**Maple Scholars Projects**

**2017**

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**Maple Scholars Faculty Proposal (Summer 2017)**

Short title:  **Mosquito Diseases**

Full title: **Identification of Mosquito Vectored Human Illnesses by PCR**

**Dr. Andrew Ammons, Department of Biological Sciences**

**Description:**

The spread of human illnesses, particularly those caused by viruses, by mosquito species vectors has been a bane of human society for thousands of years. Encephalitis, malaria, dengue, yellow fever, and Zika are just a few of these diseases that have caused untold misery and suffering for millions upon millions of people.

 It is, therefore, imperative that we have a basic understanding of how these diseases are transmitted and carried by their mosquito hosts. The study of mosquitoes and the infectious human diseases they carry involves many disciplines, from medical and tropical entomology to virology, genomics, and epidemiology. Our increasing knowledge of this disease transmission, spread, and mosquito control has saved millions of lives in the last hundred years (Spielman and D’Antonio, 2001)

 PCR (polymerase chain reaction) is an effective and vital molecular genetic tool for identifying and manipulating DNA and RNA. Through the use of sequence-specific oligonucleotide primers, we can accomplish precise targeting and amplification of genomic regions. These techniques can aid in the identification of viruses, bacteria, filarial worms, and protozoan parasites carried by mosquito vectors. In fact, recent RT-PCR experiments have successfully isolated and identified the emerging infectious flavivirus, Zika, in wild, field-caught mosquito samples collected from around the world (Faye *et al*., 2013)

For this project, the student will be expected to participate in both the field and laboratory elements of mosquito research – setting up mosquito traps and collecting samples, rearing mosquitoes in the lab, extracting and manipulating DNA/RNA from frozen samples, and performing PCR and electrophoresis. In addition, the Maple Scholar will learn primer design and how to access and utilize online genomic databases. Other skills to be practiced might include sampling mosquito blood meals, extracting and analyzing proteins, quantification of DNA and RNA (using NanoDrop technology), microsurgery of mosquito organs (salivary glands, etc.), compound and dissecting microscopy, and dichotomous key identification of mosquito samples to species.

For any students that may be interested in the field research aspects of mosquito study in particular, living arrangements in the dorms at Merry Lea could be provided (rather than living in the on-campus dorms in Goshen).

 **Other independent and unique projects focused on insect taxonomy, ecology, behavior, or molecular genetics may be proposed (and is encouraged) by students. Student enthusiasm, self-motivation, and commitment to the project are a major factor in selecting Maple Scholar finalists.**

**The principal investigator’s hopes and goals for the summer** would be to have a student engage in active research, design their own experiments with guidance, and learn how to present research in a professional format.

 **Student applicants** would be aided by some biology or science background (appropriate for first year Biology majors), but this is not necessary for applying. Attendance at informal journal clubs will be necessary for the student to train in the interpretation of scientific publications.

 **The anticipated results from summer research for the participant** would be the completion of an independent research project. This project would be suitable for presentation at local or national scientific conferences. All scholars are also asked to write a research paper using the guidelines of the National Conference on Undergraduate Research. Student research may also contribute to eventual scientific publication, in which case the student would be listed as a co-author.

 **The principal investigator agrees to all mentor responsibilities as listed in the faculty guidelines.** Appropriate supervision, support, and encouragement for the student will nurture a one-on-one mentoring relationship. Any students will be treated as colleagues in the discovery of knowledge. The advisor will be available to guide, discuss issues, and train in the use of techniques, but will also try to allow the student to develop as an independent researcher designing their own project. Expectations for student scholars include working full days (and some weekends), being receptive to guidance offered by the advisor, and being passionate about doing science.

**References**

**Faye, O., O. Faye, D. Diallo, M. Diallo, M. Weidmann, and A. A. Sall (2013). Quantitative real-time PCR detection of Zika virus and evaluation with field-caught mosquitoes. *Virology Journal* 10:311.**

**Spielman, A. and M. D’Antonio. 2001. *Mosquito: A Natural History of our Most Persistent and Deadly Foe.* New York: Hyperion Publishing.**

GCInquiryPrograms

**Maple Scholars Proposal for Summer 2017**

**The Legacy of GC’s Inquiry Programs**

**Rev. Dr. Bob Yoder, Campus Ministries**

**Description:**

The three Inquiry Programs (IPs) of Goshen College (GC)—Camping, Ministry, Service—give students the opportunity to spend three months in a camp, congregation, or service agency with the goal of exploring the intersection of faith and vocation, while also developing skills for leadership. These goals are achieved through active participation, observation of others, intentional reflection, and the tutelage of an on-site supervising mentor.

This Maple Scholars project will explore the impact of GC’s summer IPs in the lives of over 400 former students who participated in one of these three programs and who majored in over a dozen different academic programs. The student Maple Scholar will work with me to both survey and interview IP alumni and host sites, as well as type transcripts of recorded interviews, in order to collect stories and examine the role that these experiences have had on their faith and vocational pursuits. The Maple Scholar will also read through IP files containing student reflections, student and host site evaluations, etc. identifying significant threads of key impact learning moments and practices of student IPers.

The oldest of the IPs, Ministry (MIP), began in 1988 as a denominational program of the Mennonite Church and is present at the other Mennonite colleges and universities. However, GC is a leader in this endeavor with our students representing approximately 45% of all MIP alumni. Today, over 200 GC alumni have served in over 120 different churches through MIP. Service Inquiry Program (SIP) and Camping Inquiry Program (CIP) are modeled after MIP, but are unique to GC. Each program has had over 100 student participants. SIP, begun in 2001, has placed students in over forty different locations around the world, while CIP, begun in 2002, has worked with over 20 different camps.

**Background expected:**

It would be helpful if the student has some familiarity with sociological and/or faith research, statistical analysis, and conducting interviews, but ultimately, a student who is interested in collecting stories and passionate about this project topic is desired.

**Anticipated Results:**

The student will write a 25-30 page paper that includes a brief history of the IPs and significant learnings from this research project. Key insights from this project will be used to strengthen the ongoing administration of the IPs and be shared with donors, church leaders, and general constituency as an example of a high-impact practice offered to students at Goshen College.

**Agreement with Mentor Responsibilities**

I agree to carry out the responsibilities to the best of my ability.

1. I will seek out qualified students and encourage them to apply to Maple Scholars.
2. I will select scholar(s) among applicants in consultation with other mentors and the Director.
3. I will provide appropriate supervision, support, and encouragement for project activities for the chosen scholar(s) during the entire eight weeks of the program.
4. I will communicate clear expectations to scholars with respect to work hours, duties, and any other relevant aspects of the project.
5. I will attend the first-day meeting, weekly colloquia, and the end-of-program celebration activities.
6. I will prepare the scholar(s) on the mentor’s project for presentations at the weekly colloquia and end-of-program celebration.

Regarding what I believe to be “appropriate supervision” for my project, I believe it is vital that I am in regular contact with them and that I am accessible and available to them throughout the eight weeks. The student will spend significant time alone reading through files, conducting interviews, and interpreting data.

Regarding appropriate work hours, I basically suggest, per previous guidelines, that they are to work full-time work weeks of around 40 hours, but how they accomplish their work is more up to them and in their style rather than it being a prescribed “8 to 5” type of job.

**Maple Scholars Project Proposal for Summer 2017**

**Ann Hostetler, possibly with the assistance of Micah Towery**

Assist with creating a publishing imprint, Painted Glass Press, for the Journal of the Center for Mennonite Writing. This project will involve working with Create Space, a self-publishing tool from Amazon.com. Several small presses use this tool to create their own imprint, but it requires design and editorial skills. The goal of establishing the press is to print 1-3 titles per year that have to do with Mennonite cultural identity, scholarship, literature and the arts. The first book will be the recently published (online) MennoFolk3, which will provide us with a full text and illustrations by local artist Doug Swartzentruber. After working with this book, we will curate some of the issues of JCMW and explore what is required to make the available in print.

The student should have some experience in design and a talent for editing and arrangement of materials. They should also be interested in the subject. This would be an ideal project for communication, English, graphic design, history or religion majors with editing experience, strong writing skills, and some experience in working with digital design or willingness to acquire such.

The project will serve the scholarly and literary community more broadly, but it will also give us an opportunity to explore and evaluate a new kind of publishing format that could be used for Pinchpenny Press and Red Cents publications. I would like to involve Micah Towery, an English Department adjunct faculty member with publishing experience, and in particular, with Create Space.

Goshen Spotlight

**Maple Scholars Proposal for Summer 2017**

**Goshen Spotlight Documentary**

**Kyle Hufford, Communication Department**

**Description:**

BACKGROUND

The last four years the Goshen Spotlight project has provided students opportunities to not only explore their own discipline but experience a variety of disciplines across the college. This project has also provided a service and benefit to our local.

This project doubled the visitors to the Goshen Commons site in 2013. In 2014 we partnered with the Elkhart Truth where these stories gained even more attention and exposure in our local community.

Over the last four years we have learned what works and what doesn’t in our process to capture these stories. In 2015 we expanded our scope and diversity within our community to reach areas we had not before. And last year by taking a whole new approach to this project we created new educational opportunities through a long format documentary that has had lasting power beyond Maple Scholars’ summer term.

One fact remains over the course of the projects, there are an endless amount of heartwarming and intriguing stories in Goshen.

PROJECT SCOPE

I am proposing for this summer to research and create a long form single topic documentary. This was very successful last summer and opened avenues to expand this year. We will research topics prior to the summer and choose a story that is both uniquely Goshen and one that has received little attention up to this point. A long form documentary will allow the student to focus on one topic for the summer term and be immersed in the research and telling of a singular story. This will be a departure from the multiple story approach of the last three years. The length of the documentary will be between 20 and 40 minutes.

UNIQUE CREATIVE OPPORTUNITY

Local news outlets like Goshen News and the local TV stations are good at representing the current news of the day. However, they don't always have the resources or interest in covering the stories of our community. This project would attempt to highlight a story that few have heard before and at the same time contribute to the discipline of documentary storytelling. No other organization is creating long form video packages focused on our local Goshen community.

**Background expected:**

The Maple Scholar student would need to meet the following requirements: (1) Have taken DMP I & II or the transferred credit equivalence. (2) Be at least a second year student. (3) Have interest in journalism and story telling (4) Ability to work well with others in group settings and also be a self motivator. (5) Have a US drivers license.

**Anticipated Results:**

SCHOLARLY BENEFIT

The discipline of journalism has seen tremendous changes and shifts in the last 10 years. Goshen Commons itself is an effort to provide a different kind of journalism in an alternative format. Convergence is becoming more and more important in the field of communication. We would like to answer a few questions such as;

1. What unique untold stories are in our community?
2. Why have these stories not been told?
3. What about these stories will relate to an audience?
4. How do we tell a story that connects and is interesting?

INTERDISCIPLINARY BENEFITS

This project will give both the professor and the student interdisciplinary experiences within the field of Communication. Opportunities to use one area of study in another are always encouraged in our field because they all relate to each other so well.

The major interdisciplinary benefit is the research and qualitative study that goes into every story. As we saw in 2015, for every story gathered there is an opportunity for the student to learn and research a topic they never approached before. In turn their work educates the public on their story’s topic.

STUDENT BENEFIT

In addition to a lot of the benefits already mentioned the student would get to practically implement theories learned in classes. Our media student will also leave the project with portfolio material to use for jobs or internships.

GOSHEN COLLEGE BENEFIT

Goshen College will gain more community exposure and good PR as Goshen Commons becomes more popular. It is also possible that if a process is developed and in place for Goshen Commons to have video content that this can be continued after this project is over.

**Agreement with Mentor Responsibilities**

I agree to carry out the responsibilities laid out in the Faculty Proposal Guidelines. I will also meet with the student at various points of the week’s assignment to help them in the pre-production planning phase, the production phase and the post production process phase. In addition to this I will be meeting with the student to evaluate their work and how the processes can be improved.

PROJECT EXPECTATIONS

The student is expected to have a completed documentary by the end of the Maple Scholars term. This includes all research, production, post production and audio.

PROJECT FEASIBILITY

Each week will have goals and milestones to hit in order to complete the project in time. A full story outline will be finished prior to the start of Maple Scholars in order to get a jump on research and filming. This also gives us time during the week to implement an evaluation process so we can improve on our workflow and style. Expectation would be 30hrs a week on the assigned video. Some of this time is going to be in the evenings and weekends.

**Maple Scholars Proposal for Summer 2017**

**Establishing Standards for Scientific Data Management**

**Justin Heinzekehr, Institutional Research**

**Description:**

Scientific researchers are under increasing pressure to organize, maintain and disseminate their data in a responsible way. Major research grants, for example, may require researchers to have an established data management plan before awarding funds. Data management plans not only save the researcher time in the long run, but also ensure that data can be preserved and made into useful information for future research projects.

The National Science Foundation (NSF) has suggested that Goshen College may have gaps in our understanding and application of scientific data management, as well as related policies, procedures and supporting infrastructure. The purpose of this proposal is to establish a collaborative relationship between the department of Institutional Research and the Maple Scholars Program around our common interest in establishing repeatable standards and practices for the proper management of institutional scientific research data.

This proposal provides an opportunity for a student researcher to learn about best practices in scientific data management, help to develop a curriculum that could be used to teach good data management practices to future Maple Scholars participants, and to collect and organize past Maple Scholars research data according to these practices. The student would benefit by gaining expertise in an important facet of the scientific research process, and the college would gain a consistent, sustainable data management policy.

Student tasks would include the following:

* Identifying centralized storage and taxonomy for preserving research data and artifacts
* Identifying and selecting appropriate metadata standards for various scientific disciplines
* Establishing a training protocol for both faculty and student participants in the Maple Scholars program.
* Attempting to locate prior year research data and applying newly-established standards to those projects.

Recommended text: Briney, Kristin “[Data Management for Researchers: Organize, maintain and share your data for research success](https://www.amazon.com/Data-Management-Researchers-Organize-maintain/dp/1784270113/ref%3Dsr_1_1)”

**Background expected:**

A successful student collaborator will have background and interest in scientific research with strong analytical abilities and coursework in the sciences. Some preference for prior coursework in computer science/informatics due to the nature of the discipline. There is an expectation that the student will develop a level of mastery over the discipline of scientific data management and develop implementation and communication strategies for the successful application of data management to the Maple Scholars Program and more broadly at Goshen College.

**Anticipated Results:**

Outcomes of this project would include:

* The development of a GC data management policy that could be implemented across disciplines.
* The development of a short training curriculum communicating expectations and standards for data management, which could be incorporated into the Maple Scholars orientation in future years.
* Retrieval and organization of past data from Maple Scholars research projects.

**Agreement with Mentor Responsibilities**

I have read the Maple Scholars Mentor Responsibilities and agree to fulfill the responsibilities outlined in that document. I agree to meet with the student on a daily basis and to provide clear expectations for the student’s work. I would subdivide the project into four smaller phases (reading and research, reporting of best practices, data retrieval and organization, developing training materials) with defined tasks, goals and timeline. This will help provide structure to the student’s time and allow us to measure progress as we go along. I expect the student to work approximately 40 hours per week, most of which would occur during regular business hours (8 am to 5 pm).

One caveat is that I will be traveling the last two weeks of May (May 22 to June 2). However, during the latter week, I would be available to resume daily meetings with the student by phone or Skype.

Game Theory

**Maple Scholars Proposal for Summer 2017**

**Game Theoretic Models of Power, Cooperation,**

**and Fair Allocation**

**David Housman, Mathematics**

Description: The first veto by a United States President was against a bill apportioning congressional representatives to states. The United Nations Security Council passes measures by simple majority but five permanent members can veto any measure. Some European parliaments have representatives assigned based on votes for a political party. Some New York State county councils have members with weighted votes because they represent different numbers of constituents. How can voting power be defined and distributed fairly in these types of situations?

Under what circumstances will self-interested individuals cooperate with other self-interested individuals? This is a central question underlying attempts by scholars to understand how cooperative behavior has evolved in humans and other organisms. One model that has been extensively studied has been repeated play of the two-player Prisoners’ Dilemma game. How can this work be extended to other situations and more players?

By collaborating, several cities can save money on upgrading their water treatment facilities. What is a fair way of allocating the savings? Several people have inherited an estate, but they differ in their opinions about the worth of each item in the estate. What is a fair way of allocating the estate? Different sportswriters have different rankings for college football teams. What is a fair way of melding these different opinions into a single ranking? In these situations, do the agents involved have incentives for stating their true costs, valuations, or rankings?

Game theory is the mathematical study of situations of conflict and/or cooperation. In this research, students develop a mathematical model of a situation, define fairness properties or rules of engagement, suggest solution concepts, determine solutions for their specific situation, and/or provide appropriate interpretations. Students may extend, modify, or rely on previous work done by students or results found in the mathematics, economics, biology, and political science literature, or students may begin with a totally new situation, model, properties, rules, or methods.

Background Expected: A student participant should have the ability to read, critique, and write mathematical proofs. For some research areas, the student participant should have the ability to write computer programs to explore possibilities.

Anticipated Results: Development of new mathematical results communicated via a written report, which may be submitted to a journal for publication, and an oral presentation at one or more professional meetings.

Agreement with Mentor Responsibilities: I agree to carry out the responsibilities of a Maple Scholars mentor. During the first week of the summer, I typically meet with my students a few hours each day to explore possible research problems and approaches. Before the student’s first seminar presentation, I require the student to present to me and I provide feedback for improvement. During the remainder of the summer, Im available to meet with my students almost daily and we negotiate how often we will definitely meet. I have had students who wish to meet for one to two hours daily for the entire program and some students who I have met with for a couple of hours each week. I have been able to take my students to one or two mathematics or game theory conferences during the summer where they have been able to present their work and interact with other faculty and students having a more narrow disciplinary focus. Mathematics involves a mixture of divergent and convergent thinking. Some of the most important ideas occur while taking a shower or hiking through the woods. So, I am fairly flexible about when and where students work; however, I do expect full-time effort: 40- plus hours per week and no other commitments.

Additional Information: I have mentored over seventy undergraduate students in summer and/or academic year research (see list at http://www2.goshen.edu/~dhousman/ugresearch/ugresearch\_complete.htm). Gina Richard, a Maple Scholar in 2008, won an award at Math Fest, the national summer meeting of the Mathematical Association of America, for a presentation of her research. Seth Unruh, a Maple Scholar in 2009, published "Envy-Free Divisions" in the Rose-Hulman Undergraduate Math Journal, Vol. 10, Issue 2, 2009, which can be accessed at http://www.rose- hulman.edu/mathjournal/. During the summer of 2014, Garrett Ahlgrim characterized all two- player three-strategy symmetric strategic games in which all three strategies are present in the unique evolutionarily stable equilibrium and both strategies are present in the unique evolutionarily stable equilibrium in the subgames when one strategy is removed. This result helps to delineate when different alleles will maintain a presence in a population. Joel Pepala explored different ways of defining voting power indices when the voters can be modeled as points in a policy space, and applied these ideas to voting power in the U.S. Supreme Court. During the summer of 2015, Kenan Bitikofer characterized situations when cooperation evolves in some simple spatial prisoner’s dilemma games. During the summer of 2016, Matt Chen explored when a method for allocating benefits from a collaboration satisfies a desirable fairness property and Jon Kaasa explored the fairness of Norway’s system of proportional representation in its legislature.

Mixed Media Sculptures

Maple Scholars Proposal for Summer 2017

**Combining differing materials to make mixed media sculptures**

**Associate Professor of Art John Mishler**

**Description:**

This Maple Scholars research and practical project is to develop a series of techniques to synthesize fabrics, wood, metal and ceramic into visually effective and engaging public sculptures. The student will discover and practice techniques and develop skills in order to integrate a variety of materials into cohesive and engaging sculptures. The student will research woodworking, metal fabrication, textiles and ceramics as well as explore ways to integrate the materials through techniques including welding, adhesives, drilling, wiring, knotting and more. The student will develop a series of processes and process descriptions that will exploit the wide variety of materials available to sculpture students and the vast and opportune world of sculpture. The student will do research on sculptures that use mixed media techniques and will also visit area sculptors studios and see how they combine materials to create sculptures.

**Background expected:**

The student will have taken beginning sculpture class and have also taken advanced sculpture for several semesters. The student will also need to be self-motivated and able to work independently with direction from the faculty advisor.

**Anticipated Results:**

The anticipated results are that through learning techniques and doing research the student will create a series of mixed media sculptures. The student is also expected to keep a sketchbook of ideas and techniques developed during this project.

**Agreement with Mentor Responsibilities:**

Besides making mixed media sculptures this project is an opportunity for the student to learn about the life of being an artist-sculptor beyond the regular class setting. Being an artist is not usually a 9 to 5 job, but one needs to learn how to plan ones time and develop a schedule for working at creating art. The student and faculty member will develop a schedule for working at the learning new techniques, doing research and making mixed media sculptures. The student is also expected to attend the first-day meeting, weekly colloquia, prepare and present their progress at the weekly colloquia and the end-of-program celebration. They will take part of the end-of-program celebration activities. There will be a schedule set up for the mentor to meet with the student on a regular bases. It is important to support and encourage the student for their project, but to also give them freedom to learn on their own.

Air Quality

**Maple Scholars Proposal for Summer 2017**

**TRAQR Traveling Air Quality Recorder**

**John Buschert, Physics Department**

**Description:**

Air quality in Elkhart County has been of some concern due to the presence of major industries and pollution sources upwind and also many smaller local manufacturing facilities. The EPA measures air quality fixed sites all over the country but in Elkhart County there are just two.

With the advent of inexpensive microcontrollers and sensors, it is feasible to make portable devices that could be mounted on a car, truck or other vehicle making regular trips throughout the county. Outfitted with sensors for various pollutants, temperature and humidity, in addition to a clock and GPS, these could log data about the air quality anywhere it was driven. By including wireless connectivity, they could upload their data to a website whenever they were in range of a suitable wi-fi signal.

This project will include:

1. Existing Data. We will research the existing data and find out as much as possible about what is already known about the air quality in Elkhart County. One aim of this would be to know what level of various pollutants we might be expecting to find with our portable devices.
2. Device. We will design, build and test a portable device. This will include choosing sensors, choosing a platform (likely some type of Raspberry Pi or Arduino related board), adding GPS, data logging and wi-fi capabilities. Construction will likely need to include a printed circuit board or boards to make the device robust against mechanical and thermal exposure. The devices will need to be programmed (likely in C) to operate autonomously. Various features could be included such as some type of live indicator to the driver of the current air quality.
3. Web page. We will design and build a web page that can receive the data from the devices over the internet. The aim would be to show a map with the data overlaid a bit like google maps shows traffic data.
4. Instrument. We will choose, buy and set up a more accurate and specific measuring instrument that is still somewhat portable. When our small devices detect some type of air pollutant, we’d like to be able to go and take more accurate and specific measurements with some well calibrated, sensitive, instrument that can tell us exactly what the pollutants are and at what concentrations. This might be some type or combination of Gas Chromatograph or Mass Spectrometer
5. Data collection. When uploaded device data indicates a pollutant in some area, we’ll take many sensors and also our better instrument out to the area and collect much more data over as much public area as we can. This might eventually even include using a quadcopter carrying one of our devices to get data on concentration vs altitude.
6. Modelling. Using the data collected as well as wind speed and direction, we will try to model the flow and spread of pollutants in order to try to identify the location and emission rate of possible sources.
7. Connections. We will try to identify others interested in our data and those with expertise to help us understand and interpret the data. As a start we will contact local, state and federal government agencies with responsibilities for air quality and monitoring.
8. Confronting. If we identify local sources of unhealthy levels of emissions, we may contact them to share what we have found and try to help them find ways to reduce the emissions.

Students will participate in all aspects of planning, designing, building, testing, collecting data, managing the system, modeling, as well as searching for others’ data and contacting other parties about our data.

**Background expected:**

Students with a variety of backgrounds will be considered but applicants should have taken General Physics and have some computer programming experience. Electronics experience would be very helpful, as would particular knowledge of C, html, or PHP programming. Chemistry might be of some use.

**Anticipated Results:**

The aim is to build several such devices and test them by the end of the Maple Scholars program. The student(s) will be fully involved in the design construction and testing of the devices as well as all the other areas outlined above.

**Agreement with Mentor Responsibilities**

I agree to serve as a mentor for a Maple Scholar student. I will be directly supervising the student(s) typically by working directly with them for several hours in the morning of each weekday. I plan to be present for all or nearly all of the colloquia. I expect the student(s) to put in full time work on the project for the duration of the 8 weeks. I may be gone for a one week period but will prepare the student to carry on independently during that time.

Gravity & Groundwater

**Maple Scholars Proposal for Summer 2017**

**Measuring groundwater from outer space**

**Paul Meyer Reimer, Physics Department**

**Description:**

Earth’s rising population is putting pressure on many natural resources, including water. Climate change may be changing precipitation patterns. In the United States, agriculture accounts for 80% of water use. (USDA) Water for irrigation comes from both surface and ground water. Water levels in lakes and streams (surface water) can be easily monitored, but monitoring of groundwater (water below Earth’s surface) has required drilling wells, and the cost has meant that there has been sparse sampling of underground water resources.

But, in 2002 NASA launched two satellites for the Gravity Recovery and Climate Experiment (GRACE) mission. These two satellites operate together as a sensitive probe of Earth’s gravity. It turns out that Earth’s gravity varies on the scale of months and years mostly due to changes in the amount of water close (within a few kilometers) of the surface. By subtracting the changes due to the surface water, one is left with the changes due to the groundwater. The satellites cover the whole globe each month, and the data is publicly accessible.

Isaiah Breckbill was a Maple Scholar working on the project in the summer of 2015. He managed to visualize the GRACE data using Google Earth.

We next turned to comparing the GRACE data with climate data from the Community Land Model (CLM). By comparing the actual changes of stored water from GRACE with the changes that *would have been expected* due to climate factors alone (modelled by the CLM), the hope is to disentangle human impacts on stored water (primarily irrigation) from effects due to climate variations.

Bryan Yoder worked on the project as a Maple Scholar in 2015. He looked at the suggestions from NASA about sharpening the data, and compared to other methods. Though the methods produce differences in small scale variations of total water storage, he found no significant difference for calculations over a whole water basin.

**Research goals and anticipated results:**

The focus of the project this summer (2017) will be to quantify the difference between CLM and GRACE in Earth’s for basin-wide calculations, and then be able to rank them according to human impacts.

The student will also research other available data sources that would complement the ranking we find. The availability of such additional data sources will play a role in determining a region that we would look at in more detail.

 **Background expected:**

The student will be expected to do a good deal of programming. Any experience in programming would be helpful, though a programming class is not required.

**Maple Scholars Proposal for Summer 2017**

**Loss of Redox Homeostasis: the Root Cause of Chronic Disease?**

**Michael Sherer, Department of Information Technology**

**Description:**

Each year, the US spends over a trillion dollars treating oxidative stress-driven diseases, including cancer, cardiovascular disease, lung disease, kidney disease, liver disease, diabetes, rheumatic diseases, infectious diseases, autoimmune diseases, musculoskeletal diseases, digestive and neuro-psychiatric ailments, etc. Yet in 2016-17, we still do not test for or treat oxidative stress or loss of antioxidant capacity, which together technically described as loss of redox homeostasis. Scientists have long known that reactive oxygen species (ROS) (O2+, H2O2) and reactive nitrogen species (RNS) cause tissue and cellular damage, as well as oxidative damage to lipids, carbohydrates, proteins, DNA and RNA. More recently scientists have discovered the role of ROS and RNS as signaling molecules responsible for immune system activation, HPA axis activation, sympathetic nervous system activation, as well as a variety of other cellular and systemic regulatory functions. Together, oxidative damage, defective signaling and resulting inflammation and systemic dysregulation drive the pathogenesis and progression of most if not all chronic disease.

The core of this Maple Scholars collaboration is to survey and explore existing and emerging research into the bio-chemical mechanisms of redox imbalance (elevated oxidative stress/diminished antioxidant capacity) and associated disease progression. This work involves identifying effective biomarkers, testing protocols, disease processes and treatment protocols. The student’s research will supplement and extend the sponsor’s prior research and writing, which includes a 60 page manuscript, a redox-driven disease model, and smaller article length pieces. There is some opportunity for the selected student, in conversation with the sponsor, to shape this experience to match their skills and interests.

The broader goal of the research is to flesh out a new, emerging health paradigm, along with graphical models, open health record datasets, biomarkers and proposed testing and treatment protocols. In the spirit of translational medicine, it seeks to interpret cutting edge science and make it accessible and usable to health consumers.

**Background expected:**

This project would be ideal for an upper level bio-chemistry or pre-med major with broad interest in research topics and synthesis of primary research available on PubMed. There may be opportunities for gathering and analysis of original data, as well as interpretation of select findings for non-technical audiences in written or web form. Key skills include:

* Systems and analytical thinking
* Writing
* Data Management and visualization
* Computer use
* Problem-solving
* Information evaluation

**Anticipated Results:**

While this project continues to evolve, I would anticipate further fleshing out and refining a visual model of redox-driven disease progression. I have a very early prototype in Google Drawing that could serve as a [prototype](https://docs.google.com/drawings/d/1MAP-qXOMVRa7sxhyGPIPqwgPmnrUDblOmYaQpXF8BN0/edit). This work will involve more in depth research into key biochemical processes and structures, such as calcium signaling, the blood-brain barrier, oxidative phosphorylation, methylation, etc. and how they relate to the broader area of disease progression.

On the process side, I would also be interested in exploring whether using Google Drawing, Docs or other tools could facilitate collaborative research and crowd-sourcing of medical research and paradigm building.

**Agreement with Mentor Responsibilities**

I have read the Maple Scholars Mentor Responsibilities and agree to fulfill the responsibilities outlined in that document. I will meet with the student initially to understand their gifts, interests and abilities and create a strategic plan and goals for the summer. I agree to meet with the student on a regular basis and to provide clear expectations for the student’s work. I expect the student to work approximately 40 hours per week, most of which would occur during regular business hours (8 am to 5 pm).