Middle Georgia State University

Friday, April 22nd
8am–1pm
Macon Campus, Jones 102

Hosted by The Departments of Mathematics & Statistics and Natural Sciences

Contents

About

Middle Georgia State University STEMposium

Welcome to the first annual Undergraduate STEMposium at Middle Georgia State University. This one day in-person conference that provides an opportunity for our undergraduate students involved in STEM research areas to present their work or research interests. We have invited students in the natural sciences, mathematics, and I.T. departments to take part in the conference. We will have students and faculty participating in either oral or poster presentations today.

For the oral presentations, each student will be giving a 15 to 20 minute talk about their projects to showcase what they have learned and hopefully teach the audience a few things they might not know. Each student will answer questions from the audience after their presentation.

After the student oral sessions, we will have oral presentations from some of our faculty. These presentations will be about the CURE (Course Undergraduate Research Experience) projects that our faculty have conducted with students in the classroom.

The last event of the day will be the poster session. In the poster session, students will stay near their posters and answer any questions you may have for them. Feel free to grill them!

The organizing committee welcome you to the STEMposium and hope you enjoy hearing about the awesome undergraduate research our students have been conducting!

Sincerely,
Duane Day
Co-chair of the STEMposium Committee

Organizing committee

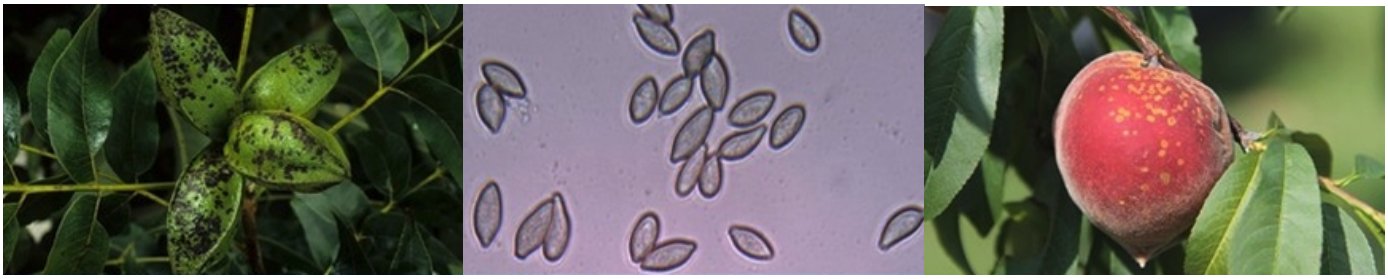
Christine' Rigsby, Natural Sciences	Co-Chair
Duane Day, Mathematics & Statistics	Co-Chair
Tom Hancock, Natural Sciences	
Sharon Mozley-Standridge, Natural Sciences	
Pushpa Yadav, Natural Sciences	
Guarisco, Victoria F, Natural Sciences	
Alan Stines, I.T.	

STEMposium Schedule

7:30am - 8:00am	**STEMposium participants arrive and check in.**
8:00am–9:15am	**STEMposium Opening & Plenary Speaker (Jones 102)**
8:00–8:15	**Opening Remarks/Welcome - Prof. Duane Day (Math)** **Introduction of Speaker - Dr. Jaya Rao (NatSci)**
8:15–9:15	**Plant Pathology: Digging Up the Dirt on Plant Diseases** **Plenary Speaker: Dr. Clive Bock, Ph.D.**
9:15am - 9:30am	**Break (Jones Atrium 1st/2nd Floor)**
	Oral Presenters - go to your session room and load your talks on the computers. **Poster Presenters - May hang your posters at this time (See Prof. Day).**
9:30am - 10:15am	**Oral Sessions I: Student Presentations**
	Oral Session I - A: Mathematics Students (Jones 277)
	Moderator: Dr. Joshua Harrelson **9:30-9:45** **Exploring Riemann's Rearrangement Theorem** **Presenter: Garrethe Edge** **9:45-10:00** **Conjectures on the Product of Matrix Exponentials** **Presenter: Justin Barnwell** **10:00-10:15** **Monte Carlo Simulation** **Presenter: Erin Taylor**
	Oral Session I - B: Natural Science Students (Jones 279)
	Moderator: Dr. Tom Hancock **9:30-9:45** **Water quality and physical character assessment of three oyster spat (Crassostrea virginica) settlement sites on Jekyll Island, Georgia** **Presenter: Kara Cruse** **9:45-10:00** **Separation Techniques for Isolating Magnetotactic Bacteria from Environmental Samples** **Presenters: Miracle Odom & Haley Starr** **10:00-10:15** **How does water quality, physical setting, and coastal development affect oyster spat (Crassostrea virginica) settlement on Sapelo Island, Georgia?** **Presenters: Kyra Morris, Katelyn Collins, & Michael Walker**
10:30am–11:15am	**Oral Session II: Faculty CURE Presentations (Jones 279)**
	Moderator: Dr. Dawn Sherry **10:30-10:45** **Implementing CURE Studies in the Genetics Class** **Presenter: Dr. Pushpa Yadav** **10:45-11:00** **Application of Probability to CURE Projects** **Presenter: Dr. Joshua Harrelson** **11:00-11:15** **Adventures in Preparing a CURE: Water Quality in CHEM 1212** **Presenters: Dr. Victoria Guarisco & Dr. Estelle Nuckels**
11:15am–11:30am	**Break (Jones Atrium 2nd Floor)**
	Poster Presenters should go to posters during this time.
11:30am–12:30pm	**Poster Session (Jones Building, 2nd Floor Hall, Adjacent to Jones 279)**
	Moderator: Prof. Duane Day

Plenary Speaker

Today we welcome our special guest speaker Dr. Clive H. Bock. Dr. Bock is a Research Plant Pathologist at the USDA-ARS, Byron, GA. Dr. Bock received a BA and MA in Botany from the University of Oxford, an MSc in Crop Production from the University of Bath, and a PhD in Plant Disease Epidemiology from the University of Reading in the U.K. He has worked on several diseases of different crops in tropical, subtropical and temperate regions in the U.S., U.K., Africa and Australia. He has collaborated nationally and internationally with the aim of improving plant disease management to provide more sustainable, competitive and safer crop production for producers and consumers. Dr. Bock's current research is concerned primarily with the epidemiology, population biology and management of pecan pathogens, with specific emphasis on pecan scab here in the Southeast. Scab is the most damaging disease of pecan. He has authored or co-authored more than 130 papers in scientific journals, and more than 200 additional publications including proceedings, scientific reviews, monographs and book chapters. Dr. Bock is a Senior Editor of the international journal Phytopathology and an Associate Editor for the European Journal of Plant Pathology and CABI Agriculture and Biosciences. He is an adjunct professor at the University of Georgia.We are honored to have Dr. Bock with us today. Please check out his abstract below.



Plant Pathology: Digging Up the Dirt on Plant Diseases

Dr. Clive Bock, Ph.D.

USDA-ARS, Byron, GA

We need food and raw materials from agriculture. Plant diseases are a constant threat to agriculture production, and historically have caused famines, cultural upheaval, madness and death. Plant pathology is the study of plant diseases, and embraces science, technology, engineering and mathematics (STEM) to understand and control plant diseases. A brief history of plant disease epidemics will be presented, and how STEM contributes to the ongoing battle against plant disease will be described and illustrated. STEM are an integral component of the future of plant pathology and the broader developments in precision agriculture.

Natural Sciences' Students

Water quality and physical character assessment of three oyster spat (*Crassostrea virginica*) settlement sites on Jekyll Island, Georgia

Kara Cruse; Advisor: Thomas Hancock

Middle Georgia State University, Macon, GA

Over the past twenty years, there has been renewed interest in establishing an economically and ecologically viable oyster aquaculture industry in the state of Georgia. To this end, considerable research effort has been expended to document oyster spat (*Crassostrea virginica*) settlement patterns and recruitment success at specific locations in coastal Georgia. Researchers have measured water quality and physical characteristics of sites to determine what factors may correlate with increased oyster settlement and growth. The ultimate goal of this work is to identify desirable sites for lease or restoration. Areas of the Georgia coast that have received attention in the past include the Sapelo Island National Estuarine Research Reserve and estuaries around Savannah. In contrast, no oyster studies have been conducted in the estuaries surrounding Jekyll Island. Therefore, a study was begun in the spring of 2021 to document water quality and physical characteristics of three sites on Jekyll Island and to relate these parameters to oyster spat settlement patterns. Water quality, sediment characteristics, and settlement were measured every six weeks from April 2021 until November 2021. On March 12, 2022 water quality samples were taken regularly from sunrise to sunset over one tidal cycle. Data is currently being analyzed to determine trends in water quality and sediment characteristics within and between sites. Correlational analysis will then be performed to determine if a relationship exists between these physical parameters and oyster spat settlement patterns.

Separation Techniques for Isolating Magnetotactic Bacteria from Environmental Samples

Miracle Odom & Haley Starr; Advisors: Prof. Ed Wallace & Dr. Sharon Standridge

Middle Georgia State University, Cochran, GA

Magnetotactic bacteria (MTBs) are microaerophilic gram negative microbes with the unique ability to sequester iron from their environment in order to synthesize magnetic iron particles. The iron particles are used to help the cells align at the right point in a water column for optimum nutrient absorption and oxygen concentration. In this study, we investigated an alternative method for isolation of MTBs from environmental samples by filtration through a magnetized substrate. Our experiments looked at whether the intensity and uniformity of an external magnetic field and a varying flow rate would yield a higher isolated MTB cell count.

How does water quality, physical setting, and coastal development affect oyster spat (*Crassostrea virginica*) settlement on Sapelo Island, Georgia?

Kyra Morris, Katelyn Collins, & Michael Walker; Advisor: Dr. Thomas Hancock

Middle Georgia State University, Macon, GA

Much of the United States' East Coast has experienced a decline in eastern oyster (*Crassostrea virginica*) landings since the early 1900s. In Georgia, this decline has been linked to overharvesting, disease, storms, and alterations in both water quality and natural flow regimes. Although past research has provided important information about the distribution of Georgia oyster reefs, microsite differences of spat settlement in relation to water quality, sediment composition, and coastal development have not been adequately addressed. A study was begun in March 2020 to determine if oyster spat settlement is correlated with these parameters. Three sites were chosen on Sapelo Island based upon proximity to development and location along the upland-estuary-sound gradient. Oyster spat settlement racks were established at each site. Tiles were collected every six weeks and number of oyster spat along with other biofouling organisms such as barnacles (Chthamalus fragilis) were determined. Additionally, water quality and sediment composition were measured during each collection period. The highest oyster spat settlement occurred in open sites with relatively high salinity, low turbidity, and high nitrogen levels. The highest barnacle settlement occurred in upper tidal creeks with relatively low salinity, high turbidity, and low nitrogen levels. Implications of this correlational analysis are discussed as well as future in-field manipulation experiments. This study is a preliminary attempt to develop a model for identification of potential oyster reef restoration sites.

Mathematics' Students

Exploring Riemann's Rearrangement Theorem

Garrethe Edge; Advisor: Prof. Duane Day

Middle Georgia State University, Macon, GA

Riemann's Rearrangement theorem details an interesting phenomenon among conditionally convergent series. It presents us with the fact that any series of this nature can be rearranged to converge to any real number. In this presentation we shall review what a series is, how to determine whether its convergent, and how to determine if it converges absolutely or conditionally. We will lastly explore how conditionally convergent series connect to divergent permutations and what theorems follow from those connections.

Conjectures on the Product of Matrix Exponentials

Justin Barnwell; Advisor: Dr. Chris Hill

Middle Georgia State University, Macon, GA

The matrix exponential is a matrix function on square matrices analogous to the ordinary natural exponential function $f(x) = e^x$. It was originally used to solve systems of ordinary linear differential equations. In the theory of Lie groups, the matrix exponential gives the connection between a matrix Lie algebra and the corresponding Lie group. We give various properties of matrix exponentials and use them to investigate conjectures on the product of matrix exponentials.

Monte Carlo Simulation

Erin Taylor; Advisor: Prof. Duane Day

Middle Georgia State University, Macon, GA

Monte Carlo Simulation is a computer-assisted simulation technique. The simulation produces a large number of possible scenarios to explore values of interest. In some situations, it is impossible or nearly impossible to model all cases to find a desired measurement in a certain system. But Monte Carlo Simulations compute a large representation to approximate a desired quantity. By implementing law of large numbers, the more random trials that are generated, the closer the approximated quantity approaches to desired quantity. Monte Carlo Simulations are useful in inferential statistics, risk management, stock market predictions, and even meteorology to name a few examples.

CURE Faculty

Implementing CURE Studies in the Genetics Class

Dr. Pushpa Yadav

Middle Georgia State University, Macon, GA

We developed a semester-long course-based undergraduate research experience (CURE) for a genetics class to build students' knowledge on model organisms and to develop the skills required for genetic research. Students were engaged in three research projects using *Drosophila* (fruit fly) and *Saccharomyces* (yeast) model systems as part of their training. The first project was developed to help students understand the inheritance pattern of a mutant. They developed the hypothesis based on the observable trait in the filial-one (F1) generation and subsequently tested it in filial-two (F2) generations. The second project was developed to show how gene interactions affect inheritance patterns. In this project, yeast mutants with mutations in one of the two genes were crossbred to help students understand gene interactions. The third project, (BLAST), was developed to provide skills required to understand gene annotation in fruit flies. Data from pre- and post-CURE surveys were collected to assess learning outcomes. The four main elements assessed were: 1) Did the CURE course improve student learning outcomes related to genetics? 2) Did the CURE course improve students' learning of the scientific process? 3) Did the CURE have a positive effect on students' interest in science; 4) Did the CURE increase the frequency of students asking questions during the course?

Application of Probability to CURE Projects

Dr. Joshua Harrelson

Middle Georgia State University, Macon, GA

Data and Probability are some of the most used and most misused mathematical concepts. I addressed this through a research experience given to my Applied Probability class last semester. Come see how we used probability to help us make decisions and see how we avoided incorrect inference.

Adventures in Preparing a CURE: Water Quality in CHEM 1212

Dr. Victoria Guarisco & Dr. Estelle Nuckels

Middle Georgia State University, Macon, GA

While cookbook experiments are simple, straightforward and generally work every time, they lack a connection to each other and to real world scenarios that involve the scientific method and scientific reasoning. Having these connections early in science education both increases knowledge retention and interest in the material. The Principles of Chemistry II course is in this strategic position and has course material that can be easily tied together with a water quality theme. In this CURE supported research, 4 labs were modified to use lab techniques already taught to determine nitrate, nitrite, pH, calcium, magnesium and chlorine levels in a water sample. While lab design is still an ongoing adventure, students are able to deduce survivability of a theoretical fish of their choosing in the water samples tested throughout the semester.

Derangements and the Hat Check Problem

Tanner Dupree; Advisor: Prof. Duane Day

Middle Georgia State University, Macon, GA

The Hat Check Problem is a classic combinatorial problem described as follows: "The hat-checker at a party accidentally scrambles n hats and returns them to the n owners at random. What is the probability that no owner receives their own hat back?" This problem can be solved using derangements. In this poster, we discuss derangements, present both a recursive and an explicit formula to count the number of derangements, and use these formulas to compute the probability as described in the Hat Check Problem.

Pascal, Tetrahedron and The Trinomial Theorem

Jacob Cook; Advisor: Prof. Duane Day

Middle Georgia State University, Macon, GA

Pascal's Triangle is a mathematical treasure accredited to Blaise Pascal, and it possesses many properties and patterns which have amazed mathematicians for centuries. For example, Pascal's Triangle can be used for binomial expansion, by determining coefficients of terms, and in combinatorics, such as finding nCx. We will look into a 3-D expansion of the Triangle called Pascal's Pyramid or Pascal's Tetrahedron, and its relationship to the Trinomial Theorem. Additionally, we will look at special patterns that arise from the pyramid.

Design and Prototyping of a Tidal Flow Meter

Alex Kirkland; Advisors: Dr. Chris Hornung & Dr. Edwynn Wallace

Middle Georgia State University, Macon, GA

The collection of data for the MGA Biology Research team, who are studying oyster deposits, has been a challenge given their tools and environment they are working in. This project entails the design, construction, and testing of a device to measure water flow in several locations on the waterways around Jekyll Island that will provide a simple way of collecting and storing data. At each location, the environment in which the oysters are living require data to be collected over various durations of time. The flow meter being designed will be submersible and self-contained allowing the biology team to collect more data over a longer period thus being more accurate for their research. In the design process of this device, AutoCAD will be used along with filament 3D printers to create multiple prototypes allowing us to iterate and quickly refine the design to provide the best product. This device will be in the shape of a turbine with a PVC pipe body and a propeller inside that will spin with the passage of water through it. This rotational motion will then be logged in an Arduino storage device using magnets and Hall Effect sensors to detect the RPMs while all contained in a watertight box. The device will then be calibrated against a conventional flow meter to get an equation that will convert the RPMs of the spinning propeller of the device to the actual flow rate around the oyster locations. The submersible flow meter that will come from this research project will provide a more effective and simple way of collecting underwater data.

Design and Prototyping of a Robotic Arm

Mark Lucas; Advisor: Dr. Chris Hornung

Middle Georgia State University, Macon, GA

This project covers the development and design process of a rudimentary robotic arm. The purpose of this device is to give engineering students a way to apply their design and programming education as well as to serve as a demonstration unit for recruitment purposes. Due to the desire to keep costs low, the design of this system features polyvinyl chloride piping and 3D printed parts along with commercially available servo motors, and electronic control units. The initial portion of the project emphasizes getting the mechanical design and servo programming correct for basic tasks. This includes sizing, layout, location of motors/joints, and type/function of the grasping mechanism (claw). The eventual goal for this system is to incorporate cameras and rudimentary vision AI to allow for object recognition and the completion of more advanced tasks.

Identifying the Genetic Homology Among *Drosophila* Species

John Aguilar; Advisor: Dr. Pushpa Yadav

Middle Georgia State University, Macon, GA

The Basic Local Alignment Search Tool (BLAST) is a program that reports regions of local similarity between a query sequence and sequences within a database. It is a powerful tool for alignment and comparison of the query DNA with database DNA to identify the protein and its variations using the protein BLAST tool that can align and identify the differences between amino acids.

The *Drosophila* contains only four pairs of chromosomes. The fourth pair of chromosomes is highly condensed and appears as a dot on the karyotype. The genes on the fourth pair of the chromosomes are not studied well in Drosophila species, therefore, we want to study the 20 kbp DNA of chromosome 4 of *Drosophila yakuba*. We accessed the 20 kb query DNA of *D. yakuba* with the National Center for Biotechnology Information (NCBI) to get the identification code of the query DNA and used that identification code to download the FASTA file from the Protein Data Bank. The FASTA file of query DNA was used with the protein BLAST tool for the identification of a gene/s. The protein BLAST matched the query DNA with the *Drosophila melanogaster*. We found that the inquired DNA sequences in *Drosophila melanogaster* contain two genes: Dpr7 and the RhoGAP gene. The Dpr7 gene is involved in the organization of synapsis during meiosis I and is predicted to be an integral component of the plasma membrane. The RhoGAP gene is involved in the positive regulation of GTPase activity. The next step of our research will be to study the structure of the two genes in detail.

MGA Checks Its Pulse: Flatline or Healthy Rhythm?

Dr. Dawn Sherry, Dr. Christie Canady, Dr. Donna Balding and Dr. Tom Hancock

Middle Georgia State University, Macon, GA

The purpose of our project was to examine the Middle Georgia State University (MGA) biology curriculum and bring it into alignment with the goals and objectives outlined in Vision and Change in Undergraduate Biology Education (NSF 2009). The first step in this process was to address the status of the curriculum. We called a voluntary meeting for biology faculty who teach upper-level courses and who were interested in discussing and updating our curriculum. In this meeting we presented the goals and objectives outlined in Vision and Change. All fourteen faculty who teach upper-level courses participated. Following the meeting, faculty were sent surveys that asked them to identify content covered in each of the upper-level biology courses offered by MGA. If a faculty member was an instructor for a specific upper-level course, they were asked to identify content covered in their course. If the faculty member was not an instructor of a specific course, they were asked to identify areas of overlap from other courses they teach. Faculty were also asked to describe at what level and by what methods content was covered (e.g., low, high, laboratory activity, assignment, exam, paper, project, etc.). From the data, we created a heat map that characterized content coverage across all upper-level courses. Next steps will include mapping content coverage to the goals and objectives outlined in Vision and Change. Future plans include sharing this with the faculty and conversations on how to implement any strategic changes.