

Abstract Competition

Every year, hundreds of undergraduate students make leaps and bounds in independent research - a small sample of which is published in this journal. However, these full articles are the product of multiple years of work, and we at UMURJ feel that younger students should also have an opportunity showcase their work-in-progress; the second annual Abstract Competition is just that. In these abstracts are potential advances in technology and insights into culture, the future headlines of tomorrow's papers and the next generation of Michigan research. We hope that you find them as perceptive and thought-provoking as we have.

***Proteus mirabilis* Growth and Swarming Behavior on Minimal Medium**

Samantha M. Antczak

Advisor: Harry L. T. Mobley, PhD

Catheter-associated urinary tract infection (CaUTI) is the most common hospital-acquired infection. *Proteus mirabilis*, a Gram-negative, dimorphic bacterial species, is one of the main causes of CaUTI. This bacterium possesses the ability to differentiate into elongated cells with thousands of flagella, allowing the bacterium to swarm across catheters. In a lab setting the same swarming behavior occurs on LB agar with 100 mM NaCl, but not on minimal medium. However, we have found that adding combinations of glutamine, arginine, histidine, ornithine and malate promote swarming on minimal media. Our hypothesis is that these factors induce swarming by increasing growth rate.

To test this hypothesis, we analyzed growth in minimal media with the mentioned factors in comparison to plain media. Using the BioScreen automated growth curve system, we measured the optical density of minimal media containing *P. mirabilis* from overnight cultures and 10 mM of each trigger. We found that glutamine increased growth rate; malate decreased growth rate; and arginine, histidine and ornithine did not affect growth rate.

We next tested combinations of these factors to determine if swarming is correlated to increased growth. Of the 43 conditions which promoted swarming, 13 also promoted increased growth rate. Therefore, increased growth occurred in only 30% of the conditions in which swarming was also induced, meaning that swarming can occur without growth increasing. However, since 13 of the 17 conditions which promoted increased growth rate also promoted swarming, there is a significant chance that swarming will occur whenever growth rate increases. Additionally, different carbon and nitrogen sources and iron amounts were found to affect both growth rate and swarming. Specifically, iron, urea as a nitrogen source and glycerol as a carbon source allowed for increased growth and swarming. In conclusion, while certain combinations of triggers induce both growth and swarming, other factors and conditions are also involved in inducing such behaviors. Because swarming behavior allows *P. mirabilis* to colonize in the urinary tract, understanding how factors induce swarming will allow for better CaUTI treatment options. As a result, future work will focus on determining how these conditions promote swarming independent of growth rate.

Lipooligosaccharide Structures and Serum Resistance of *Haemophilus Influenzae* Causing Otitis Media

Deborah Daniel

Advisor: Kirk McCrea, PhD

The *Haemophilus influenzae* bacterium exists ubiquitously in throats and nasal passages. The bacteria causes ear infections in many children, but it leaves most adults healthy. However, the bacterium in elderly or smoking adults predisposes them to infections such as COPD and pneumonia. This project is looking at the differences between strains in their serum resistance, which is the ability to resist complement-mediated killing. We hypothesize that serum resistance correlates with certain lipooligosaccharide (LOS) structures on the bacterial surface. This will be tested by looking for statistical differences of serum killing among strains with predicted structures. There are two of six major LOS configurations that are predicted to be more prevalent among disease than non-disease isolates. Our current data indicates that strains vary widely in their serum resistance, some being completely sensitive or resistant to the dilution of human serum that we are using. All strains will be tested prior to making statistical inferences between resistance and predicted LOS structural configurations. Results obtained from these studies will be used toward the development of an LOS vaccine capable of eliminating diseases caused by *Haemophilus influenzae*.

Supermassive Black Holes in Barred Galaxies

Samsul Hoque

Most galaxies have a supermassive black hole in their centers. For most of these galaxies, the mass of the black hole (MBH) is tightly correlated with the velocity dispersion (σ , i.e. the standard deviation of the velocities of stars) in the central region of the galaxy. This important correlation is referred to as the “MBH- σ ” (M-sigma relation). However, the M-sigma relationship does not seem to hold for barred galaxies. Barred galaxies appear to have velocity dispersion (σ) values higher than expected for their black hole masses. The purpose of this research project is to better understand why the relationship between the mass of a supermassive black hole and the velocity dispersion of its host galaxy breaks down for barred galaxies.

According to a recent paper by Hartmann et al. (2012 in preparation), bar formation in a galaxy has various effects on the bulge velocity dispersion of a galaxy. In addition, a bar can affect the central mass density and anisotropy of the velocity distribution (i.e. how much the velocity distribution changes with direction within the galaxy). However, this paper studied simulations which did not actually include the gravitational effects of a central supermassive black hole. In my project we analyze a series of simulations which do include a supermassive black hole and study the simultaneous effects of both the changing bar and the growth of the black hole.

My specific task in this project is to use IDL to analyze data from the simulations. My first job was to plot the positions of particles from two different simulations, each with nearly 40 thousand particles. Next I made plots of the density as a function of radius, rotation curves, and the velocity dispersion for both sets of data. After completing the velocity dispersion, I moved on to analyze eight simulations generated by Dr. Juntai Shen (Shanghai Observatory). The difference between the Hartman simulations and the simulations that I worked on is that 1) they either already had a stable bar or have never formed one and 2) they had a black hole slowly growing in the center. These simulations will not only enable us to gain a deeper understanding of the effect of a black hole on the dynamics of stars within close proximity, but they will also help us understand the roles that black holes play in the evolution of galaxies.

Competitive Adsorption of Methane and Carbon Dioxide on MOF Adsorbents

Zachery Gizicki, Trinh Tran, Christian Lastoskie

There is a growing acceptance of the need for humanity to utilize energy resources in an environmentally sustainable manner. One of the biggest challenges confronting our society is how to meet future energy needs while reducing CO₂ emissions, which are a major component of the greenhouse gases that are responsible for global warming. The Lastoskie laboratory is addressing this issue by investigating the possible use of metal-organic framework (MOF) adsorbents to separate carbon dioxide from combustion gases. MOFs are porous materials that consist of metal ions connected to one another by organic linkers in a three-dimensional configuration. Our research group is assessing the effectiveness of two particular MOF adsorbents synthesized in our laboratory, ELM-11 and ELM-12, to separate carbon dioxide from gas mixtures. We are measuring isotherms – graphs showing the relationship between pressure and adsorption – for CO₂ on volumetric adsorption instruments over a range of temperatures from 25 to 75 °C, conditions under which carbon capture might be carried out at major CO₂ emission sources like coal-fired power plants. Our laboratory is also investigating the adsorption of methane, the principal component of natural gas, on these materials. By finding an efficient way to separate CO₂ from combustion gases and from the shale gases produced during hydraulic fracturing operations we will be one step closer to finding an economically viable way to reduce CO₂ emissions and improve our nation's energy sustainability.

Respiratory Scores in Children with Bronchiolitis

Blake Sanford

Advisor: Marisa Louie M.D.

Bronchiolitis is a viral infection of the lower airways and is the most common reason for the hospitalization of infants. Currently, several numeric scoring systems exist to aid in the clinical management of these patients. Three commonly used scoring systems are the Wang Bronchiolitis Score, the Modified Cincinnati Score and the Respiratory Distress Assessment Index (RDAI) Score. It is not known whether any score can assist in admission versus discharge decisions, nor has the inter-rater reliability been described or compared.

The goal of this study is to identify an accurate and reliable scoring system for the evaluation of pediatric bronchiolitis. We believe that one of three commonly used scoring systems for bronchiolitis, or a combination of elements from these three, best correlates with admission and discharge decisions and will be reliable across different providers. We prospectively enroll patients between the ages of 0-24 months who have been diagnosed with bronchiolitis in the Emergency Department or inpatient setting of Mott Children's Hospital. We then evaluate each patient daily according to the protocols of each of three commonly used scoring systems and compare these scores to patient disposition at the end of each day. Additionally, inter-rater reliability is determined via the simultaneous evaluation of a subgroup of subjects.

Subject enrollment is ongoing. We expect to conclude that one of the scoring system, or parts of different systems, best correlates with discharge from the hospital and has the highest level of inter-rater reliability. This system will be the optimal current scoring system for bronchiolitis. We intend to incorporate this system into the UMHS Clinical Practice Guideline for Bronchiolitis, which we plan to publish on the Agency for Healthcare Research and Quality's National Guideline Clearinghouse website.

Gender Perceptions in Mathematics

Alexandra Tourek

Advisor: Dr. Anjel Vahraton

Many US researchers have found alarming rates of girls' disassociation with mathematics compared to boys along with the persistence of the pervasive stereotype that "math is for boys."¹ Researchers at the University of Washington go on to say this is even before actual gender performance differences begin to appear in mathematical subjects. Gender plays a strong role in shaping collective attitudes towards the abilities of women in mathematics, leading to inequalities in opportunities for women to enter and sustain positions within mathematics. About 27% of the University of Michigan's undergraduate math program is female². Tenured staff in the Science, Technology, Engineering and Mathematics (STEM) fields at the University is only around 23% women³. These trends are consistent throughout many US institutions despite the growing acknowledgement of gender disparity and institutional shifts towards promoting diversity through minority outreach programs.

My objectives for this project are to (1) begin the analysis of the gendered culture of mathematics, (2) develop a strong basis for understanding how the roles of women and minorities in mathematics are socially constructed and (3) understand the implications of gender disparities in mathematics as well as how to begin to combat deeply engrained inequalities.

I aim to address the three points above through a review of the literature on how gendered perceptions affect mathematical achievement and the self-perception of it, feminist interventions in the math classroom and other strategies for change. I will also implement a survey to test my two main research questions: How do the perceptions of math differ between genders? Do these perceptions have predictive power regarding students' success in mathematics?

¹ PSYPost. "Gender stereotypes about math develop as early as second grade." <http://www.psypost.org/2011/03/gender-stereotypes-develop-second-grade-4665> March 14, 2011.

² Grapevine, Rebecca. "Solving the Gender Equation." Michigan Daily. 20 February 2007. <http://www.lsa.umich.edu/psych/news/department/news/?id=195>

³ Advance: University of Michigan. "Institutional Indicators of Diversity for Faculty at the University of Michigan: AY2010." September 2010. <http://www.advance.rackham.umich.edu/AY2010IndicatorReport-Public.pdf>