CLASSES WITHOUT QUIZZES 2021

College of Natural Science

EXAMINATION BLUE BOOK

Name _____

Subject _____

Class _____ Section _____

Instructor _____ Date _____

No. 1855

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10 SHEETS/20PAGES

April 24, 2021

Welcome to Classes Without Quizzes at the College of Natural Science – an insider's look at MSU's science research and education.

As an important member of the College of Natural Science family, we're pleased that you're joining us for this virtual event. We've organized a fun and unique event, and hope you find this experience to be informative, engaging and inspiring.

We welcome your feedback, so please do not hesitate to contact us at natsci4u@msu.edu.

With regards,

Phillip M. Duxbury
Dean, College of Natural Science

GO GREEN!

Notes

SCHEDULE OF CLASSES

TIME	CLASS	INSTRUCTOR
9:00am - 9:15am	Welcome	Phillip M. Duxbury Dean, College of Natural Science
9:15am - 9:45am	You Are What You Eat: Understanding the Nutritional Requirements of Bacterial Infection	Neal Hammer, Assistant Professor Department of Microbiology and Molecular Genetics
9:45am - 9:50am	Introduction of Dean's Research Scholars and Racheal Nassimbwa	Angela Wilson, Associate Dean, College of Natural Science and John A. Hannah Distinguished Professor of Chemistry
9:50am - 10:05am	Dean's Research Scholar Presentation	Racheal Nassimbwa
10:05am - 10:35am	Chemistry, Life, the Universe & Everything	Melanie Cooper, Lappan-Phillips Professor Department of Chemistry
10:35am - 10:50am	Dean's Research Scholar Presentation	Brent Strong
10:50am - 11:20am	Building Quantum Technologies . . . One Electron at a Time	Johannes Pollanen, Assistant Professor Department of Physics and Astronomy and Jerry Cowen Chair of Experimental Physics
11:20am - 11:30am	Closing Remarks	Corey Palmer Senior Director of Development, College of Natural Science

You Are What You Eat: Understanding the Nutritional Requirements of Bacterial Infection

Neal Hammer
Assistant Professor, Department of Microbiology and Molecular Genetics
hammern2@msu.edu

Our bodies experience a multitude of harmless interactions with bacteria on a daily basis. However, some bacteria are capable of causing devastating diseases.

“Methicillin-resistant *Staphylococcus aureus* (MRSA), for example, is one of the most common types of bacterial infections in the clinic,” Neal Hammer said. “It’s the number one cause of skin and soft tissue infection, endocarditis, septic arthritis and osteomyelitis. It can colonize anywhere in the body and cause disease.” MRSA is tougher to treat than most strains of *S. aureus*—or staph—because it's resistant to some commonly used antibiotics.

To grow and cause disease, pathogens such as MRSA must scavenge essential nutrients from the host environment—the human body—including carbon, nitrogen, phosphorous and sulfur.

“Some of the mechanisms that support the nutrient heist have been established; but the strategies that pathogens use to acquire the essential element sulfur are largely unknown,” Hammer said. “What makes sulfur so unique is one of its major functions in the cell is to act as a redox buffer—two sulfur-containing molecules can link together. Sulfur has the propensity to link two proteins together, and that allows for various functions to occur within the cell.”

Hammer’s lab is now seeking to discover nutrient sulfur acquisition strategies employed by MRSA. Other researchers previously defined cysteine transporters in a bacterium that is closely related to *S. aureus*.

“We used genetic analysis to figure out that *S. aureus* also contained some of these transporters,” Hammer said. “We also identified the genetic requirements for utilization of another sulfur source called glutathione—a molecule that’s abundant in our cells.”

The goal of the work in Hammer’s lab is to provide novel therapeutic strategies to combat MRSA by impeding nutrient sulfur acquisition.

“One way to combat antibiotic resistance is to always stay one step ahead of the problem,” Hammer said. “As long as there are researchers who are continuously identifying new therapeutic targets—and small molecules that inhibit those therapeutic targets—I think we can stay one step ahead of antimicrobial resistance.”

A Conversation with Neal Hammer . . .

Came to MSU: 2015.

Hometown: Schaumburg, Illinois—a suburb of Chicago. I currently reside in Okemos, Mich., with my wife, daughter and son.

Muses: Phenotypes, metabolism and family.

Favorite food: Pizza.

Best song/group: Currently, the *Puppy Dog Pals* theme song—the only music I get a chance to listen to is what my toddler listens to! Overall, Zeppelin; “When the Levee Breaks” and “Gallows Pole” are fantastic songs.

Book I’d recommend: *And the Band Played On*

Coolest gadget: I'm a big fan of our Nespresso coffee machine.

Best invention: Sanitation; word processing

Worst invention: Social media

On my bucket list: I'd like to take a vacation to one of those villas in Fiji that are on the water.

Person I’d most like to meet (living or dead): Abraham Lincoln

Best trip/vacation: I was fortunate to visit Aguadilla, Puerto Rico, several years ago before hurricane Maria; the snorkeling was amazing!

On a Saturday afternoon, you’ll likely find me: Hanging out with my daughter, wife, and son or landscaping (when the weather's nice).

Major research breakthrough of the next decade: Programming microbes to cure diseases.

Chemistry, Life, the Universe and Everything (CLUE)

Melanie Cooper
Lappan-Phillips Professor of Science Education, Department of Chemistry
mmc@msu.edu

MSU's general chemistry course is designed to help students get a CLUE—to Chemistry, Life, the Universe and Everything (CLUE).

"Chemistry, often referred to as the 'central science,' is crucial to our understanding of phenomena as diverse as the transmission of genetic information, how we can design better building materials or drugs to combat disease, and even how we can understand the composition of the stars," said Melanie Cooper, Lappan-Phillips Professor of science education who holds joint appointments in the College of Natural Science (NatSci) and the College of Education. "However, learning chemistry is uniquely difficult because to explain and predict the properties of materials in the macroscopic world we inhabit, we must understand how invisible atoms and molecules behave.

"Our research focuses on how we can support students' understanding of these abstract ideas by designing new curriculum materials and teaching approaches," continued Cooper, who is responsible for putting the CLUE curriculum in place 10 years ago.

The CLUE curriculum is all about getting students to use their knowledge rather than just memorize it.

Scientists know that experts possess different types of cognitive learning structures compared with novices. While experts' knowledge is connected and contextualized, novices' knowledge is typically fragmented, rendering it not as useful because of poor recall.

"The goal of our work is to design curricula where students learn things with the expectation of becoming more 'expert-like,'" Cooper said. "What they learn is connected and useful. They learn ways to use their knowledge—not just do numerical problem solving or memorize bits and pieces of facts. We want them to solve more complex problems, construct explanations and analyze data."

Data gathered over the past 10 years shows that the number of CLUE students who can move forward into next-level science classes has increased by 700-800 students each semester. Following CLUE students in subsequent years has shown that they perform at least as well as students who have taken more selective courses—such as through MSU's Lyman Briggs or the Honors College. In addition, the number of women in NatSci has increased and the retention of women has risen.

"The CLUE curriculum makes chemistry more realistic," Cooper added. "For instance, a scientist doesn't run off to a lab and do 50 end-of-chapter problems!" Neither do her general chemistry students.

A Conversation with Melanie Cooper . . .

Came to MSU: January 2013.

Hometown: Originally from England (near Manchester); I spent almost 30 years living in Clemson, S.C., and I now live in Okemos, Mich., with husband Fred and dog Lola.

Muses: David Attenborough! Still inspiring people during a tremendously long career.

Favorite food: Spicy vegetarian food (I am trying to eat healthier).

Best song/group: Anything by Leonard Cohen.

Book I'd recommend: *The Overstory* by Richard Powers, a truly wonderful novel that changed the way I think about trees! I also love mysteries and recommend Louse Penny and the Inspector Gamache Series.

Coolest gadget: Apple Watch—I use it for so many things.

Best invention: Vaccinations; and the Haber-Bosch process for "fixing" nitrogen from the air to make fertilizers (without which more than half the world's population would starve).

Worst invention: Social media.

On my bucket list: Seeing the Northern Lights and Angkor Wat (not at the same time!).

Person I'd most like to meet (living or dead): Mary Wollstonecraft—an early feminist philosopher and mother of Mary Shelley (author of *Frankenstein*).

Best trip/vacation: Any warm, sunny, sandy beach where I can laze to my content.

On a Saturday afternoon, you'll likely find me: In the garden—either gardening or reading (summer); walking the dog (winter).

Building Quantum Technologies . . . One Electron at a Time

Johannes Pollanen
Assistant Professor, Department of Physics and Astronomy and a Jerry Cowen Chair of Experimental Physics
pollanen@msu.edu

Johannes Pollanen's lab is using the weird, spooky and strange behavior of quantum physics to develop new computing technologies. It's so strange it may seem like science fiction—but it's not.

"Creating, and precisely controlling, quantum systems is at the forefront of modern physics and quantum information science," said Pollanen. "Developing tools to control and exploit quantum phenomena provides fundamental insight into the working of nature and also opens the door to next generation quantum technologies for sensing, simulation and ultimately computing."

Quantum physics governs how atoms and electrons behave. In the past 100 years, scientists have figured out how nature works at the quantum level. Now they are ready to take the next step by making useful devices and circuits that behave by the same quantum laws.

"We can now control these synthetic quantum systems and use them for simple computation and sensing. It's still early days, but it's amazing what researchers have already been able to do," Pollanen said.

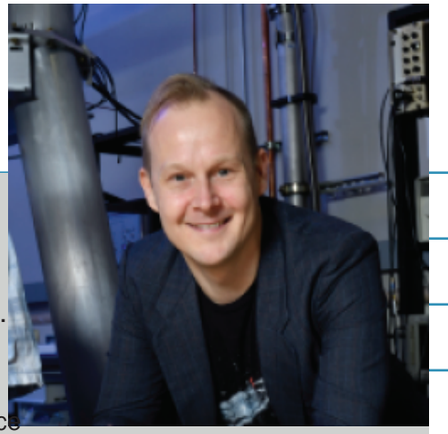
"We take the devices we make and put them in the right environment so they will behave according to the laws of quantum physics," Pollanen said. "We need to cool them down to exceedingly low temperatures (- 459 degrees F) to quiet out the disturbances caused by the ambient environment."

The new technologies being developed in Pollanen's lab, and in other quantum labs around the world, have the potential for groundbreaking discoveries with applications across many disciplines, and could lead to novel drug discoveries and new search algorithms for data science.

Right now, said Pollanen, the United States is in the lead in an international race to build the best quantum computers. In December 2018, the National Quantum Initiative provided federal funding of $1.4 billion over five years to accelerate this research.

"In our group, the Laboratory for Hybrid Quantum Systems, we're working to push the cutting edge of quantum science to achieve these goals," said Pollanen, who is also the associate director of MSU's Center for Quantum Computing, Science and Engineering (MSU-Q).

A Conversation with Johannes Pollanen . . .



Came to MSU: January 2016.

Hometown: I was born in Helsinki, Finland, but I've lived all over the United States—south Florida, North Carolina, Chicago, Pasadena.

Muse: Calliope Porter (https://www.imdb.com/name/nm2655347/), my wife. She was named after the Greek muse who presides over eloquence and epic poetry.

Favorite food: Falafel.

Best song/group: Hands down, Lucero—an American country-punk rock band based in Memphis, Tennessee.

Book I'd recommend: *The Republic, by Plato*.

Coolest gadget: Ahhh, this is a moving target. Right now, for me it's the iPhone, mainly because I just learned how to use Apple Pay.

Best invention: The transistor.

Worst invention: Water bottles with an aspect ratio that makes it impossible to wash them out easily; these are maddening.

On my bucket list: Publishing a paper in every version of the *APS Physical Review* journals. I already have PRL, PRA, PRB and PRC. Also, I'd like to one day run a marathon in under three hours.

Person I'd most like to meet (living or dead): Keanu Reeves.

Best trip/vacation: After finishing up my postdoc, my wife and I took a weeklong road trip from California to Michigan by way of Tennessee before I started my job here at MSU.

On a Saturday afternoon, you'll likely find me: Watching cartoons or playing with my kiddos.

2020-21 College of Natural Science Dean's Research Scholars

Alaina Brenner, genomics and molecular genetics and anthropology '21
Hometown: Haslett, Mich.

Cade Dembski, physics and clarinet performance '22
Hometown: East Lansing, Mich.

Rachel Dubuque, biochemistry and molecular biology/biotechnology '21
Hometown: Hartland, Mich.

Aalayna Green, zoology '21
Hometown: Clarkston, Mich.

Josh Klein, human biology and microbiology '21
Hometown: Lake Orion, Mich.

Alexandra Korabiewski, biochemistry and molecular biology and music performance '22
Hometown: Sterling Heights, Mich.

Jessie Miller, astrophysics and physics '21
Hometown: Lockport, N.Y.

Racheal Nassimbwa, biomedical laboratory science '21
Hometown: Kampala, Uganda

Mariam Sayed, physiology, french and human biology '22
Hometown: Sterling Heights, Mich.

Brent Strong, physiology '21
Hometown: Saline, Mich.

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