interests of the faculty that can benefit Middlebury students now range from the molecular action of the neuronal transporters to the chemical basis of antibiotics that derive from microbes. Recent changes in the curriculum ensure that graduates receive breadth in molecular biology and biochemistry in addition to research experiences.

Neuroscience (Dr. Tom Root, director)

The Neuroscience Program changed substantially this year, from the curriculum, through collaborative events, to a new faculty member. We substantially revised the neuroscience major, by adding several new elective courses, changing the introductory course sequence, and most importantly adding new “Fundamentals” courses. These fundamentals courses, include two completely new courses, designed specifically for neuroscience majors, *Fundamentals of Cellular and Molecular Neuroscience* (NSCI 251) and *Fundamentals of Behavioral Neuroscience* (NSCI 252). We also created an additional option in the Fundamentals of Philosophical Neuroscience requirement, by adding *Rationality and Cognition* (PHIL 358).

Our program added a new faculty member. We are excited that, starting in September, Amanda Crocker will be our new Assistant Professor of Neuroscience. Besides teaching in the fundamentals of neuroscience courses, she may offer courses in areas like systems neuroscience, neurogenetics, sleep and circadian rhythms, the molecular basis of learning and memory, and human genetics and public policy.

Several of our students participated in outreach to local high schools in preparation for the Brain Bee, others volunteered at clinics and assisted living facilities, and our recent graduates are entering positions in teaching,

medical school, and research in labs, ranging from molecular neuroscience to mindfulness.

We had an especially successful seminar series this year, ranging from the multi-media program “Self Comes to Mind” to Nobel laureate, Dr. Martin Chalfie. Further, expanding our collaborations with other programs and departments, we co-sponsored a series of seminars and events ranging from computer science to film and media studies.

At the end of this year, the Neuroscience Program therefore looks substantially different than previous. We are very excited, needless to say, by the changes in our curriculum, faculty, expanded collaborations, and the growth and accomplishments of our students.

Physics (Dr. Noah Graham, chair)

In Physics, new faculty member Michael Durst and his students have established a new experimental lab that uses infrared lasers for biomedical imaging. His research uses nonlinear optics and biomedical imaging to look deep through biological tissue without making an incision. Ultrafast pulsed lasers penetrate scattering samples and create high resolution three-dimensional images through multiphoton microscopy, temporal focusing, and photothermal imaging. Observations of merging black holes by second-year professor Eilat Glikman and her collaborators, published in *Nature*, were featured in the New York Times. During her pre-tenure leave, Anne Goodsell has created ultracold atoms by laser cooling, a major experimental achievement that will form the basis for a variety of experiments to be carried out with student collaborators.

Senior faculty have been active in teaching and scholarship as well. Department Chair Noah Graham and his students have calculated quantum-mechanical Casimir forces in



applications relevant to nanotechnology, in the process developing new computational tools applicable to a variety of problems in physics and engineering. Noah is also advising the third year of the STEM innovation program, with students focusing on applications of infrared imaging to the diagnosis of hoof disease in dairy cows. Susan Watson and her students are using carbon nanotubes to investigate quantum bits (qubits), the fundamental building blocks of quantum computation. Steve Ratcliff has developed a new first-year seminar on the physics of sound, including

extensive hands-on lab activities. Jeff Dunham has developed a new course on computational physics and scientific visualization and is supervising students developing high-performance computational projects using massively parallel CPU and GPU processors. Finally, Rich Wolfson has taught an interdisciplinary course on the physics of climate change, been involved in a number of student environmental projects on campus, and created a new video course for the Teaching Company's Great Courses series.

Psychology (Dr. Marcia Collaer, chair)

External Review Preparation.—A subcommittee of four faculty members (Collaer, Dash, Hofer McCauley) began preparation in January 2015 for our external review (scheduled for March 2016). We met every two weeks to consider strengths and weaknesses of our program, particularly with regard to our foundations courses (Introduction to Psychology, Statistics, and Methods) and to consider how our major compares to that of other schools. Subsequently, we held a department retreat in May to discuss our findings with our fellow faculty and to identify the major issues on which we hope for feedback from the external review committee. Further preparation is continuing this summer.

New Faculty.—New tenure track faculty members for 14-15 were Rob Moeller (converted to tenure track after a one-year term position in 13-14), and Mike Dash. Clarissa Parker started the second year of her tenure track position at the college, but 14-15 provided her first full year of access to her own laboratory space, permitting her research program to expand.

Research.—The addition of new faculty has dramatically expanded the research opportunities for our students, as all of these faculty are involving multiple students in their labs. In terms of the specific foci of our new faculty:

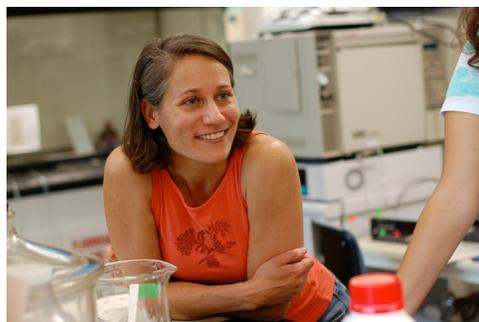
- Mike Dash (new TT 14-15) studies the physiological, behavioral, and cognitive consequences of spontaneous brain activity with regards to sleep, learning and memory, and cerebral metabolism
- Clarissa Parker (new TT 13-14, but with her first full AY of laboratory access in 14-15) uses the relative simplicity of mouse models to develop concepts, test neurobiological hypotheses, and identify genes that underlie traits with relevance to human psychiatric disorders
- Rob Moeller (new TT 14-15) focuses on the development of health behaviors among adolescents and young adults studying risks and resiliencies associated with substance use, mental health and sexual behavior

Curriculum and Teaching.—The Psychology department solidified its interdepartmental contributions by designing and/or offering new courses to contribute to the recently revised Neuroscience curriculum: *Sensation and Perception* (taught beginning 14-15); *Genes, Brain, Behavior* (senior seminar, taught first 14-15); and *Fundamentals of Behavioral Neuroscience* (designed 14-15). We offered a new course jointly with the Religion Department (taught first in 14-15). We continue to contribute critical courses to the Conservation Psychology focus in the Environmental Studies Program, and multiple courses to the Education Studies Program.

Interdisciplinary Initiatives

Dave Allen (Biology) collaborated with artist Sarah Bryant on a letterpress artist book titled *Figure Study* (<http://mcbaprize.org/bryant/>).

Molly Costanza-Robinson (Environmental Studies and Chemistry & Biochemistry) and **Diane Munroe** (Environmental Studies) developed a community-based laboratory project for *Instrumental Analysis Laboratory* (CHEM 311) in which chemistry students partnered with the Addison County River Watch Collaborative to investigate Dead Creek as a source of phosphorus to Otter Creek.



Susan DeSimone (Biology) and **Roger Sandwick** (Chemistry & Biochemistry) developed and ran a 2-week summer immersion program for the new STEM Posse from Los Angeles.

Jim Larrabee (Chemistry & Biochemistry), **Mez Baker-Medard** (Environmental Studies), **Molly Costanza-Robinson** (Environmental Studies and Chemistry & Biochemistry), and **Diane Munroe** (Environmental Studies) facilitated student collaboration across disciplines, allowing CHEM 311 (*Instrumental Analysis Laboratory*) students to “scientifically consult” for ENVS 401 (*Environmental Studies Senior Seminar*) by analyzing lead (Pb) content in soils, compost, and cosmetic products.

Jonathan Kemp (Science Technical Support Services) collaborated with **Tracy Weston** (Education Studies) to bring telescopes and astronomy into the science curriculum at a local elementary school.

Robert Moeller (Psychology) participated in the *Movement Matters* program (led by **Christal Brown** in the Dance Department) during the Winter Term.

Pete Ryan (Geology) and **Dave Allen** (Biology) collaborated on a paper that demonstrated that arsenic in bedrock aquifers is inversely proportional to metamorphic grade.

Jeremy Ward (Biology), **Frank Swenton** (Math), and **Noah Graham** (Physics) continued to offer the STEM Innovation Program in Summer 2014. This iteration of STEM IP developed a GPS-guided vessel that was capable of sampling water from Lake Champlain to assess toxic bacterial levels to aid in water use recommendations.