HONORS COLLEGE & COLLEGE OF SCIENCE RESEARCH SHOWCASE
1. **QUESTION**
   While it is known that tooth enamel is strengthened by fluoride, what other factors affect tooth strength?

2. **EXPERIMENTAL SYSTEM**
   Tooth treatment followed by tests of strength

3. **RESULTS**
   In her Honors College thesis, Karissa Renyer studied fluoride uptake. She found that pH 6 is optimal for fluoride uptake into tooth mineral. Ten different municipal water sources showed remarkably similar fluoridation potentials (graph to the right). We are now examining other possible tooth strengthening factors including protein factors in the water and in the teeth, with the goal of understanding biomineral versatility, improving health, and brightening smiles.

Karissa Renyer
D.M.D. Candidate, Class of 2024
OHSU School of Dentistry

Current OSU undergraduate students on the project include: Bereket Berhanu, Alyssa Abonitalla, Nazrawit Berhe, and Abigiya Bekele
The Rowe lab in the department of Microbiology studies direct and indirect interactions between Influenza viruses and the microbiome of the host.

Hannah Rowe
Nash 434
hannah.rowe@oregonstate.edu

Role of Bacterial-Viral Interactions in Transmission

Respiratory Transmission  Zoonotic Transmission

Role of Bacterial-Viral Interactions in Pathogen Evolution

Genetic Drift During Co-Infection

Bacterial Horizontal Gene Transfer

Viral Reassortment
Research

Our Geomicrobiology Lab investigates microbes in earth and ocean systems (diversity, abundance, and function). **Opportunity:** Thiamine deficiency complex (TDC) leads to high mortality in early life stages of salmonids. Causes of TDC are hard to pin down. What is the relationship between thiamine deficiency in fish and microbial communities?

Research skills you’ll learn

- Lab and field experience
- Sampling
- DNA extraction and sequencing
- Characterization of microbial communities
- Bioinformatic (computational) analysis
- Data synthesis

General scientific practice

- Oral/poster presentations
- Technical writing (thesis, technical papers)
- Teamwork
- Outreach
Does snow control streamflow in the Willamette Basin?
Most people, including most hydrologists, think that snow is the most important source of water for summer streamflow in the Willamette Basin.

I hypothesize this is not true – that the most important source of water for summer streamflow is spring rain.

Diagram at left shows results from all 85 stream gauges in the basin. If snow is correlated to summer streamflow, a dot is shown (only about 20). Size of dot = flow. Blue/brown is low correlation. Red/black is high correlation. Dot not shown = no correlation.

Help me test this hypothesis.

Background needed:
- Any major in Science; Experience coding in Python; Lots of curiosity
Ecosystem Ecology in a Changing Ocean

Are we facing a “hot, sour, and breathless ocean?” What are the consequences and what can we do about it?

Let’s find answers together
Materials Discovery Laboratory (MaD Lab)

Metal-organic Frameworks (MOFs)

Applications

Prof. Kyriakos C. Stylianou, Department of Chemistry, Oregon State University
Role of Oxidants in Tumor Development and Growth

Peroxynitrite & Tyrosine nitration

Tumors of the nervous system
Role of Oxidants in Tumor Development and Growth

Peroxynitrite & Tyrosine nitration

Tumors of the nervous system

The Franco Lab

DNA

Lipids

Proteins

ONOO-

Primary culture of GBM from patient

Human U87 cells

Nitrotyrosine – DAPI (nuclear staining)

Nitrotyrosine

Tubulin

DAPI (nuclear staining)

GBM 1

Cytoskeleton Nitrated Hsp90

Nitrated Hsp90

Nucleus Merge

3D cell culture model

Protein structure

Hsp90

Nitrated Hsp90

DNA

Lipids

Proteins

ONOO-
**Translational Research**

Drugs that specifically target the nitrated form of the protein
- Surface Plasmon resonance
- *In vitro* functional assays
- Drug screenings

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**Role of Oxidants in Tumor Development and Growth**

**Peroxynitrite & Tyrosine nitration**

---

**Cell and Molecular Biology**

**Role of Nitration in tumor growth**
- Relevant nitrated proteins
- Cell metabolism
- Signaling pathways
- Mechanism of action
- OMICS
- *In vitro* and *in vivo* models

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**Structural Biology**

**Protein gain-of-function**
How does nitration affects protein structure to induce a gain-of-function?
- Analytical ultracentrifugation
- Negative stain
- Cryo-EM

---

**Maca Franco, Ph.D.**
(She, her, hers)

Biochemistry and Biophysics
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**The Franco Lab**

1. Identification of oxidized proteins with activities relevant to disease process
2A. Mechanism of action
2B. Structural changes induced by oxidation
3. Drug development

---

**Graph**

- Sed coefficient (S)
- C(S)
- 0 5 10 15
- 0.0 0.1 0.2 0.3

---

**Image**

- Cell and nucleus
- Assay results
- Membrane and cell structure
A microbiological and viral view of the causes and consequences of coral reef decline
Rebecca Vega Thurber Lab

In our lab

Science is Real
Love is Love
Black Lives Matter
Feminism is for Everyone
Marine micro is Cool
Immigrants are Welcome
Microbial Evolution in Ocean Deserts: How do microorganisms adapt to nutrient loss in warming seas?

Stephen Giovannoni, Department of Microbiology
Dedicated to Lynn Margulis, 1938-2011

Global warming is causing ocean gyres to expand, increasing habitat for some of the simplest and most successful microorganisms known. These organisms are different – they have undergone extreme transitions in their genomes and cell architecture that enable them to efficiently use the diminished nutrients in ocean gyres, which are sometimes called ocean deserts because of their high water clarity and low productivity.

We’re trying to understand how many different cell types underwent similar changes when they expanded their ranges to ocean gyres. It was once thought this process, called genome streamlining, was caused by the loss of genes for repairing mutations. Now we know that is not true.

We want undergraduate students interested in computational science and microbiology to help us study these cells and to understand their unique evolution.
How does metallicity influence the types and distribution of extrasolar planets that form?

We have now discovered 4390 planets in 3313 planetary systems:

Preliminary research (diagrams to the right) shows that these planets fall into three "groups" based on their mass and distance from their parent star.

Questions:

1. What is the statistical likelihood of these groupings? Cluster analysis.

2. Do the planets in these groups have different metallicities? Do their parent stars? Do newer generations of stars produce more metal rich planets, and will this affect the types of planets that form in the future?

3. Is there evidence for two different types of gas giants, one that form more metal rich and one metal poor? Do planets in binary stars tend to belong to one group versus the other?

Dr. Rebecka Tumblin - Physics

Help me explore these questions using data analysis and data mining!

Background needed: Any science major with experience coding in python; the ability to fail at something and keep trying; an infectious enthusiasm for scientific inquiry; unbridled curiosity.

Planets in Binary stars are highlighted in blue and hot Jupiter's in red.
Metastable semiconductors: TiO$_2$

Important photocatalyst, pigment, and electrode

Some versions aren’t “stable” but have better properties!

How do metastable versions form?

Janet Tate, Department of Physics, College of Science, OSU (Janet.Tate@oregonstate.edu)
Project:
How fast do crystals grow?

When amorphous films crystallize ...
- what determines how fast they grow?
- can we model the growth and make sense of the model parameters?

You need
- some curiosity about materials
- to know a bit about image-processing software or be willing to learn quickly
- to be detail-oriented and organized

Janet Tate, Department of Physics, College of Science, OSU (Janet.Tate@oregonstate.edu)
Cell transplantation is a promising therapy for degenerative retinal diseases and is currently being investigated in multiple clinical trials to treat Age-related Macular Degeneration (AMD), which affects over 196 million people worldwide. In rodent model's cell transplantation has been shown to rescue rod and cone photoreceptors and preserve eyesight. Characterization of cell-based therapies relies on specific information regarding cell survival, migration, and integration in the host that is primarily derived from post-mortem histological assessments. However, the serial nature of this method requires large numbers of animals for these studies at multiple time points since there is currently no method for evaluating efficacious cell-based therapies longitudinally in vivo. Consequently, there is a critical need for the development of technology that would enable us to understand the consequence of transplanting cells into the eye to visually track transplanted cells survival and migration in vivo.

We hypothesize we can use tiny pieces of gold to visually track therapeutic cells in vivo? Help us test this hypothesis by joining our research group and publishing our results. To learn more, check out the MackLab

Background needed: any science major who want to learn how to do materials synthesis, work with a diverse and awesome team, and who want to engage their curiosity.
College of Public Health and Human Sciences
Simone Burton, Dr. Diana Rohman

REducing Plastic Pollution: A Communication Strategy

Studying the most effective modes of marine science communication on plastic pollution in the ocean.

INTRODUCTION
Ocean health and human health are inextricably linked. Consumer choices and the prevalence of plastics have led to significant marine plastic pollution. This thesis project evaluated communication strategies to reduce marine plastic pollution. We hypothesize that the visual modes of science communication will be more effective at increasing knowledge of plastic pollution in the oceans and inspiring changes in plastic use.

METHODS
1. An online survey was sent out to various organizations. The survey included 14 different science communication products (Figures 2-6). Participants were asked to:
   - Self-assess marine plastic pollution knowledge
   - Rank the products from best to worst and explain why
   - Select the likelihood of reducing plastics use
2. Data were analyzed in nvivo. Statistical tests were conducted to identify differences in participants based on location and self-assessed knowledge
3. A thematic analysis was conducted to better understand which products were most effective, in addition to a weighted vote analysis using normative ranking scores.

RESULTS
- Participants were mostly college-educated with a high level of marine plastic pollution knowledge
- Ranking: video 4L infographic 4L image 4L, and last is
- The higher the self-assessed knowledge, the more willing people are to complete action items (Figure 6)
- Most participants were very likely to use reusable dishes (84%) and participate in a beach cleanup (74%)
- People residing outside of Oregon were more likely to contact their congress people and participate in beach cleanups than using reusable dishes at eliminating plastic
- Common themes: 1) The video was most engaging, 2) The infographic was clear, 3) The text was readable, 4) The image evoked emotion but needed context.

DISCUSSION
Overall, study participants exhibited an existing knowledge of marine plastic pollution and a willingness to reduce plastic use. People were most likely to be associated with the likelihood of completing plastic pollution action items.

Visual modes of communication were preferred over text and the image would have been better if both solutions to the problem and more context were included. We conclude that graphical products are best when communicating the plastic pollution problem.

Best practices: use visuals, include context and solutions, don't clutter the graphics, don't overwhelm the viewers visually, and keep the message succinct.

Rather than using images to make the point, pair the visuals with a custom designed map.

NEXT STEPS
- These positions were used to create an original science communication product (Figure 7) that was aimed at the plastic pollution inflated by the COVID-19 pandemic. The graphics target the action items of wearing a reusable mask, using containers instead of disposable gloves, and shopping touchless or to shop without plastic together when ordering online.

This product will be published shortly in a second online science communication product created by the Science Communication Group at Oregon State University.

ACKNOWLEDGEMENTS
Special thanks to:
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- Maryland General, Sardine Foundation
- All those who were out there
- Our participants

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Using The MPA Guide to Better Understand Global Marine Conservation Efforts

By Madeleine McArthur | Thesis Committee: Dr. Kirsten Grorud-Colvert, Dr. Jenna Sullivan-Stack, Dr. Sarah Henkel

**Introduction**

Marine Protected Areas (MPAs) are a popular ocean conservation tool. They have a primary goal of biodiversity conservation, and they achieve this by limiting or prohibiting fishing and other extractive or destructive activities. Through the biodiversity conservation outcomes that occur by limiting or reducing damaging activities, MPAs can support fisheries, promote ecosystem services and resilience against the effects of climate change, and benefit human communities.

The significant ecological benefits that MPAs offer have led to ambitious MPA coverage goals, with many calls to protect 30% of the ocean by 2030. Currently, 7.7% of the ocean is protected within MPAs and other conservation designations worldwide. Yet, there is a need to address an important issue—there are different types of MPAs:

- **Types of MPAs**
  - Activities allowed or not may be allowed in another
  - MPAs don't all offer the same amount of protection
  - Fusion between MPA design and implementation often determines their success or failure as a conservation tool

**Methods**

- Used a novel MPA scoring system which standardizes terms related to MPAs by defining stages of establishment and levels of protection.
- **Stage of Establishment**
  - Proposed/Conceptual: An intention to create an MPA has been made public
  - Designed: An MPA has been designed and formalized
  - Implemented: An MPA is in existence and likely to be managed
- **Level of Protection**
  - Not Protected: No environmental protection is occurring
  - Low: Protection is occurring but does not significantly benefit the ecosystem
  - High: Protection is occurring but significantly benefits the ecosystem
  - Very High: Protection is occurring and benefits the ecosystem significantly

**Results & Discussion**

- **Map of the MPAs Assessed**
  - Map showing the distribution of MPAs globally

**Acknowledgements**

Thanks to all those who have contributed to the project and provided support throughout. Special thanks to [names of individuals or organizations].

**References**

[List of references]

**Map of the MPAs Assessed**

- A map illustrating the location and coverage of the 25 largest MPAs globally.
THE ROLE OF NITRATED HSP90 IN SCHWANNOMA CELL SURVIVAL

Sharon R. Kim, Maria Clara Franco

ABSTRACT

Neurofibromatosis Type 2 (NF2) is a genetic tumor disorder caused by mutations that inactivate the gene coding for the Neuroligin-2 tumor suppressor. Patients with NF2 develop multiple tumors throughout the nervous system, mainly schwannomas, for which there is no cure or effective treatment. In contrast, NF2, a de novo signaling pathway has been found to contribute to tumorigenesis. Reaction oxygen and nitrogen species play an essential role in regulating various pathways including proliferation, survival, and the malignant progression of tumor cells. In particular, peroxynitrite is a powerful oxidant produced by cells that causes the nitration of tyrosine residues in proteins. Tyrosine nitration has been detected in several tumor types and has been confirmed that there is increased tyrosine nitration in the Schwannomas of NF2 patients. Furthermore, the present study showed that peroxynitrite and tyrosine nitration regulate schwannoma cell proliferation and support survival and that nitration of the molecular chaperone HSP90 at protein (Hsp90) regulates key metabolic processes in pathological conditions. Our long-term goal is to develop pharmacological approaches targeting nitrotated Hsp90 to prevent schwannoma growth in NF2.

INTRODUCTION

Neurofibromatosis Type 2 (NF2) and Tyrosine Nitration

Peroxynitrite (ONOO·) and Tyrosine Nitration

Nitrotated Hsp90 chaperone protein 90 (Hsp90) decreases mitochondrial activity by inhibiting cyclochrome c oxidase

RESULTS

Tyrosine nitration supports cell survival in mouse MD-Medullary Schwannoma cells

Intracellular delivery of nitrotated Hsp90 decreases schwannoma cell survival

Peroxisomes down-regulates multiple parameters of mitochondrial activity in mouse MD-Schwannoma cells

CONCLUSIONS

• Peroxynitrite and nitrotated proteins are essential for schwannoma cell survival, as prevention of tyrosine nitration induces cell death by apoptosis.

• Upon the loss of function, there is a peroxynitrite-mediated metabolic reprogramming to decrease activity of mitochondrial oxidative phosphorylation.

• Nitration of Hsp90 at specific residues alters the spatial distribution of the protein; nitrotated Hsp90 could potentially play a fundamental role in regulating schwannoma cell proliferation and survival.

Future Directions:

• Determine the effects of nitrotated Hsp90 on other metabolic pathways relevant to tumor energy metabolism such as glycolysis and glutaminolysis.

• Identify other endogenously nitrotated proteins and perform additional survival/proliferation assays to determine the effects on tumor cell survival.

Acknowledgements:

The work was supported by the Office of the Adjunct Secretary of Defence Health Affairs, through the Neurofibromatosis Research Program (NRP), New Investigator Award (NIA), under Award No. PRED00241-1-1-0038, and AR012026-07, from NIA, NIH to MCF.

I would also like to thank Dr. Maria Clara Franco, Dr. Alvaro D'bang, Carmen Mares, Reystra, James C. Fyant, Tofnake Christensen, Kyle Hughes, and all of the undergraduate and graduate students of the Franco and Estrela lab for their assistance and support in the completion of this project.
METHOD VALIDATION OF QUANTITATIVE ANALYSIS OF OXYLIPINS IN HUMAN PLASMA VIA MASS SPECTROMETRY

Author: Madeline B. Bloom
Committee Members: Dr. Claudia Maier, Dr. Manuel Garcia-Jaramillo, Dr. Gerd Bobe

BACKGROUND

Oxylinps are a class of bioactive lipid metabolites derived from polyunsaturated fatty acids (PUFAs) via enzymatic and non-enzymatic pathways. Overall, oxylinps mediate a variety of physiological functions that regulate apoptosis, tissue repair, blood clotting, blood pressure regulation, and inflammation. Their role in the body shows their potential for chemobiomarkers in various human diseases that are associated with inflammatory events. Therefore, it is essential to assess the entire oxylinp profile because there are competing effects from each compound that will alter the positive or negative outcomes in the human body. Quantitative analysis of oxylinps is still very difficult with traditional analytical methods because of their low endogenous concentrations and structural similarity between compounds. A reproducible, robust, and sensitive analytical method is needed in order to validate the quantification results.

METHODS

Participants: Oxylinps were analyzed in 120 human plasma samples collected from OSU collaborators. Their sex, age, and health status were unknown in this study.

Sample Preparation: A mixture of 19 deuterated internal standard (IS) was added in order to quantify the oxylinp species. Samples were extracted using Waters OTOST flow-through 56K well plate to remove phospholipids and proteins. IS was added as an IS to correct for injection volume differences and platform stability.

Analysis: Samples were separated by liquid chromatography (LC) with a Shimadzu system and mass analyzed using an AB SCIEX QTRAP 4000 mass spectrometer (MS/MS) in multiple reaction monitoring (MRM) mode. Data was processed using an in-house compound library in MultiQuan.

Validation: The analytical method was validated using the following parameters: intra- and inter-day accuracy and precision, 3 recovery, and matrix effect from solvents and plasma matrix.

RESULTS

- Quantification: This analytical method was able to quantify 68 oxylinp species and 3 PUFAs from a wide range of metabolic pathways (Figure 1). The limit of quantification (LOQ) for the oxylinps ranged from 6 pm to 17 nm by evaluating the signal-to-noise ratio from the blank samples to the plasma samples.

- Method validation:
  - Intraday accuracy and precision between IS in quality control samples had an average of 9.7% (± 2.4%, n = 22) accuracy and 13.5% (± 2.9%, n = 20) precision.
  - Figure 3 shows over 80% intraday accuracy and precision for 86% of the oxylinp and PUFAs in the validation set (n = 20).

  - Recovery of IS was over 100% for 75% of compounds (n = 20).

  - Between the ETOH and ACN-MeOH calibration curves, a matrix effect was observed as the peak area for the ACN-MeOH mixtures was on average 20% (n = 48) greater at the same concentration. Additionally, the analysis of the extraction blends with IS showed an average of a 38% (n = 22) difference in peak area from the plasma samples after extraction through the OTOST plate.

CONCLUSIONS

The dynamic LC-MS/MS quantitative analysis method of oxylinps that showed a high amount of sensitivity and reproducibility at PM concentrations. The method also showed improvement in LOD and specificity from previous studies, which shows that this method can be applied to clinical chemistry analyses with success. Method validation parameters revealed a robust analysis that can evaluate the comprehensive oxylinp profile, both pro- and anti-inflammatory lipid mediators were quantified successfully.

Oxylinps at this level of sensitivity continues to demonstrate their potential for biomarkers of human disease that can lead to improved diagnosis protocols or drug treatment designs.

ACKNOWLEDGEMENTS

The use of the OSU Mass Spectrometry Center and their instrumentation was funded by the NIH grant #1S10RR027289-01, and my project was funded by SURE through the College of Science.

LITERATURE CITED:


Figure 1: Formation of oxylinps via enzymatic and non-enzymatic pathways from precursor fatty acids arachidonic acid (AA), linoleic acid (LA), di-hexadecanoyl phosphatidylcholine (DHP), and dihexadecanoyl acid (DHA) (shown in red). The pathways are modified from Godin et al. Oxylinps shown in blue were analyzed and quantified by LC-MS/MS. Enzymes involved in PUFAs and oxylinp metabolism are shown in purple. OAT: crotochrome, XP: soluble epoxide hydrolase, LOX: lipooxygenase, COX: cyclooxygenase, ROS: reactive oxygen species; NES: non-enzymatic.

Figure 2: Intra- and inter-day accuracy and precision of oxylinps. Accuracy = 100% ± 10%

Figure 3: Intraday accuracy and precision of oxylinp compounds and precursor PUFAs in calibration curve standard mixtures injected on two different days and analytical runs.
Chemistry and Grit: The Impact of Prerequisites vs Perseverance on Academic Success in Biology

Author: Kiersten Sparks
Mentor: Lori Kayes

Oregon State University College of Science, Honors College

INTRODUCTION

- Biology is interdisciplinary and relies on chemistry background, especially when covering biochemistry in general biology courses (AAAS, 2011).
- Research has shown that general biology students who take chemistry as a prerequisite earn higher course grades than those who take chemistry as a corequisite (Kulesza, 2019).
  - OSU’s Principles of Biology for Life Science Majors has a mandatory chemistry corequisite.
- When students do not have the background in chemistry that would help them better understand biochemical concepts in the course, they may rely on other skills and motivations to succeed.
  - “Academic success” is multifaceted accounts for multiple parts of a student’s success, but in this study academic success will be measured by academic achievement (course and exam grades).

RESULTS

How much influence does a student’s grit prior chemistry exposure have on their academic success and performance on assessments covering biochemistry?

- NOTE: Grit had no impact on exam 1 grades regardless of the student’s cumulative GPA.
  - * = p < 0.05, ** = p < 0.01

How much influence does a student’s prior chemistry exposure have on their academic success and performance on assessments covering biochemistry?

- Increase Due to Grit
- Increase Due to Course Exposure
- Increase Due to Grit
- Increase Due to Course Exposure

RESEARCH QUESTIONS

The research was guided by the following questions:

1. How much influence does a student’s grit have on their academic success and performance on assessments covering biochemistry?
2. How much influence does a student’s prior chemistry exposure have on their academic success and performance on assessments covering biochemistry?
3. Does grit or chemistry exposure provide a greater increase in student academic success on assessments of biochemical content?

METHODS

- Data were collected via a survey from two classes of the BI 212 quarter of the Principles of Biology series.
- Survey included demographic questions, questions about prior chemistry courses taken, and a 12-item Grit Scale questionnaire.
- Data was processed in bins according to GPA using a multiple linear regression, with course grades or exam grades as the dependent variables, and chemistry exposure, grit, and gender as independent variables.
- Models displayed low correlation (R^2) but were found to be significant, and the best fitting models were selected for analysis based on AIC score.

Does grit or chemistry exposure provide a greater increase in student academic success on assessments of biochemical content?

- Grit is only significant in the highest achieving students (GPAs between 3.7 to 4.0), and only for final course grades.
- Grit is the most significant predictor of success in all exams with a GPA of 3.69 or below, for both exam grades and final course grades.
- Chemistry exposure provided the greatest additive value on student grades (exam or course) and impacted students in both the GPA and G3R bins (those with GPAs of 3.69 and below).

DISCUSSION

Grit

- Grit was only found to be significant in the highest achieving groups, aligning with the pattern seen in previous literature (Buckworth et al., 2007; Borsato et al., 2016; Credé et al., 2017).
- The model in which the variable grit was significant was not significant itself, so conclusions about whether grit impacts biology students in a meaningful way is still unclear.
- However, student’s level of grit can be increased by:
  - “Deliberate practice” which increases both content knowledge and perseverance.
  - Goal setting, which better prepares students to persevere to attain their long-term goals.
  - Encouraging a growth mindset.

Chemistry

- In all cases except the highest achieving group (GPAs of 3.7-4.0) chemistry exposure provided the greatest additive value to both exam 1 grades and final course grades.
- Note: Chemistry exposure score is measuring the amount of chemistry courses taken, and only accounts for the understanding of chemistry by proxy. It may not fully represent the student’s grasp of chemical concepts.
- The magnitude of the impact of chemistry exposure is called into question based on the low significance of the overall model, but it is reasonable to assume based on this data that chemistry has a small but significant role in student success in biology.
- This may suggest that increasing students’ prerequisite knowledge of chemistry may help improve their performance in biology, especially regarding biochemistry topics.
- Students’ prerequisite knowledge of chemistry can be improved by:
  - Scaffolding more fundamental chemistry skills into the biology course.
  - Providing supplemental chemistry materials for biology students.
  - Consideration of the implementation of a chemistry prerequisite rather than corequisite.

Other Considerations and Limitations

- Data were a sample of convenience, subject to response bias.
- GPA was the largest explanatory variable examined in the preliminary analysis, and its removal in order to reveal the nuanced factors at play impacted the significance of the overall models, leaving R^2 values low, explaining between 2 and 21% of the variance in the data.
- GPA and chemistry were highly correlated, so impacts due to chemistry may be inflated due to the association with GPA.
- Grit may also be correlated with another variable not present in this analysis, like a student’s self-concept or other factors.
- Both knowledge of biology and chemistry were measured by proxy, and therefore are not perfect in their estimation of a student’s subject knowledge in these areas.

CONCLUSIONS

- All variables considered provided only a small percentage of influence over students’ grades.
- Chemistry provides more additive value on student grades than grit.
- It may prove beneficial to promote increased chemistry knowledge before taking Principles of Biology.
- More studies should be conducted to elucidate what traits or knowledge best prepare students for Principles of Biology.

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Aquarickettsia rohweri Dynamics in Disease Susceptible and Resistant Acropora cervicornis Corals

Shalvi Patel1, Grace Klinges1, Rebecca Vega Thurber1 PhD
1Department of Microbiology, Oregon State University, Corvallis, OR, USA

INTRODUCTION

- Coral reefs are one of the most diverse ecosystems.
- Their structural complexity provides a wealth of biomes and life forms.
- Over half a billion people depend on coral reefs for food, income, and culture.
- Direct threats such as fertilizer pollution severity impacts the ability of the corals to survive.
- Having a diverse microbiome with beneficial bacteria allows the coral to optimally adjust to changing environments.

- Acropora cervicornis corals are among the most abundant reef-building corals found in the Caribbean.
- In the 1800s, they declined 80-90% from anthropogenic stressors and diseases placing them on the Endangered Species list.
- One of the primary disease responsible is White Band Disease (WBD) being the most studied, a little is known about the disease.
- Previous work has discovered a parasite, Aquarickettsia rohweri, that is associated with WBD, but is not strongly stimulated by nutrient pollution.
- A. cervicornis genotypes, that are susceptible to WBD, are known to be resistant genotypes.
- This study hopes to further our understanding of the impact of nutrient exposure on the abundance of parasites, A. rohweri.

We hypothesize that nutrient exposure variable stimulates proliferation of A. rohweri in different A. cervicornis genotypes with combined nutrient exposure inducing the largest change.

METHODS

16S RNA Gene Sequencing + Bioinformatics

Sampling

DNA Extraction

PCR Step 1

PCR Step 2

Gel Electrophoresis

qPCR + Normalization

Bioinformatics

RESULTS

16S Sequencing Richness between Genotypes

FIGURE 1. Boxplot comparing richness (alpha diversity) of genotypes 50 and 7 A. cervicornis coral samples between the weeks of nutrient exposure using Simpson's and Shannon index.

The significant decrease in richness in Genotype 50 samples at Week 3 from Week 0 suggests that three weeks is enough to induce a response in microbial community compared to genotype 7 samples which did not have significant decrease in richness until Week 6.

16S Sequencing Relative Abundance

FIGURE 2. Biplot comparing richness (alpha diversity) of genotypes 50 and 7 A. cervicornis coral samples using Simpson's and Shannon Index.

Genotype 7 samples had a significantly greater average richness than genotype 50 samples likely due to genotype 50 samples being dominated by A. rohweri.

16S Sequencing Beta Diversity

FIGURE 3. Absolute abundance of top 10 most abundant taxa in genotype 50 and 7 A. cervicornis samples. Genotype 50 is dominated by Aquarickettsia, order Rhizobiales (blue), Genotype 7 is dominated by unclassified taxa (gray).

FIGURE 4. Beta diversity calculated using Bray-Curtis dissimilarity colored by A. cervicornis genotypes, B. Genotype 50 by weeks of nutrient exposure, and C. Genotype 7 by weeks of nutrient exposure. PERMANOVA test was used to determine significance.

A shows significance (p=0.001) clustering by A. cervicornis genotype (50 vs. 7) and B shows significant (p<0.001) clustering between Week 0 and 3/6 but not between Week 3 and 6 in A. cervicornis genotype 50 and 7 samples.

CONCLUSIONS & FUTURE DIRECTIONS

Conclusions:
- qPCR results don’t always reflect findings in amplicon data. Highlights importance of performing qPCR along with 16S amplicon sequencing when evaluating a dominant microbial community member.
- Time and off-reef incubation have a larger impact on A. rohweri abundance in genotype 50 A. cervicornis samples than nutrient amendments in this experiment, most likely due to high nutrient concentration in canal water used in the aquaria.
- Allowing that A. rohweri proliferates under control conditions: we may be inadvertently increasing disease susceptibility in reefs during reef restoration efforts.
- A. rohweri abundance was lower than expected in genotype 7 A. cervicornis samples.

Future Directions:
- Better assess which nutrients most stimulates proliferation of A. rohweri by conducting additional off-reef experiments using baseline water that is closer in nutrient concentration to Looe Keys water.

Acknowledgments:
I would like to thank my mentor, Dr. Rebecca Vega Thurber, and Grace Klinges, Ph.D. candidate for their constant guidance throughout the project; my committee members, Dr. Maudie David and Dr. Nathanael Kirk; and all the members of the Vega Thurber Lab.
Cloning the zebrafish otoferlin B wildtype and a transmembrane mutant to characterize changes in cellular localization

Rebecca France, Aayushi Manchanda, Josephine Bonventre, Colin P. Johnson

INTRODUCTION

- Ferlinas are a family of large, cytosolic calcium binding proteins that play an important role in membrane trafficking events.
- Otoferlin is a protein essential in the process of hearing and mutations in otoferlin are associated with profound recessive deafness.
- Otoferlin is known to bind calcium and is believed to play a role in calcium dependent exocytosis that leads to neurotransmitter release. However, the mechanism by which this happens remains poorly understood. Additionally, the large size of the OTOF gene makes it a challenging model for gene therapy.
- This project sought to characterize the difference between wildtype (WT) and a truncated mutant (MUT) otoferlin in vitro to go alongside in vivo studies on mutant zebrafish presenting with deafness and vestibular effects.
- The long-term goal of the Johnson lab is to understand how otoferlin contributes to hearing and why certain mutations result in deafness to be able to inform potential treatments.

METHODS

- The WT C2F-TM region of the zebrafish otoferlin B gene was amplified through a polymerase chain reaction. This was then inserted into a pCNA plasmid containing Green fluorescent protein through ligation independent cloning. The plasmid was transformed into bacterial cultures and mini-prepped. Sequencing confirmed that the proper region was amplified and inserted into the pCNA plasmid.
- Site Directed Mutagenesis created a mutant otoferlin with an early stop codon in the transmembrane domain that results in a truncated protein.
- The WT and MUT otoferlin plasmids were transfected into HEK 293 cells. A Hoechst blue nuclear stain and a red wheat germ agglutinin membrane stain were used when imaging the cells.
- Three representative images were selected for both the WT C2F-TM plasmid transfected cells and the MUT plasmid transfected cells. The percentage of cells containing otoferlin was calculated by dividing the cells showing colocalization by the total number of cells. This process was repeated twice.

CONCLUSIONS

- The MUT zebrafish otoferlin B C2F-TM appears to be trafficked differently than the WT and is possibly degraded by the cell.
- The transmembrane domain seems to be a critical component for any future gene therapy that is designed to treat deafness and should thus be included in any designed treatment.
- Studying the cellular localization of otoferlin in vitro allows us to learn more about this particular mutation as it relates to hearing loss.
- The long-term goal is to help recover hearing loss in affected individuals by better characterizing otoferlin for any future designed therapies.

REFERENCES


ACKNOWLEDGMENTS

- Members of the Johnson Lab Group, Department of Biochemistry and Biophysics, Oregon State University
- Summer Undergraduate Research Experiences (SURE), College of Sciences, Oregon State University
Role of Nitrated Proteins in Glioblastoma Multiforme Cell Survival and Migration

Mihir Palan and Maria C. Franco
Department of Biochemistry and Biophysics, College of Science, Oregon State University, Corvallis, OR 97331

ABSTRACT

Glioblastoma multiforme (GBM) is the most aggressive brain tumor, GBM tumor samples show high levels of protein carbonylation. Redox signaling by tyrosine nitration occurs in tumors and is a metric of cellular stress. Nitrated tyrosine residues on proteins can be associated with the progression of GBM. Nitrated proteins have been shown to regulate cellular signaling. The present study investigates the role of nitrosative stress in GBM and its implications on the progression of GBM. The present study demonstrates that nitrated proteins downregulate mitochondrial metabolism and induce oxidative stress, which may lead to the progression of GBM. The results also show that nitrated proteins can induce oxidative stress and mitochondrial dysfunction, which may contribute to the progression of GBM.

INTRODUCTION

The P2X7 Receptor (P2X7R) is a high-affinity receptor for extracellular ATP and is involved in the regulation of cell proliferation and survival. The P2X7R is highly expressed in GBM cells and plays a crucial role in the progression of GBM. The present study investigates the role of the P2X7R in GBM cell survival and migration. The results show that the P2X7R regulates cell survival and proliferation in GBM cells. The findings also suggest that nitrated proteins can induce oxidative stress and mitochondrial dysfunction, which may contribute to the progression of GBM.

RESULTS

The P2X7 Receptor regulates Survival/Proliferation of GBM Cells

Low density cultures of GBM cells showed increased cell death when treated with nitrated proteins. The results also showed that nitrated proteins induced oxidative stress and mitochondrial dysfunction, which may contribute to the progression of GBM.

CONCLUSIONS

- Nitrated proteins and P2X7R regulate cell survival, proliferation and migration in low-density and high-density human GBM U87 cells.
- Our findings indicate that treatment of U87 cells with the P2X7 receptor inhibitor Brilliant Blue G, as well as urate and edaravone, to compounds used to prevent tyrosine nitration significantly reduced cell survival after 48 hours in both low and high density cell cultures.
- When cells were incubated for 48 hours, urate and edaravone also had an effect on the ability of cell to migrate to fill the gap in wound healing assays.

FUTURE DIRECTIONS

- Future directions include intracellularly delivering nitrated Hsp90 into normal human astrocytes to dissect the mechanisms by which nitrated Hsp90 regulates the metabolic phenotype of tumor cells.
- Additionally, cell migration will be quantitively measured to ensure that there are quantitative findings of the affected migration due to scavengers.

ACKNOWLEDGEMENTS

- We thank Jeanne Peston, Oliver Valdivia Comacho, Corrie Moran-Reardon, and Kyle Nguyen for their supervision and help in performing those experiments. We would also like to thank Sarah Cotta for the confocal images of U87 cell introductions.
- Mihir Palan was an USRA and CURE Fellow.
- This work was supported by the Office of the Assistant Secretary of Defense for Health Affairs, through the Neuroinflammation Research Program (NRP), New Investigator Award (NIA), under Award No. W81XWH-17-1-0459, and R01NS052459 from NIH/NINDS to MCF.
Social Context Affects Response to an Acute Stressor in Captive Red Crossbills (*Loxia curvirostra*)

Natsumi Tsujihashi and Jamie Cornelius
Integrative Biology, Oregon State University

**Introduction**

- Social animals can use available information to inform behavioral and physiological responses to situations, but the way that information is processed can be influenced by the social context in which an event occurs.
- Consequently, the presence or absence of conspecífics can alter stress perception.
- In a recent experiment, red crossbills—a social songbird—that were housed in pairs (i.e., doubly-housed) lost mass when moved to a new room and presented with a neighbor cage, whereas individually-housed birds did not lose mass in the same situation.
- We tested the following non-mutually exclusive hypotheses in relation to how social grouping affects responses to a change in environment and the presentation of a neighbor:

**Dominance Hypothesis:** The weight loss observed in doubly-housed birds is due to the introduction of a neighbor, which may have temporarily disrupted the pre-existing dominance hierarchy.

**Social Buffering Hypothesis:** The maintenance of weight observed in previously isolated, singly-housed birds is due to social interactions mitigating the stress of moving rooms.

**Methods**

- 96 adult red crossbills were placed into cages based on their treatment group:
  - **Alone Control:** Individually housed birds on a natural photoperiod, not paired on move day.
  - **Singly-housed:** Individually housed birds on a natural photoperiod, paired with a neighbor cage on move day.
  - **Doubly-housed:** Doubly-housed birds on a natural photoperiod, paired with a neighbor cage on move day.
- Visual barriers were put up during the pre-pairing period (3 weeks) such that individually-housed birds in each cage could hear, but not see, the birds in other cages. Doubly-housed birds could see and interact with their cage-mate.
- Birds experienced a change in environment (i.e., a new room) on move day, which is known to be a stressor, and were allowed visual access to a second cage of the opposite housing type (i.e., singles were paired next to doubles). Aloné controls remained visually isolated in their new room.
- Mass and food intake was measured pre and post-pairing to the nearest 0.01 gram using an electronic scale. Activity was recorded continuously pre and post pair using an infrared activity monitoring system by Starr Life Sciences. Activity was summed per hour and averaged across 24-hour periods for daily activity estimates.
- A least squares method was used to test the impact of food intake, activity, treatment group, and interactions on the change in mass.

**Results and Discussion**

- The mean change in mass was significantly different by treatment (Figure 1, ANOVA: F = 72.2, P < 0.0001; IF = 0.34). With doubly-housed birds losing significantly more mass than singly-housed birds and alone controls (Scheffe Comparison of Means: F = 40.05).
- These data suggest that treatment group (i.e., social context) affects whether mass was retained or lost after exposure to a stressor.
- These data do not provide any direct support for the social buffering hypothesis, and it appears that social buffering did not occur in any context.
- However, stress physiology may still be playing an important role in our observations. Singly-housed birds and alone controls may have had an altered physiological state from being in long-term isolation, which affected their ability to initiate the hypothalamic-pituitary-adrenal axis in response to an acute stressor (i.e., moving to a new room).

**Conclusions**

- The changes in mass in doubly-housed birds did not seem to be due to dominance by any one individual and the social buffering hypothesis was not directly supported by these data.
- These data suggest that the mechanism driving this phenomenon may be a more complex interaction between social context and physiological decision-making in response to stress.
Lanthide-Based Metal Organic Frameworks for CO₂ Capture and Conversion
David Le¹ and Kyriakos Stylianou²
¹College of Engineering, School of Chemical, Biological, and Environmental Engineering
²College of Science, Department of Chemistry

Goals
- Evaluate the performance of the metal organic framework, CeHTCPCB, for the capture of CO₂ and catalysis of propylene oxide into propylene carbonate.
- Study the implications of using different lanthanides for CO₂ catalysis.
- Investigate the stability of CeHTCPCB under repeated reaction cycles.

Why Propylene Carbonate?
- Propylene carbonate is widely used as a film-forming and high boiling point solvent in paints, industrial cleaners, polymer plasticizers, pesticides, dyes, and cosmetic products.
- It can also be used as an amine alternative for CO₂ and H₂S removal from acid gases and natural gases.
- The high dielectric constant of propylene carbonate makes it an important solvent in electrolytes for lithium-ion batteries.

Background
- Metal–organic Frameworks (MOFs) are crystalline materials formed by a network of metal ions coordinated to organic ligands which are extended into one, two or three dimensions.
- The unlimited combination of metal ions (active sites) and ligands (functionalization) can generate infinite structures with applications in:
  - Carbon Capture and Utilization
  - Photocatalysis
  - Analyte sensing and capture
  - Capture and separation of hazardous molecules
- MOFs have key advantages over other materials being highly modular, structurally versatile, and possessing high porosity (100 – 4500 m² g⁻¹).
- Lanthanides are excellent Lewis Acids due to their high charge valency. This means that they are exceptionally binding to lone electron pairs of oxygen containing molecules.
- In particular, the MOFs studied in this project, CeHTCPCB and other lanthanide derivatives, are water stable, synthesized under green conditions, and thermally robust.

Characterization of Materials
- Figure 3. Powder x-ray diffraction plots. The relatively similar peaks of the material demonstrates retention of crystallinity and phase purity after three reaction cycles.
- Figure 4. Thermogravimetric analysis plots. The material remains thermally stable up to >400 °C after three reaction cycles.
- Figure 5. Fourier Transform IR spectra. All peaks remain the same after three reaction cycles demonstrating structural integrity of the MOF.
- Figure 6. CO₂ isotherms of CeHTCPCB before and after catalyst. The CO₂ uptake capacity remains the same at ~1.60 mmol g⁻¹.

Methods
- CeHTCPCB and derivatives incorporating Nd, Sm, Eu, Tb, and Dy were synthesized and characterized to evaluate crystallinity, thermal stability, and CO₂ uptake capacity.
- Propylene oxide to propylene carbonate conversion with MOFs was performed in 25 mL stainless steel autoclave reactors under 10 bars CO₂ and 100 °C for 12 hours.
- After the reaction, ¹H NMR was used to determine the yield of propylene carbonate.
- Catalysts were recovered after filtration, washing with DI H₂O/acetone, and drying.
- Additional studies were done with mixed gases, aqueous-rich solvent mixtures, and recycled materials.

Catalytic Performance
- Figure 7. Yield of propylene carbonate for three conversion cycles. The conversion is nearly the same at ~94 - 95%.

References
Qualitative Food Web Dynamics in Response to Extinction and Invasion

David J. Rockow

In this study, we investigated the impact of species extinction and invasion on the dynamics of food webs. We created a food web with 12 species, including basal species, primary and secondary consumers, and apex predators. The web was modeled using a computer simulation to understand the effects of species removal and addition on the trophic levels and interactions within the food web.

Methods

We constructed a food web with 12 species, each with a trophic level. The web was simulated using a computer model to assess the impact of species extinction and invasion on the food web dynamics. The model accounted for direct and indirect effects of species removal and addition on the food web structure.

Results

1. Species extinctions and invasions tend to make species responses easier to predict.
2. Intraspecific interactions can be the least accurately estimated in real-world systems.
3. There exists a strong negative correlation between the number of links and the probability of an incorrect prediction of the remaining responses after it was removed, at all levels of interaction strength uncertainty. For the lower and upper triangle interactions, a strong correlation only existed at larger values of interaction strength uncertainty.

Figures

Heat maps: Each four heat map bundle is from one of the fourteen webs. Each heat map was produced on the same scale, with a zero value producing a light beige color, and the highest overall value (0.442) producing a deep red color. The associated interaction strength uncertainty is shown in the top right of each associated web. The figures in each heat map are the percent of mispredicted interactions, where that interaction was misclassified.

Each of the three scatterplot bundles is from one interaction type. Diagonal is on top, lower triangle in the middle, and upper triangle on the bottom. With the diagonal interactions, there existed a strong negative correlation between number of links and probability of an incorrect prediction of the remaining responses after it was removed, at all levels of interaction strength uncertainty. For the lower and upper triangle interactions, a strong correlation only existed at larger values of interaction strength uncertainty.

Equations

Press Perturbation - Perturbing disturbance on a food web that creates a new equilibrium
Species Richness - Number of species in a web
Connectance - Proportion of potential interactions that are realized
Diagonal Interactions - Impacts of species on itself (Intraspecific)
Upper Triangle Interactions - Impacts of a predator on its prey
Trophic Level - The approximate hierarchical level of a species in a food web

References

TISSUE DEHYDRATION PREVENTION
Post-Preservation Maintenance of Cadavers to Prevent Tissue Dehydration in Educational Environments

AUTHOR: Alexandria Herrera
Mentor: Dr. Devon Quick
Committee Members: Dr. Brian Bay, Tamara Ostervoss

BACKGROUND
The human cadaver has held the spotlight in anatomy and physiology education for centuries, with dissection traced back to the 3rd century BC in Ancient Greece [1]. Medical and non-medical students rely on cadaver dissection and observation for a deeper understanding of the structural and functional anatomy that exists inside of us. It is imperative that the tissue hydration is maintained throughout the study [2]. Applying rehydrating solutions and evaporation preventing materials to the tissues can prevent dehydration. Dehydration prevention is important for quality tissue presentation, to extend the study period of distinct anatomical structures, and to respect and honor those who choose to donate their bodies to science and education.

Current Oregon State University dehydration prevention protocols:
1. Re-covering the exposed tissues with the respective cadaver skin.
2. Applying layers of plastic wrap, towels, and sheets soaked in a wetting solution to the external surfaces of the body.

This study aims to identify ideal material coverings that outperform the current methods.

It was hypothesized that an artificial material will maintain tissue hydration levels more effectively than the current methods deployed in the OSU Anatomy and Physiology labs.

RESULTS
- Skin is the only covering that demonstrated a statistically significant mass retention when compared to samples exposed to air (Fig. 1a, 1d).
- Dry samples covered in skin gained mass before losing it again (Fig. 1a, 1c).
- Samples covered in plastic wrap, nitrile rubber, and silicone rubber, generally retained more mass than the other samples (Fig. 1).
- Samples covered in woven or shroud experienced greater decreases in mass than the samples in air (Fig. 1).
- Wet oblique muscle samples covered in nitrile rubber and plastic wrap retained significantly more mass than those covered in towel (Fig. 1).
- Wet adductor magnus samples covered in plastic wrap preserved significantly more mass than those covered in towel (Fig. 1).
- Samples of the same muscle and wetness that were covered in nitrile rubber retained significantly more mass than those covered in towel (Fig. 1).

DISCUSSION & RECOMMENDATION
Within twelve hours of tissue extraction, skin significantly outperformed all other material coverings, unexpectedly rehydrating the dry tissue samples for several hours before permitting dehydration to occur. This study provides a basis for wet tissue samples in their respective skin is the superior method for hydration maintenance.

With respect to wet muscle samples, nitrile rubber and plastic wrap maintained tissue hydration better than those wrapped only in towels and sheets.

Samples covered in towel and shroud experienced more dehydration than samples exposed to air. These findings suggest that dry towel and shroud coverings may be more harmful to the quality of muscles than neglecting to cover the tissues at all, likely absorbing moisture from the muscle samples faster than the moisture would have dried via unfacilitated evaporation.

Recommended dehydration prevention strategies for the OSU cadaver lab are as follows:
1. Primarily, skin should directly cover the cadaver for as long as possible (no intermediate material).
2. If skin is not available, cover the tissues with a combination of plastic wrap and nitrile rubber.
3. Cover the cadaver with a shroud soaked in wetting solution or a black plastic tarp in order to maintain a respectful presentation of the donor.

WORKS CITED
**ABSTRACT**

Neurofibromatosis type 2 (NF2) is a genetic disorder of the nervous system caused by mutation in the merlin tumor suppressor gene. NF2 patients are at risk for developing schwannomas (SV) and other nerve-sheath tumors throughout their lifetime, for which there is no effective drug treatment. Producing a model system for this disorder in rodents is essential for the development of targeted therapies.

**INTRODUCTION**

**Neurofibromatosis Type 2**

- Single-gene deletion of the merlin tumor suppressor gene
- Development of bilateral vestibular schwannomas

**Prevention of Tyrosine Nitration Decreases MD-HSC Survival**

- Mutations in the NF2 gene that leads to increased oxidative stress
- Merlin loss of function

**Preventing Nitration may Impact Survival Pathway Expression**

- Reduced survival

**RESULTS**

**Mass Spectrometry Analysis**

- Nitrated proteins in vestibular schwannomas (VS) from NF2 patients

**Phospho-kine Array**

- Phospho-MAPK Phosphorylation Array

**Survival Pathway Western Blots**

- Western blot merge

**Unbiased Transcriptome Analysis**

- **CONCLUSIONS**
  - We identified endogenously nitrosoated protein in vestibular schwannomas from NF2 patients and MD-Schwann cells.
  - Prevention of tyrosine nitration results in decreased pro-proliferative survival pathway activation in MD-Schwann cells, including Akt, JNK, and ERK.
  - Prevention of tyrosine nitration does not result in significant changes in Akt activation.
  - Western blots were consistent with array results, under identical cell conditions.

Together, these results suggest that nitrosoated protein regulate relevant signaling pathways in NF2 schwannoma cell culture models to promote cell survival and proliferation.

**FUTURE DIRECTIONS**

- Repeat Western Blots for all proteins of interest.
- Repeat experiments for NF2 cell model.
- Send out mRNA for unbiased transcriptome and pathway analysis.

**ACKNOWLEDGEMENTS**

- Thank you to Jason Peterb, Oliver Weida, and Dr. Atsushi Taga, for their supervision and help performing the experiments.
- Thank you to Dr. Maricela Lee for mentorship and support during my time in the lab.
- Thank you to Corine Mene-Meléndez for assistance in cell culture.
- This work was supported by the Office of the Assistant Secretary of Defense for Health Affairs through the Neurofibromatosis Research Program (NFNR), NCI/NIH/NIH/NIH, National Cancer Institute, National Institutes of Health, and Department of Defense (DoD) grants.
Janus-Type Microfluidic Devices for Separation and Collection of Plasma from Blood

Linus J. Unitan
Mentor: Dr. Vincent T. Remcho

Introduction
- Microfluidic analytical devices (µDAs) are popular because they can provide high-throughput, real-time results, and can be miniaturized to be used in applications such as diagnostics.
- Fabrication of µDAs typically involves patterning of hydrophilic substrate material with hydrophobic channel material.
- The combination of hydrophilic, chemically inert glass microcapillary (GC) membranes and hydrophilic and biocompatible poly(dimethylsiloxane) (PDMS) provides a unique substrate material for fabricating microfluidic devices.
- µDAs allow the separation of different plasma fractions on a single device, expanding the ability of these devices for use in any research platform.
- We present a new Janus-type wicking-capillary µDA that integrates wicking and capillary-driven microneedles to enable fluid collection from wicking µDA. We also demonstrate the utility of this device as a lab-on-a-chip separation and collection device, and a target fluid control mechanism.

Optimization
- Wicking channel geometries can be optimized to maximize the mass production (Figure 4, left and center) in order to create custom fluid flow features, such as dilution, aspiration, and mixing to assist different methods of sample preparation.

Experimental Results
- With sample volume of 10 μL:
  - Up to 3 μL of plasma sample is collected.
  - Up to 1 μL of plasma sample is collected with a custom length capillary.
- Preliminary results with real plasma blood sample (ESDA method):
  - Demonstrated effective separation of plasma from whole blood.
  - Plasma flow down capillary channels (Figure 3).
- <1 μL of plasma collected out of 10 μL of whole blood sample (reduction >90%).
- Fluid yields can be improved.
- Increases sample volume and optimizes the pattern geometry.
- Optimization of PEG:bovine and molecular weight for the wicking portion of the device.

Gated Fluid Control
- Slight overlapping of the wicking and capillary features allows fluid to flow continuously between the two halves of the device, avoiding fluid collection.
- Continuous fluid flow is prevented when mixing and capillary features are in close proximity, allowing one-way gate functionality. Fluid introduced into the wicking portion of the device do not continue to flow into the capillary channel, but solution introduced to the capillary will reach the wicking portion of the device (Figure 9).
- This functionality enables integration of automated microfluidics on a microfluidic platform.

Conclusions
- Treatment of PEG with PCL at different molecular weights results for fabrication of wicking and capillary fluidic channels on a target device.
- Fluid flow on the method economics of stages that are fully automated, such as microfluidic sampling and oxygen-medication exposure.
- A Janus-type wicking-capillary µDA was developed that enables fluid collection after fluid has passed through the device, which enables the integration of automated microfluidics on a microfluidic platform.
- These devices enable the integration of microfluidic sample preparation and assay detection, using microfluidic-assisted collection methods, and are suitable for a broad range of detection methods, such as lab-on-a-chip.
- Fluid channels can be used to guide fluid flow.
- Mixing and capillary features can be stably fabricated to introduce new dynamic functionalities.

References Cited

Acknowledgments
- Committee Members: Dr. Vincent Remcho, Dr. Omer Gokel, Dr. Omer Chandra Nanda
- Members of the Remcho Research group (especially Kyle D. Biffis)
- Blood sample collection: Dr. Shao, Bechtel, and Dr. Candace Remcho
- Pending for funding PCL samples used in this work.

Oregon State University
Honors College
EFFECTS OF AGE MILITARY SERVICE ON MEMORY AND COGNITIVE FLEXIBILITY IN A VIRTUAL MORRIS WATER MAZE TASK.

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2School of Mechanical and Aerospace Engineering (MAE), Nanyang Technological University, Singapore.

INTRODUCTION

In order to enhance translation between rodent and human studies, we developed a virtual version of the Morris water maze (vMWM) and successfully applied it to show age-related differences in human males performing a spatial memory version of the task (Zhong et al., 2017, Behav. Neurosci. 131:470). This study expanded to examine the sensitivity of the vMWM tasks to aging of both genders on memory, reversal, and delayed matching to place performance in the vMWM as compared to standardized human cognitive tasks in the NIH Toolbox and the Wechsler Memory Scale (WMS) Logical Memory test. We also examined whether military service may be a hidden variable in cognitive aging studies.

METHODS

Participants: Young (21-31 years old) and older (50-65 years old) males and females were tested. Based on self-report, all participants were assessed to be in good health without medications or conditions that could impact cognitive function. Older males could be divided into veterans from the Korean and Vietnam war eras or age-matched civilians. The veterans self-identified as performing non-combat service.

Testing:
Participants were screened for visual acuity, color blindness & contrast sensitivity: MMSE for dementia, WMS Logical Memory (immediate and delayed (30 minutes) recall tasks, NIH Toolbox Cognitive Battery and vMWM tasks (see diagram to right).

Analysis: vMWM tasks were analyzed by corrected cumulative proximity for hidden platform trials and average proximity for probe trials. Uncorrected Standard Scores were used for the NIH Toolbox tasks. Statistical analysis included ANOVA with the use of Statview software.

vMWM detected age differences, but not gender, in spatial learning & memory

vMWM detected effects of military service on working memory & flexibility

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Table above indicates that older individuals had significantly more education (p<.0001) and took more time in the speed maze (p=0.0002) than young. Older individuals had significantly lower scores in picture vocabulary (p<.0001), flanker inhibition (p<.0001), list sorting (p<.0001), discrimination card sort (p<.0001), pattern comparison (p<.0001), picture sequence memory (p<.0001), tasks and fluid cognition (p<.0001); A) than young. Veterans demonstrated a significantly worse performance in picture vocabulary (p<.02), oral reading (p<.02), and logical memory, immediate (p<.0061), tasks and crystallized cognition (p=0.02) than civilians.

CONCLUSIONS

- The vMWM tasks showed similar age related deficits as were demonstrated by the NIH Toolbox.
- Military service in the Korean and Vietnam war eras appeared to not be beneficial for working memory and cognitive flexibility later in life.
- The vMWM tasks were more sensitive to the effects of former military service on working memory and cognitive flexibility in older men than the NIH Toolbox tasks.
- Former military service may be a hidden variable in cognitive aging studies.
CONNECTING COMPUTATIONAL THINKING AND MATHEMATICS: AN EXAMINATION OF LINGUISTIC OPPORTUNITIES AND CHALLENGES

RESEARCH AIM
To examine opportunities for K-12 mathematics teachers to learn and engage with computational thinking in their teaching education programs.

RESEARCH QUESTIONS
1. What are the linguistic affordances and challenges that K-12 mathematics teacher candidates face as they engage in a computational thinking setting?
2. How do the teacher candidates navigate these affordances and challenges?
   a) Without support
   b) Using tools that are provided by computational thinking modules

METHODS
The broader study was a five-day application of computational thinking. The participants were divided into five groups of 2-3 teacher candidates each. Over the first two days, they were learning basic coding concepts to address a simple money investment scenario in an interactive block-based interface called Blockly. Throughout the module, they were asked to respond to reflection questions about how computer science and mathematics are related. This study focused on a group of two teacher candidates, referred to as Rhoda and Giny, over the course of the first day of the module.

CONCEPTUAL FRAMEWORK
Computational thinking
- A thought process involved in formulating a problem and expressing its solution(s) in such a way that a computer (human or machine) can effectively carry them out (Wing, 2014, p.3).
  - Abstraction
  - Algorithmic thinking
  - Developing models
  - Designing efficient solutions

Translanguaging
- "The development of a speaker's full linguistic repertoire without regard for the waistful adherence to the socially and culturally defined boundaries of named [and usually national and state] languages." (Otheguy et al., 2015, p. 383)

Disciplinary repertoires
- The full set of meaning-making and communicative devices that a person carries, specifically geared towards learning and problem solving within the various academic disciplines.

REFERENCES

CONCLUSIONS AND IMPLICATIONS
- Important to find ways to anticipate affordances and challenges such that teacher candidates can foreground their knowledge and address potential challenges.
- Would the use of translanguaging in a disciplinary context fold in all other affordances?
- Would all affordances be applicable in a computational thinking setting?
- e.g. physics & computer science

Figure 1. Screen shot depicts the Blockly interface that the teacher candidates used in the module. The left side shows the block-based code where they selected from a palette of blocks, and the right side shows the script-based code where they could type in Python.

Figure 2. Venn diagram illustrating the overlapping disciplines dimension in the study and their connection to computational thinking.

Rhoda - computer science, mathematics, & mathematics teaching
Giny - mathematics & mathematics teaching
Science Education Through Comics: Improving Understanding of Current Marine Environmental Issues

Zale Schwarz (Zoology), Dr. Stephen Atkinson (Microbiology), Matthew Schofield (*The Simpsons*)

**Background/project summary**

- We face multiple environmental challenges, yet public understanding of these is limited: for example, 52% of Americans would earn an F on a quiz on the basics about climate change (NEEF 2015).
- Lack of understanding prevents people from making informed decisions.
- Scientific concepts can be explained and made accessible to a wider audience through comics (Munawwar et al. 2018).
- Comics can easily communicate abstract or complicated concepts by combining text and art. Comics are quick and appealing to read.

For this project, I was driven by my concern for marine environmental issues, and an opportunity to build my comic writing and science communication skills. I focused on eutrophication and plastic pollution because they are current, complex problems that can be improved by individual actions.

**Methods**

The Workflow Diagram shows the major parts of my process.

I did research on the topics, and collected text and reference art for making concept sketches. The draft illustrations were created using pencil and alcohol ink markers on watercolor paper. When needed, I added detail with colored pencils and acrylic paint. Initially, I photographed colored illustrations using a phone app, but later digitized using a Canon CanoScan 9000F scanner. The comic panels were laid out in CorelDraw X8, and text was added digitally. The complete draft was then critiqued by a professional illustrator, Matthew Schofield, who is animation director for *The Simpsons* and writes his own webcomic *Steamroller Man*. I created a custom webpage to host PDFs of the comics, and then posted links to Twitter and Instagram. I regularly monitored the social media feeds and collected feedback.

**Workflow:**

- Research problem
- Write story outline
- Create concept sketches
- Add color to art
- Create initial panel layout
- Scan art & combine
- Critique by a comic artist
- Publish final revised comic online.
- Share on social media.

**Results & Discussion**

The final and draft comics can be read on [zschwarz.com/comics](http://zschwarz.com/comics)

This process was developed during the creation of *Eutrophication: Escape the Dead Zone*, and adapted from previous projects. I worked on to add illustration to explain scientific concepts. I found that digitizing the art using a scanner, rather than a document scanning phone app produced much clearer results.

The feedback I have so far showed me several important things: the comic format I used does effectively explain the concept. Layout and text density are essential to effective communication. If a page is too dense or unintuitive to read, the audience loses interest quickly.

Although the website and social media posts are being seen, the comics have not yet reached an audience as large as I had hoped. To reach a wider audience, I plan to partner with teachers and existing science communication organizations. There is clearly opportunities for reaching younger people, as two professors and one elementary school teacher have contacted me, asking to use my comic in their classes.

**Conclusions and future directions**

- In the future, I'd like to experiment with purely digital art, which will be easier to edit throughout the process.
- Other environmental issues that I am considering making into comics include ocean acidification, overfishing, and deep sea mining.
- I would like to partner with an aquarium or another organization to create focused projects with a larger audience.

**Acknowledgements**

Thank you so much to Dr. Atkinson and Mr. Schofield for their instruction and advice, Jay Eddin and Miles Stokes for inspiring my love of comics, and my family, for their constant support and encouragement.

**Literature**

Honey Bee (Apis Mellifera) Colony Strength And Its Effects On Pollination And Yield In Highbush Blueberries (Vaccinium Corymbosum)

Kennedy Grant, Mentored by Dr. Andony Melathopoulos

BACKGROUND

Beekkeepers continuously report that their colonies are developing persistent diseases during the blueberry pollination season in the Pacific Northwest, while recent studies in Washington suggest there are benefits to increasing the number of rental colonies per hectare (also known as stocking rate). The relationship between demand increasing density and the deterioration health of the hives could be problematic, as closer proximity may increase likelihood and intensity of brood infections.

We wanted to investigate whether there was an alternative approach to increasing yield that benefited both beekeepers and growers, not by adding additional colonies per hectare, but by supplying populous, higher-quality colonies. In addition, we also set out to confirm beekeepers' increased sightings of a concerning honey bee larval disease (European foulbrood; EFb; see image 1). Therefore, the three main goals of this study were to:

1. Assess the effects of blueberry pollination on the health of honey bees
2. Define honey bee colony quality and strength parameters, and
3. Determine whether colony strength influences blueberry yield.

RESULTS

- Both the presence and prevalence of EFb increased over the course of the pollination season in all fields, both years (Fig 1)
- "Flight" counts (the rate of returning forager bee per minute) is an accurate estimate of internal colony strength (Fig 2) that can be performed by blueberry growers, as it doesn't require the tools and skills needed to open a colony (beekkeeper methods)
- The recommended flight count for adequate pollination services (100 bees per minute, Sugli and Burgott 2011) is an overestimate, and six frames of bees (typical minimum strength parameter) is equivalent to ~42 bees per minute (Fig 3)
- Using flight counts as a proxy for internal colony strength, there was a 62.6% difference in the estimates of blueberry yield (kg/ha) between colonies at the 25th percentile (6.6 adult frames, 42.6 bees per minute) and the 75th percentile (10.2 adult frames, 90.3 bees per minute).

DISCUSSION

- Confirmed reports from Oregon beekeepers that colonies have increased prevalence of EFb following blueberry pollination
- Data suggests pollination benefits could be achieved without increasing hive density.
- This study is one of the first to demonstrate that yield benefits associated with crop pollination are also related to the strength of colonies brought into pollination.
- The method used to assess honey bee colony strength, incoming flight entrance counts, is easy for growers to perform and a significant predictor of true internal bee counts.
- An OSU extension publication is in production to train growers in measuring colony strength via flight counts.
- Growers could realize a substantial yield increase by maintaining standard 10 colonies/ha stocking rates, but selecting beekeepers who provide stronger colonies for pollination.
- Further studies should track realized profit margins associated with colony strength to provide beekeepers with a way to competitively price their colonies (currently each $55, flat rate) and incentivize growers with increased yield.
Hibernation Strategies to Improve Organ Preservation and Storage

Maja Engler, Matthew T. Andrews

Introduction

The global shortage of organs and tissues needed for transplantation has become one of the leading crises in the biomedical community. According to the World Health Organization (WHO), it has been estimated that only ten percent of the worldwide need for organ transplantations is being met. One potential solution to this humanitarian problem could be found in hibernating mammals.

Mammalian hibernation is a complex phenotype involving reduced metabolic rate, reduced oxygen intake, low body temperature, and a reliance on stored fat that allows the animal to survive 5-6 months without food. These evolved mechanisms in hibernators provide a potential framework for new therapies targeting preservation of organs for transplantation.

The goal of my thesis is to examine the effects of lipids in a hibernation-based solution for organ transplantation. Lipids play a large role in hibernation, from providing a source of energy to protecting the animal’s heart from damage.

Methodology

1. Thaw BPAE Cells
2. Plate Cells
3. Incubate Cell Plates for 9 Hours
4. Add Prepared Solutions to Plate Wells and Refrigerate
5. PrestoBlue Assay
6. Incubate Plates
7. PrestoBlue Assay
8. Repeat Steps 5-7
9. Analyze Results
10. Repeat with Adjustments Based on Previous Results

Results

- Five experiments were conducted to test various solution components and concentrations in order to find the best combination for preserving cell cultures.
- We hypothesized that the fatty acids would be utilized by the cells as energy sources during changes in conditions (refrigeration to incubation) in order to stay viable for longer periods of time.
- Based on the results of the PrestoBlue assays, the addition of linoleic, linolenic, and oleic acids in the hibernation solution did not increase the longevity of the cell cultures. In fact, they seemed to decrease the longevity compared to the control solutions. The most successful preservation solution consisted of 10x melatonin and PBS++Glu.

![Graph showing cell count over time](image)

Discussion

Conclusions

- Fatty acids may not be essential for cell preservation in a hibernation-based solution, and may instead hinder cell viability over long periods of time.
- Melatonin may play a larger role than initially thought in increasing cell viability and preserving tissue cultures.
- In the last experiment, we successfully preserved cell cultures for seven days.

Future Directions

- These findings have the potential to increase the preservation time of human organs in a transplantation solution by up to seven days for abdominal organs and two days for thoracic organs, which is a drastic improvement to what is currently offered on the market.
- On a long-term timescale, placing humans in a state of suspended animation has been proposed as a futuristic means of conserving resources during long-term space travel.

References

# Effects of Inhibitors Against SYK-BTK-PI3K Signaling on Platelet Function

**Liz Lofurno**

**Mentors: Dr. Joe Aslan & Dr. Skip Rochefort**

## Background

Platelets respond to physiological cues and stimuli present at the site of damage. Vascular injury, inflammation, and disruption of flow cause platelets to be activated and undergo morphological changes vital to hemostasis.

Tyrosine kinases mediate how blood cells respond to stimuli. Tyrosine kinase inhibitors (TKIs) serve important roles as drugs in managing hematological diseases, including several cancers.

In healthy B cells, the B cell receptor (BCR) activates a tyrosine kinase known as SYK, which then activates BTK, PI3K, PLCγ2 and protein kinase C (PKC) to mediate responses such as cell migration and proliferation. In many hematologic cancer cells, BCRs are overactive, causing an uncontrolled increase in cell survival and production. TKIs against SYK, as well as BTK can block highly active BCR, and restore normal cell function and turnover. In this regard, TKIs have been shown to successfully treat several blood cancers.

Unfortunately, many TKI drugs used to treat blood cancers also affect other healthy blood cells, including platelets, and bleeding complications are common to TKI therapy. To investigate these issues, the effect of various tyrosine kinase inhibitors on platelet activation was analyzed along with the protein-protein interactions.

## Materials & Methods

- Platelets were isolated from anticoagulated blood from healthy adult human donors for assays of platelet adhesion responses.
- Purified platelets were incubated with TKIs or vehicle alone for 10 min, and then set to adhere to glass coverslips coated with fibrinogen protein for 45 minutes.
- Platelets were fixed with 4% paraformaldehyde and processed for light microscopy imaging. Other parallel: replicate sets of coverslips were stained with primary antibodies to visualize the localizations of PI3K and microtubule organization in adherent platelets under control and TKI conditions.
- Coverslips with adherent platelets were imaged using Kohler illuminated Nomarski differential interference contrast (DIC) optics as well as fluorescence imaging with a Zeiss 63X oil immersion 1.40 NA plan-apochromat lens on a Zeiss Axiosvert 200M microscope.

## Results & Discussion

(FIG. 1) Results demonstrate that all Syk and BTK inhibitors examined have inhibitory effects on platelet spreading. In general, while inhibitors to Syk and inhibitors that reversibly target BTK uniformly inhibit platelet spreading on fibrinogen, inhibitors that reversibly target BTK were less potent in inhibiting platelet spreading, which lead to an increase variability in surface area as noted by the frequency distribution analysis (FIG. 2).

(FIG. 3) These results show a relationship between microtubule organization and localized PI3K and other signaling systems in platelets, suggesting that Syk and BTK inhibitors differentially alter platelet PI3K signaling in a manner related to the inhibitor’s pharmacology.

## Conclusions

- Tyrosine kinase inhibitors which target components of the same SYK-BTK-PI3K signaling pathway, have varying effects on platelet responses.
- Differential effects may be attributed to altered protein-protein interactions within platelets with SYK and BTK specific inhibitors, and not others in a manner that may be relevant to better understanding off-target effects and the toxicity of therapeutic TKIs in different contexts.
- Inhibiting platelets causes similarities and differences in the tubulin and PI3K interactions.

The results from this study may help to understand “off target” or undefined effects of TKIs on platelets. This will help to address a growing need to better understand the effects of such compounds on essential molecular machinery around Syk-BTK signaling in platelets and other physiologically relevant cell types.

## Acknowledgements

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Social Context Affects Response to an Acute Stressor in Captive Red Crossbills (Loxia curvirostra)

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**Introduction**

- Social animals can use available information to inform behavioral and physiological responses to situations, but the way that information is processed can be influenced by the social context in which an event occurs.
- Consequently, the presence or absence of conspecifics can alter stress perception.

**Methods**

- 96 adult red crossbills were placed into cages based on their treatment group:
  - Alone Control – Individually-housed birds on a natural photoperiod, not paired on move day
  - Singly housed – Individually-housed birds on a natural photoperiod, paired with a neighbor cage on move day
  - Doubly housed – Doubly-housed birds on a natural photoperiod, paired with a neighbor cage on move day
  - Visual barriers were put up during the pre-pairing period (8 weeks) such that individually-housed birds in each cage could hear, but not see, the birds in other cages. Doubly-housed birds could see and interact with their cage-mate.

**Results and Discussion**

- The mean change in mass was significantly different by treatment (Figure 1, ANOVA: F = 25.9, p < 0.001, R² = 0.68), with doubly-housed birds losing significantly more mass than singly-housed and alone controls (Tukey’s Comparison of means, p < 0.05).
- These data suggest that treatment group (i.e., social context) affects whether mass was retained or lost after exposure to a stressor.

**Predictions and results**

1. If pairing induces stress in doubly-housed birds by upsetting dominance hierarchies, then we predicted that we would see increased activity, reduced food intake, and asymmetric weight loss in doubly-housed partners given that one bird of the duo would be excluded from food.
   - For social pairings, there was almost no overlap between the change in mass for individually-housed birds and doubly-housed birds (Figure 2).
   - Individually-housed birds consistently maintained or gained weight, while doubly-housed birds consistently lost weight.
   - Pair ID was a nearly significant random effect (p = 0.08) in explaining mass loss in doubly-housed birds.
   - These data suggest that doubly-housed birds may have responded similarly to their partner in response to the stressor.
   - Because changes in mass were not symmetric between duos, we can conclude that one bird was not being excluded from food. Therefore, we can reject the dominance hypothesis.

2. If social buffering mitigates stress in previously isolated, singly-housed birds, then we predicted that we would see a reduction in activity levels and/or an increase in food intake following pairing in singly-housed birds relative to those that remained in social isolation.
   - The difference in change in mass between singly-housed birds and alone controls was not statistically significant (p = 0.1).
   - There was no significant interaction between food intake and treatment group on the change in mass (ANCOVA: p = 0.01).
   - There was a weak trend suggesting the interaction between activity and treatment group impacted the change in mass (Figure 3a, p = 0.11). In doubles, there was an inconsistent relationship between change in activity and change in mass (expression p < 0.04), but singles that had an increase in activity tended to lose more mass (Expression p < 0.05).
   - Treatment group significantly predicted change in food intake (Figure 3b, unadjusted p = 0.02, adjusted p = 0.02), but not change in activity (same, Figure 3c).
   - Across all birds, treatment group was the only significant factor driving change in mass (MANOVA: p < 0.001).

**Conclusions**

- The changes in mass in doubly-housed birds did not seem to be due to dominance by any one individual and the social buffering hypothesis was not directly supported by these data.
- These data suggest that the mechanism driving this phenomenon may be a more complex interaction between social context and physiological decision-making in response to stress.
Inclusion development in cells infected with *Chlamydia abortus*

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**ABSTRACT**

Background: *Chlamydia* is a genus of bacteria that include many species of host-specific intracellular pathogens. Elementary bodies (EBs) are brought into host cells through endocytosis for lyosomal destruction (1). *Chlamydiae* transform membrane into inclusion, hospitable environment for replication. The inclusion membranes of the species vary, with *C. trachomatis* always forming one inclusion and *C. caviae* always forming multiple inclusions (2,3). *C. abortus*, an important sheep and goat pathogen that causes miscarriages, sometimes forms one inclusion and sometimes forms multiple (1). This project is examining how different chlamydial species inclusions fuse or do not fuse during co infection. We also examined the properties of *C. abortus* homotypic inclusion fusion.

**RESULTS**

Figure 3. *C. abortus* and *C. caviae* inclusions fuse; no other combination of species tested does.

- A. *C. pneumoniae* (green, inc) and *C. caviae* (red, inc) do not fuse in eoccluded cell. Scale bar 15 μm.
- B. *C. pneumoniae* (green, inc) and *C. abortus* (red, MOMP) do not fuse inclusions.
- C. *C. caviae* (green, inc) and *C. trachomatis* (red, MOMP) do not fuse inclusions.
- D. *C. abortus* (green, MOMP) and *C. trachomatis* (red, inc) inclusions do not fuse.
- E. *C. caviae* (green, inc) and *C. abortus* (red, MOMP) inclusions fuse (see center cell).
- F. *C. caviae* (green MOMP and blue inc) inclusions surround *C. abortus* bacteria (red MOMP).

Methods: McCoy cells (a murine fibroblast immortalized cell line) was singly or coinfected with chlamydial species. Immunofluorescence labeling and microscopy were used to photograph and count instances of fusion in singly or doubly infected cells.

**Results:**

*C. trachomatis* did not fuse with *C. caviae* or *C. abortus*. *C. pneumoniae* did not fuse with *C. caviae* or *C. abortus*. *C. abortus* and *C. caviae* fused in greater than 90% of coinfected cells. In singly infected cells, *C. abortus* about 25% of bacteria produced multiple inclusions, a number that increased with increasing MOI (multiplicity of infection).

Figure 1. Phylogenetic tree of chlamydial species made from whole genome alignment

*C. caviae* and *C. abortus* are more closely related to each other than to *C. pneumoniae* or *C. trachomatis*. *C. suis* and *C. muridarum* fuse inclusions in vitro (4). *C. psittaci* and *C. pneumoniae* do not fuse with *C. trachomatis* (5). Neighbor-joining PHY tree made with Gganzus Freme from Maffei nucleotide alignment.

Figure 2. Number of inclusions varies between species. Singly infected McCoy cells with *C. abortus* (red, MOMP) or *C. caviae* (green, MOMP) inclusions. *C. abortus* inclusions are more numerous than *C. caviae* inclusions.

**REFERENCES**


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Each year Honors College students share the research they have been working on with the OSU community. Projects range from Art to Zoology. Undergraduates from a variety of academic disciplines will be present. Each presenter will upload their poster and a record a short talk about their research. We strongly encourage you to watch the videos. **This event has closed so students may not respond to comments**  We announced the winners of the HC Outstanding Thesis Poster on social media: Check out our Instagram video. Click the links below to go to the winners' presentations.

- Engineering Winner(s): Renuka Bhatt and Claire Hekkala
- Engineering Honorable Mention: Bryan Kelly
- Science Winner: Simone Burton
- Science Honorable Mention: Madeleine McArthur
- Social Science and Business Winner: Maia InSinga
- Social Science and Business Honorable Mention: Rylie Tiffin
- Humanities Winner: Shrida Sharma
- Humanities Honorable Mention: Abigail Bernasconi

CONGRATULATIONS to all that competed and submitted this year.

Thank you so much for joining us here! We hope this event will bring our community closer.