Examples of Student-Led Independent Study, Research and Presentations

Phillips Academy
ANDOVER
Abbot Independent Scholars Program

The AISP provides selected seniors (and the occasional younger student) who have exhausted the course offerings in their desired area(s) of study an opportunity to work independently with a faculty mentor for course credit. The number of credits assigned to a student's independent project depends on the nature and scope of the planned work. Each project is graded on the standard 0–6 scale by the supervising faculty mentor. Seniors who have completed a term of independent work successfully may apply to be Abbot Scholars in the spring term. As an Abbot Scholar, the student will pursue an independent project (typically a continuation or expansion of work done previously), prepare some form of public exhibition based on his or her work, and, together with his or her mentor, participate in a colloquium involving all Abbot Scholars and their mentors. Additional information on the AISP and its application process is available on PA net under Academic Resources, Student Information.

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**Winter Term 2008**

**Student: Joel**  
Costume Design - Creating a costume portfolio for *The Jungle Book*. (mentor: B. Murray)

**Student: Alex**  
Mathematics - Computer Algorithms: Learning algorithms beyond those taught in AP Computer Science using MIT's OpenCourseWare. (mentor: M. Litvin)

**Student: Alex**  
English - Professional Science Writing: Reading science journalism and literature, and creating a portfolio of pieces of topics such as quantum mechanics, relativity, game theory, information theory. (mentor: J. Bird)

**Student: Samantha**  
Chinese - Literature Study: Reading and analyzing *Journey to the West* (aka *The Monkey King*), one of China’s oldest folk legends, and writing a research paper in Chinese. (mentor: T. Conley)

**Student: Charles**  
Mathematics - Computer Science: Constructing a fully interactive Java computer game that allows users to simulate owning and operating a cookie-selling business. (mentor: M. Litvin)

**Student: Blaine**  
Spanish - Literature Study: Reading and writing in Spanish about the poetry of Gustavo Adolfo Becquer. (mentor: P. Neissa)

**Student: Paul**  
Music - String Composition. (mentor: J. Matheson)

**Student: William**  
Mathematics - Computer Algorithms: Learning algorithms beyond those taught in AP Computer Science using MIT’s OpenCourseWare. (mentor: M. Litvin)

**Student: Meng**  
Mathematics - Advanced Geometry: Study of the text *Geometry Revisited* by Coxeter & Greitzer. (mentor: D. Penner)

**Student: Kim**  
Mathematics - Computer Algorithms: Learning algorithms beyond those taught in AP Computer Science using MIT’s OpenCourseWare. (mentor: M. Litvin)

**Student: Lucas**  
Theatre and Dance - Directing: The full-length play *A Taste of Honey* by Shelagh Delaney. (mentor: K. Heelan)

**Student: Benjamin**  
Mathematics - Differential Equations: Studying math tests typically used during the fifth semester of college. (mentor: D. Kuhlmann)
Student: Zach
Theatre and Dance - Playwriting II. (mentors: K. Heelan & M. Efinger)

Student: Molly
Theatre and Dance - Directing the full-length play. (mentor: M. Efinger)

Student: Alex
German - Advanced German. (mentor: L. Svec)

Student: Alyssa
History and Social Science - Abolitionism in black and white. (mentor: B. Chase)

Spring Term 2008

Student: Joel
Theatre and Dance Costume Design - Assembling and constructing costumes for the school production The Jungle Book. (mentor: B. Murray)

Student: Elizabeth
English - Novella Writing. (mentor: R. Peffer)

Student: Man-Kit
Chemistry - Environmental Technology: Read extensively in the field of environmental chemistry [on topics such as fuel cells, biofuels, waste treatment, energy production from waste with microbiological methods, and nanotech/cleantech] and work in laboratory to achieve sustained photobiological hydrogen gas production. (mentor: D. Stern)

Student: Rachel
Biology - Human Pathophysiology: Case studies and research. (mentor: R. Keller)

Student: Tantum
History and Social Science - International Relations II: Reading, discussion, and research with focus on China. (mentor: C. Gurry)

Student: Alex
Mathematics - Number theory. (mentor: D. Penner)

Student: Zachary
Biology - Human Pathophysiology: Case studies and research. (mentor: R. Keller)

Student: Adam
History and Social Science - International Relations II: Reading, discussion, and research with focus on Islam. (mentor: C. Gurry)

Student: Samantha
World Languages - Linguistics: Introductory course making use of textbook by Akmajian et al and MIT's OpenCourseWare. (mentor: P. Merrill)

Student: Alex
History and Social Science - Presidential Campaigns: 1960 vs. 2008: Involves research at JFK Library. (mentor: B. Chase)

Student: Kate
English - Novella writing. (mentor: J. Gould)

Student: Alison
Biology - Sustainability: Reading and research to produce actionable steps at and lesson plans for Andover. (mentor: R. Bogdonavitch)

Student: Meng
Chinese - Chinese Idioms: Collect Chinese idioms and document their backgrounds. (mentor: N. Dong)
**Student: Christopher**
Biology - Human Pathophysiology: Case studies and research. (mentor: R. Keller)

**Student: Phillip**
History and Social Science - International Relations II: Reading, discussion, and research with focus on Russia. (mentor: C. Gurry)

**Student: Allison**
Music - Composition. (mentor: J. Matheson)

**Student: Arun**
Mathematics - Number theory. (mentor: D. Penner)

**Student: Thomas**
German - German 600: Advanced study. (mentor: L. Svec)

**Student: Alyssa**
Psychology - Child Development and Music: Reading and research in the area of child development generally and specifically in the role music plays in brain development. (mentor: C. Israel)

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**Fall Term 2008**

**Student: Radmila**
Physics - Asteroid Study: Using the 16-inch telescope in Gelb observatory, as well as SBIG’s CCD camera, we will take a series of pictures of a main-belt asteroid and collect valuable data. (mentor: R. Fienberg)

**Student: K. Mai**
Japanese - Study of Keigo: The levels of honorific form in Japanese are very complex, including, polite, respectful and humble language. The use of honorific forms are essential in business settings and functioning in Japanese society. However, they are usually not taught in universities or high schools. (mentor: T. Bourne)

**Student: Kwon-Young**
Math - Real Analysis: This independent project will familiarize the students with rigorous mathematical thinking in analysis with the ultimate goal of training us in the mathematical insight and creativity necessary to not only appreciate the construction of existing proofs but also construct proofs of similar level on our own. (mentor: D. Kuhlman)

**Student: Jiageng**
Computer Science - Applied Artificial Intelligence: The project will focus on using genetic programming to evolve a poker AI. We chose the game of poker because it is very well-defined (it has easy-to-understand rules and scoring) and simple to represent visually and algorithmically. (mentor: J. Hugon)

**Student: Victory**
Classics/Japanese - Greek Mythology & Shinto: The objective of this independent project is to establish the absence, presence, and nature of commonalities between the mythological religions of two of the oldest and most distinct cultures, with a particular focus on the role and characterization of gods. (mentors: D. Pottle & T. Bourne)

**Student: Catherine**
Latin - Advanced translation. (mentor: E. Meyer)

**Student: Ryan**
Math - Using the programming language Ruby on Rails, the goal for this project is to make a functioning social networking Website, similar to, though not as powerful as, Facebook or MySpace. (mentor: J. Hugon)

**Student: Elizabeth**
Spanish - Colombian Literature as a Function of Memory in Colombian History: Colombian literature and how it has often come to function as a historical record of the Twentieth-century. At the same time it will instruct the student with the basic knowledge of the different Colombian literary and political movements, which also mirrored the larger Latin American and literary and political movements and transitions. (mentor: P. Neissa)
“Doing science,” the first goal of Andover’s science program, is the mechanism by which many students learn best. It is this principle that guides the Molecular Biology Research Program. Beginning with instruction on basic techniques in biology, students embark on independent research projects of their choosing. These projects have ranged from looking at the abrogation of cancer cell proliferation in the presence of substances, such as vitamin D, to gene silencing in C. elegans worms using RNA interference techniques to the complexities of improving the fidelity of in vitro DNA synthesis and PCR. The laboratory space provides students with a wealth of resources, including a mammalian tissue culture area and a multitude of molecular biology reagents and equipment. The students enrolled in this program typically carry out research projects ranging from one term to more than one year. The projects culminate in a written scientific paper and a poster session for the entire PA community. Dr. Kristen Johnson, Instructor in Biology, runs the molecular biology lab.

Student Researcher: Ryan
On-demand DNA synthesis promises to open up a wide array of opportunities in molecular biology research, including the charting, design, and synthesis of novel proteins, genetic circuits and biochemical pathways. This potential will be unlocked through the availability of cheap, reliable, efficient de novo DNA synthesis, and the main prohibitive factor is the high error rates currently inherent to oligonucleotide synthesis (Carr, Park et al. 2004). DNA repair pathways in organisms, where error rates of DNA replication are often 1 in 1,000,000 bp or lower, present models to mimic and adapt to in vitro DNA synthesis methods. At present, the lowest numbers in DNA synthesis error rates have been 1 in 10,000 bp, offering much room for improvement (Carr, Park et al. 2004). Archaeal DNA repair pathways, interesting because no convincing candidate proteins exist for detection of DNA mismatches, are thought to rely heavily on single-stranded DNA binding proteins (SSB) (Cu beddu and White 2005). Crenarchaeal SSB is a monomer with a single oligonucleotide-binding fold, of which the sequence is similar to eukaryal Replication Protein A (RPA), coupled to a C-terminal tail reminiscent of bacterial SSB (Kerr, Wadsworth et al. 2003). I have over-expressed and purified a Histagged version of Sulfolobus Solfataricus SSB (SsoSSB) and demonstrated ssDNA-binding activity on 39 bp oligonucleotides. I have attempted to show that SsoSSB can selectively melt duplex DNA containing a mismatch error. Based on this melting activity, I consider future applications of SsoSSB in improving the efficiency of PCR and accuracy of de novo DNA synthesis, allowing for the practical synthesis of long (high kb range) DNA constructs.

Student Researcher: Sardis
Vitamin D serves a multitude of purposes within the human body, including those that relate to differentiation and control of cellular growth by means of apoptosis. These experiments were designed to test the effects of the biologically active form of vitamin D, 1α,25-dihydroxycholecalciferol [1α,25(OH)2D3], on the growth rate of the osteosarcoma cell lines U-2 OS and SAOS-2. The U2-OS cell line was allowed to reproduce until approximately 75% confluent, and the SAOS-2 cell line was allowed to reproduce until 40% confluent, both were then treated with 1α,25(OH)2D3 in concentrations ranging from 10-5 - 10-9M for 48 and 96 hour trials. It was found that, rather than limiting cellular growth, exposure to 1α,25(OH)2D3 increased the rate of reproduction of the U-2 OS cells and had no significant effect on the SAOS-2 cells.

Student Researcher: Andrew
Gene therapy is a relatively new technology, which uses vectors to introduce novel DNA into cells. Gene therapy could potentially be used to correct genetic disease; however, there are many obstacles that must be overcome before this technique can be used clinically. One such issue is the targeting of gene therapy to specific cells in the body. The goal of the experiment was to create an epidermal growth factor (EGF)-liposome complex that could act as a targeted gene therapy vector to deliver death-inducing drugs or genes to cancer cells over-expressing EGF receptors on their surface. Streptavidin was used to attach biotinylated epidermal growth factor (EGF) to biotinylated arachidonic acid embedded in liposomes. In this experiment, the EGF-liposome complexes were used to transfect Saos-2 osteosarcoma cells with a GFP-mammalian expression plasmid. Transfection efficiency was measured using green fluorescent protein expressed by transfected cells.
Research in the Gelb Observatory

Gelb’s roof-level dome rotates 360 degrees and is outfitted with a DFM 16-inch Schmidt-Cassegrain reflector telescope. Computer control of both the dome and telescope allows remote astronomical viewing and data analysis for students and faculty alike who are conducting research or simply enjoying an evening of observing and learning. Former Sky & Telescope Magazine Editor in Chief, Rick Fienberg, runs the observatory and teaches astronomy. Dr. Fienberg is the Visiting Scientist in Astronomy on the Israel Family Foundation.

Student Researcher: Radka
The first part of my project (fall 2007) focused on becoming familiar with the SBIG Self Guided Spectrograph (SGS). Attached to a CCD (charge-coupled device) camera, the spectrograph is used to take spectra of celestial objects. An object’s spectrum provides astronomers with valuable information that would otherwise have been difficult to obtain. The second part of my project focused on collecting stellar spectra and analyzing it. Along with the spectra taken of a star, spectra also had to be collected using a calibration source. By comparing the spectrum of a calibration lamp with a star’s spectrum, I was able to determine the wavelength of every spectral line in the star’s spectrum. The relative strength and weakness absorption lines, especially those of hydrogen and helium, allowed me to classify the stars according to spectral type. Since the occurrence and strength of different absorption lines depend on temperature, the spectrum of a star reveals a star’s surface temperature. In the fall 2008, I will use the 16” telescope in Gelb observatory, as well as SBIG’s CCD camera, to take a series of pictures of a main-belt asteroid. By taking frequent pictures and using different colored filters, I will not only be able to refine the asteroid’s orbit, but will also be able to determine the asteroid’s rotation rate, light curve, and surface composition. I will use special-purpose astronomical software to analyze my results. From the images that I acquire, I will be able to measure the position of the asteroid over a few months as well as the brightness. The peaks and valleys in the light curve will allow me to determine the rotation rate and give me an idea of the shape of the asteroid. By taking exposures using different filters, I will be able to determine the asteroid’s color, which will also reveal its surface composition.

Student Researcher: Zachary (2008 Intel Science Talent Search Semifinalist)
This project investigates how sporulating Bacillus subtilis cells determine which direction to transport their chromosomal DNA. Sporulation is a developmental process initiated by poor nutrients in the environment, by which a polar spore is formed inside a mother cell (sporangium) and released, requiring the lysis of the mother cell. Once the polar spore has begun to form, 70% of the spore’s chromosome is still on the mother cell side and must be transported to the forespore. The DNA translocase protein SpoIIIE has been shown to use its ATPase activity to pump this DNA into the forming spore. Specifically, this investigation focuses on the role of a proposed DNA-interaction domain (the gamma domain) of SpoIIIE in controlling or influencing the direction of DNA pumping. The gamma domain is thought to determine the direction of transport by reading the direction of a set of non-palindromic skewed nucleotide sequences. In this study, fluorescence microscopy and assays for sporulation efficiency were used to demonstrate that the gamma domain is necessary and sufficient for successful directional pumping of the DNA and for successful formation of viable spores. Specific residues within the domain were also identified as being necessary for pumping and sporulation.

Student Researchers: Sebastian and Joshua (2008 Siemens Competition Semifinalists)
Succinimidylester of 6-((acryloyl)amino)hexanoic acid is a bioconjugator that can be incorporated into a polyacrylamide gel through inclusion in the radical polymerization process. Adding an antibody to a gel containing this molecule enables the covalent attachment of antibody to the succinimidyl ester units. Such a complex yet durable acrylamide-antibody matrix has the capability to capture viruses for which the antibody is specific when they are passed over its surface. We selected Enterobacteria phage T4, a type of bacteriophage that infects Escherichia coli and antibody that is specific for it to prove this concept. After the creation of the gel-antibody hybrid and the addition of bacteriophage, we eluted the coliphage from the matrix via a salt wash. Subsequently, we found it possible to prove its presence by observing plaques formed on plates of E. coli that had been grown from a mixture with the extracted viruses. Our data indicates that this
idea is a feasible one, with each gel sample that contained the correct antibody capturing a high percentage of the T4 virus. In the future, this filtration system will have myriad applications in the detection and extraction of viruses in biological systems, as well as the removal of infected cells by attaching a CD4+ protein to the gel in lieu of a specific antibody.

**Student Researcher: Gary (2007 Intel Science Talent Search Semifinalist)**
Resveratrol: A Natural cyclooxygenase inhibitor induces head and neck cancer cell arrest through activation of p53 and inhibition of PGE2 production.

**Student Researcher: Katherine (2006 Intel Science Talent Search Semifinalist)**
Effect of Electrical Stress on Gate Current in Metal-Insulator-Silicon Structures.

**Student Researcher: Krisha (2005 Intel Science Talent Search Semifinalist and Siemens Westinghouse Finalist)**
Photochemistry of CH3COCCIO and Dissociation of the Nascent CH3OCO Radical.

**Student Researcher: Vaishali (2005 Intel Science Talent Search Semifinalist)**
The Development of an Environmentally-Friendly Enzyme Based Antifouling System.
The CA M D Scholars program was created during the spring of 2007 by the Office of Community and Multicultural Development (CAMD) to allow students to apply for summer research grants to pursue topics in multiculturalism. Funded by the Abbot Academy Foundation, the scholarship provides a small stipend and a faculty advisor to each student selected.

### 2007 - 08

**Student: Jessica**  
A New Direction for Self-Expression: The Poetry Revolution. (mentor: Lou Bernieri)

**Student: Mary**  
Government Sponsored Education Programs for Spanish-Speaking Migrant Children in Florida. (mentor: Mark Cutler)

**Student: Daniah**  
Why do They Hate Us? (mentor: Randy Peffer)

**Student: Britney**  
I Am: A study of self identification among biracial teenagers. (mentor: Elwin Sykes)

**Student: Simone**  
Adversity to Diversity: Understanding the Southern Experience. (mentor: Barbara Chase)

**Student: Thomas**  

### 2008 - 09

**Student: Courtnie**  
The Multiethnic Dilemma: Identity formation for the Latina, Afro-Latina, and African American. (mentor: C. Hoyt)

**Student: Radka**  
Retaining Cultural Identities: A Look at the Rusyn community. (mentor: V. Svec)

**Student: Kimberly**  
Cambodian Immigrants in America. (mentor: A. Murata)

**Student: Jane**  
The Next Step: The Choctaw a century after the trail of tears. (mentor: M. Blustain)

**Student: Tori**  
White Privilege: A history and its role in contemporary education. (mentor: S. Curci)
Brace Center for Gender Studies
Student Fellow Presentation Series

Each spring, returning Phillips Academy students are invited to submit proposals for fellowships to support independent summer research projects in gender studies, including multiracial and multicultural dimensions. The Student Fellows Series is presented in the fall and provides an opportunity for the fellows to share their research findings in a public forum. Read below for descriptions of past student fellows projects.

2006

Student Fellow: Alison
Educated American Women: Career paths to motherhood?

Student Fellow: Stacy
Kiss of the Spider Women: Analysis of traditional and revolutionary concepts in sexual relationships according to gender identification.

Student Fellow: Erin
Living in the outer layers: Gender roles in Tsitsi Dangarembga’s portrait of Zimbabwe.

Student Fellow: Susan
Women in China: Interpreting the influences.

2007

Student Fellow: Alexa
The Mystery of the Disappearing Veil: The current state of the Islamic headscarf on Muslim-American women.

Student Fellow: Oliver
Freedom for Who? Sodomy saw, the Supreme Court and American popular opinion.

Student Fellow: Stephanie
Despair, Disease, Death: Mysteries of the red lanterns.

Student Fellow: Jennifer
Housewives, Astronauts, and Superwomen: The development of the status of Hong Kong women in marriage from the 1950-present.

2008

Student Fellow: Elias
Gender Prejudice in Journalism: The careers of Harriet Quimy and Amelia Earhart.

Student Fellow: Jennifer
Whatever Happened to Feminism? The paradoxical decline of feminist self-identification among young women.

Student Fellow: Curie
The Role of Women in Transforming Korean Corporate Culture: “Hoishik.”

Student Fellow: Elizabeth
Murder? Women’s Right? A Cultural Trend?: Attitudes and practices of abortion and contraception in Russia.

Student Fellow: Zoe
Financial Empowerment, Political Exclusion: NGO’s role in women’s journeys toward economic independence and public office in Senegal.