TNS UNIVERSITY SCIENCE LABS HOST SCIENCE + ART + DESIGN LAB MODULES (open labs or customized w/faculty)

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Sustainable Cities: Sewage & Water (Testing of the Gowanus Canal) (Link to Resources) [IMAGE] or [IMAGE]

Clean water is important for drinking, recreation, and fishing, and urban environments must manage water. With increased climatic weather events, we are seeing local waterways contaminated by toxic runoff, hormones, and sewage. In the US, the EPA provides a summary of water quality assessment of each body water type and often use the coliform bioindicator test to indirectly measure the level of sewage contamination in rivers, lakes, and oceans. Join us as we test our local waterways for microbial biodiversity, and discuss how evolution is happening as a consequence of our antiquated combined sewage overflow system, and the ways in which designers can meet water quality challenges.

Purpose: To demonstrate how our vintage underground system of plumbing was originally designed for sewage and later for rain runoff, and how heavy rains increased by climate change result in combined sewer overflow exposing some communities to health hazards.

Concepts: Gene-environment interactions/ evolution/ artificial and natural selection/screens.

Social Connections: History of NYC sewage, cholera outbreaks, privatization of water, and access to clean water, design solutions.

Method of lab experimentation: Microbial testing using color as an indicator of genetic diversity and metabolism to distinguish human bacteria from other kinds (two sessions at least 24 hours apart).

Sustainable Plastics: Bioplastics (Link to Resources and Slide Set)

With 8 billion tons of plastic waste entering a "Plastic cycle" research shows that there is more plastic waste in our air than soil or water, emphasizing the need to go beyond recycling and reuse. A movement to create biodegradable plastics is underway. Commercially, if a plastic contains 20% renewable material it is considered to be "bio-based." This 20% is usually made of shrimp shells, wood, coconut, wheat, corn or other renewable materials. This also means the remaining 80% can be made from traditional fossil fuel-based plastic polymers. These fuel-based plastics leach and create a concentrated source of estrogen mimics that can disrupt biodiversity and affect human health. Join us as we explore more sustainable and less toxic polymers in an effort to protect ecosystem health and reduce plastic waste. In this lab, we use a very simple proof of concept approach to creating biopolymers from household items such as starch, milk, and sugar and examine variables such as temperature, concentration, and time in their synthesis.

Purpose: To explore biopolymers (starch, water, milk, etc) as an alternative to traditional polyester and other synthetic plastics that use estrogen disruptors as plasticizers and in their degradation serve as sponges for these hormone disruptors influencing both ecological integrity and human health.

Concepts: Chemical polymerization and biomimicry

***Social Connection*:** Action against plastics in the environment, and the role that estrogen disruption has on health (Link)

***Method of Experiment*:** Mixing materials, using molds, and heating and cooling cycles to craft products or textiles (two sessions one week apart).

Sustainable Energy: Microbial Fuel Cells (Link to Resources and Slide Set)

Current energy systems rely heavily on petroleum/crude oil to generate power but their production and use have contributed to climate change and pollution. Scientists and designers have discovered sustainable alternatives to crude oil such as solar panels and wind turbines, but their implementation is limited by economics, politics, and geography. The microbial fuel cell is currently being researched as an alternative form of energy that can both treat and create energy from wastewater and locally sourced sediment. The microbial life in these systems has evolved to survive and carry out metabolic processes to transfer electrons from molecule to molecule. We can harness this process to design a circuit that directs the flow of these moving electrons such that they can be captured, thus, creating a microbial fuel cell. Join us as we explore genomics and ecological research to utilize biodiverse bacteria identified to be highly electrogenic and suited for this emerging technology as well as the manipulation of variables the affect texture, consistency, and rate of synthesis.

Purpose: Harnessing the metabolic pathways of electron transfer in soil microbes to power a calculator or led light; sustainable energy resources

Concepts*:* Metabolism, chemistry, energy, electrogenic diversity in populations, manipulating variables (genes and environment)

Social Connection: How to create sustainable energy proof-of-concept designs to minimize climate change.

Method of Experiment: Microbes in soil (one session) using variables such as amount of sugar or genetically diverse bacteria. (two sessions one week apart).

Sustainable Dyes: Biopigments: (Link to Draft of Resources and Slide Set)

[IMAGE]

Textiles are a $3 trillion-per-year business that employs nearly 60 million workers worldwide, and is a large contributor to environmental pollution and occupational health hazards. This industry has shifted its practices from chemical dye processes, to natural dye processes and most recently has begun to explore biological pigments from bacteria, and algae to color textiles. This latter process reduces land and water use for plant growth, CO2 emissions required for heating dye baths, and chemical treatments required to chemically reduce the dyes to adhere to fibers. Come to the labs to "paint and dye with living bacteria" and learn how pigments can be applied to textiles, and promote sustainable and safe dying practices, and how environmental factors and genetic differences affect color profiles.

Purpose: Using bacterial pigments to dye fabrics thereby reducing the use of acid, dye, and heat, thus, less toxic dying processes that unlike plant dyes do not require large land plots or water (natural resource management); but to consider the fact that the pigments are often antibiotics.

Concepts: Gene-environment interactions, metabolism, cell division, sterile technique - potentially genetic engineering (rDNA)

Social Connections: History of dyeing, indigenous practices, and bacterial biopigment for fashion

***Method of Experiment*:** painting/printing/dying with living bacteria or engineered yeast (beta carotene) (two sessions at least 24 hrs apart).

*Sustainable Populations & Social Justice (Immortality, Population Growth, and Limited Resources):

(Link to Resources; customized by course, can connect to HeLa cells**)**

[IMAGE]

As the field of stem cell biology expands, knowledge is being harnessed for a variety of different applications: tissue regeneration for degenerative diseases; cell regeneration for life extension; emerging technologies for the creation of new life forms; and cell transplants for life rejuvenation. These applications raise new questions regarding how humans manipulate and control life, and the impact that a growing population may have on our increasingly limited resources, and concerns regarding climate change. Join us as we replicate the earliest experiments contributing to regenerative biomedical research using the model organism Planaria, and extend the conversation to the establishment of the first human cells grown in culture (HeLa), the role that autonomy, agency, compensation, and the social good play in our policy and practices, and our ever-changing definitions of life and death. .

Purpose: To address the impact that advances in stem cell research can have on an aging population and to consider the consequences of limited access and increased resource depletion and pollution (land, water, energy). Different iterations focus on the history of cell culture/cell regeneration as it relates to issues of self, kinship, ownership, and privacy.

Concepts: Stem cell niches, gene environment interactions, cell division, and cell differentiation, immortalization.

Social Connections: Different kinds of cell death, immortality, quality of life, population expansion, soft eugenics, ownership, privacy, self

Method of Experiment: Planaria worms, that have the natural ability to regenerate/microscopy (2 sessions 1 week apart).

*Sustainable Nutrition: GMOs (Customized for each course: Food Studies Link to Resources) [IMAGE]

Genetically Modified Organisms are those that have been intentionally and artificially altered at the DNA level to possess specific traits. Though domestic breeding took place over centuries to improve livestock and agriculture, in the 1970s, the technique of combining very specific DNA sequences from one species with another led to rapid genetic changes within one generation. Given the rapid uptake of this technology to address the needs of a growing population, and a rapidly shifting climate, debates about the use of GMOs abound, with some advocating for bans or labels and others seeing GMOS as a solution for the future. Join us as we test food products and plants from our local community for genetic modification and explore these policies and practices.

Purpose: Testing various foods for the presence of genetic modification DNA sequences

Concepts: Genetic/phenotypic changes, DNA amplification, Viral integration/jumping genes, evolutionary diversity,

Social Connections: New regulations on food labeling (Link), debates on safety and transparency (Link) conservation of endangered species, food vaccines

Social Connections: Indigenous versus genetically engineered approaches to food, agriculture, and health.

***Method of Experiment*:** DNA isolation, PCR amplification of specific plant and GM DNA sequences (3 sessions with one on theory, 2 lab session; cooking show style is an option)

*Sustainable Production/ Health GMOs/Biomimicry: Lateral Gene Transfer (Jellyfish & Bacteria) (Link to Resources) customized for each course

[IMAGE]

Genetic modification of organisms has taken on new life with the emergence of CRISPR and other site-specific genomic targeting tools. Join us as we will explore the history of GMOs and conduct an experiment that exploits what we know about the ways in which genes

flow naturally across species and potentially how this phenomenon led to life on Earth today. Come to the lab to become a genetic engineer and move a gene that codes for a jellyfish protein into a bacterium and see how this transforms its color to bright green.
Purpose: To perform a proof of concept experiment in genetic engineering, in which students mimic natural lateral gene transfer events that contribute to biodiversity
Concepts: Genetic and phenotypic changes, viral integration, evolutionary diversity, gene therapy, sterile technique
Social Connection: Movement of genes means no organism is unique; role of CRISPR in gene modification for reproduction, food, health, also for some classes, using biodiversity, or engineering biodiversity for bioremediation(Link)
***Method of Experiment*:** Bacterial transformation using a K12 bacteria strain, Jellyfish gene in plasmid, and CaCl2 and selecting for transformants with antibiotics and screening for rDNA uptake with color. (two sessions at least 24 hours apart).

*Sustainable Drugs: Environmental Stewardship for Antibiotics (Resistance and our Microbiome). (Link to Resources and Link to Handout) Customized for each course (Slide Set)

[IMAGE]

With increased use in antibiotics in agriculture, medicine, and materials, superbugs are becoming more common. Moreover, climate change has also been shown to be correlated with the development of antibiotic resistance in a range of bacteria. Join us as we explore the evolution of antibiotic resistance, test various bacteria for resistance, manipulate variables such as type of antibiotic, and discuss how antibiotic stewardship is necessary to protect the natural resources from which we acquire antibiotics. We will explore how practice and policy surrounding antibiotics can affect vulnerable populations and some new initiatives to curb this effect.
Purpose: To test various compounds for their ability to halt bacterial growth and to capture spontaneous mutation and understand how this impacts society and how social use of antibiotics can lead to multidrug resistance. Strong social justice theme, use of narrative to construct different stories.
***Social Connection*:** Human health, new regulations on use of antibiotic in feed and livestock, small farmer effects, and access to antibiotics for health (MDR and XDR TB), narratives (visual, text, media)
Concepts: Microbiomes, evolutionary diversity, natural and artificial selection, lateral gene transfer, sterile technique
***Method of Experiment*:** Kirby Bauer Disk assay with various strains of commonly found bacteria. (two sessions at least 24 hours apart).

*DNA Data & Social Justice : DNA/Genomics: Recreation, Lineage, Profiling . (Link to Resources and links to resources for First Year Lang and Link to Handout) Slide Set is Customized for each course

With increased construction and access to DNA databases issues regarding identity of individuals and populations are becoming more complex. Who can own, manipulate, or use DNA data has created a sophisticated set of discussion regarding commodity, privacy, and ownership. Just how much can DNA reveal about who we are, what we do, an where we come from? How have DNA databanks contributed to criminal and racial justice and/or discrimination and profiling. We will explore how practice and policy surrounding DNA databanks are shifting and how artists are pushing us to grapple with these complex issues and collect our own DNA and practice the scientific method to move through a robust discussion that will extend work by artists, sociologists, biologists, and more.
Purpose: To collect our DNA make hypotheses and predictions and discuss how this science shifts our understanding of identity. . Strong social justice theme, use of multimedia and narrative to construct different stories.
***Social Connection*:** Human evolution, migration and health, laws on privacy, access, research, access to data and meaning.
Concepts: Genomics, DNA + Environment interactions, , evolutionary diversity, natural and artificial selection
***Method of Experiment*:** simple cheek cell prep, can be done in classroom or in the lab. (one session)