Exploring Biodiversity using DNA
The DNA Learning Center has developed an inexpensive lab protocol and durable computational infrastructure—DNA Subway—to support student DNA and meta-barcoding research. There is growing enthusiasm for using DNA barcoding as a common platform for CUREs and student citizen science projects. Each year, approximately 4,000 students from 300 high schools and universities around the world do independent barcode research using our methods and tools. James Madison University has scaled a DNA barcoding CURE to engage 800 students taking the core freshman core biology sequence per semester. Students participating in this project published the first DNA barcode inventory of Marine Park, Brooklyn in PLOS One, and identified fraudulent Ginkgo products whose distribution was later halted by the New York State Attorney General’s office.

What is DNA Barcoding?
Like a unique pattern of bars in a universal product code (UPC) identifies each consumer product, a short “DNA barcode” is a unique pattern of DNA sequence that can potentially identify each species.

Integrated Website and Sample Database
DNA Learning Center Barcoding 101 is an integrated resource to support DNA barcoding programs. The site includes background, experiment planning, reagent preparation, protocols, instructions for bioinformatics analyses, and multimedia resources. Mentors log in and enroll teams, view guidelines, track team progress, register for Open Labs, and request equipment footlockers. A symposium section features student projects, team information, and results.

The Sample Database allows users to store sample metadata and was updated to include a comprehensive, searchable database of all organisms documented across Long Island, Brooklyn, and Queens. Organisms can be searched by name, habitat, or collection date. Each sample includes organism information, pictures, sequence data, and collection location.

The Blue Line of DNA Subway was developed as part of Cyller, an NSF project to develop cyberinfrastructure for life sciences. DNA Subway supports bioinformatics analysis of DNA sequence for DNA barcoding. The Blue Line also supports submission of barcode sequences to GenBank, at the NIH National Center for Biotechnology Information. To date, 16 novel sequences and 142 new entries have been published to GenBank; 10 novel sequences are pending submission.

www.dnabarcoding101.org

DNA Barcoding: The CURE for Citizen Science
Bruce Nash, Ph.D.

Moving along a continuum of Barcoding CUREs

Developing and Disseminating Barcoding and Metabaroding CUREs
- Collaboration with CUNY, JMU, and Bowie State Faculty
- Refining Biochemical and Bioinformatics Pipeline
- Training Faculty Nationwide

Highlights:
- Adapted and Piloted Barcoding CURE
- Trained 20 Faculty to implement CURE
- Evaluating impact on faculty and students

Metabaroding
High-throughput analysis of 125 and 16S ribosomal sequences is a natural extension of DNA barcoding. Moving from single barcodes to microorganisms and rDNA perfectly embodies the conceptual transition from single-gene to massively parallel genome analysis.

Example Projects:
- Tick microbiomes contain human pathogens.
  - Lone Star Ticks: *B. burgdorferi* (8/12), which causes ehrlichiosis.
  - P. floridana (3/9), which causes Rocky Mountain Spotted Fever
- Studied by students from Connetquot High School: Jacob Belous, Megan Ober, Christopher Pechelnzer, Geavina Pachos, James Scardina, and teacher mentor Victoria D’Ambrosia
- Black-legged ticks: *B. helvetica* (8/12), associated with Lyme Disease
- Studied by students from Connetquot High School: Jacob Belous, Megan Ober, Christopher Pechelnzer, Geavina Pachos, James Scardina, and teacher mentor Victoria D’Ambrosia

InnovaTEBIO National Center for Biotechnology Education
- Training Community College Faculty in Barcoding and Metabaroding CUREs
- Developing a Supply Chain Solution
- Reducing the cost of barcoding and metabarcoding

Illumina prep and sequencing
$2,000/200 = $10
$2,000/400 = $5
Reverse engineered DNA isolation kit: $10 to $20
Pre-indexing: $20 to $30
Reverse engineered DNA purification kit: $4 to $5
Goal: $10-15 per sample

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Example Projects:
- Est grass microbiomes change in unhealthy plants.
  - Studied by students from Mellen High School: Elizabeth Silano, Angela Ochoa, Philip Drawe, and teacher mentor Victoria D’Ambrosia

- Est grass using disease 50s and associated responders/adjacents/controls