

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

thealgae foundation



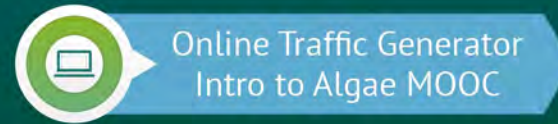
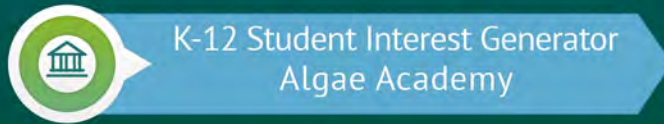
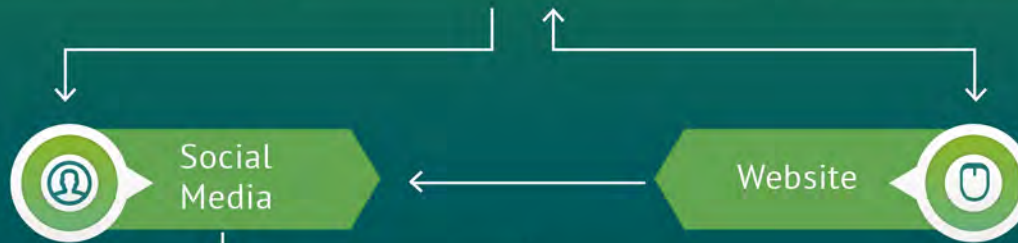
U.S. DEPARTMENT OF
ENERGY

BIOENERGY TECHNOLOGIES OFFICE

INDUSTRIAL
ADVISORY BOARD

ATEC

FEDERAL, STATE, LOCAL
GOVERNMENTS
USDA, EPA, DOL



BIOTECHNOLOGY – ACC
Micro/Macro,
Internships, Externships

Degree or Certificate

*Regional, Intensive
Lab/Field Experiences*

CULTIVATION – SFCC
Micro/Macro,
Internships, Externships

Degree or Certificate

Transfer to Advanced Degree

ENTREPRENEUR

LAB/BIOTECH

JOBS

CULTIVATION/
OPERATIONS

ENTREPRENEUR



Algae Technology Educational Consortium (ATEC)

Algae Biotechnology

Semester I

- BIOL 1414 Introduction to Biotechnology I

Semester II

- **BIOL 1415 Introduction to Biotechnology II**
RESEARCH PROJECT ON THE MANUFACTURE OF AN ALGAL PRODUCT
- BITC 1340 Quality Assurance

Semester III

- BITC 2350 Bioinformatics **(using sequences from BITC 2441) (new!)**
- **BITC 2441 Molecular Techniques**
DNA BARCODING LAB USING ALGAL STRAINS FROM UTEX
- **BITC 2411 Laboratory Instrumentation**
TOTAL LIPID EXTRACTION
TOTAL SAPONIFIABLE LIPIDS (FAME) ANALYSIS

Semester IV

- **BITC 2431 Cell Culture Techniques**
- **BITC 1491 Special Topics in Biological Technology / Technician: BioManufacturing**
MICROALGAE CULTURING METHODS: GROWTH KINETICS & BIOMASS METRICS

Semester V

- BITC 2487 Biotechnology Internship



Algae Technology Educational Consortium (ATEC)

Algae Biotechnology

- **BITC 2350 Bioinformatics (online)**
The Analysis of Algal Barcode Sequences lab will use data obtained from BITC 2441 to identify strains to the level of genus, and sometimes species using BLASTn, sequence alignments (CLUSTAL), and phylogenetic analysis
- **BITC 2411 Laboratory Instrumentation**
The Analysis of Microalgal Lipids lab contains the following modules: lipid extraction, lipid class analysis by TLC, fatty acid derivatization to FAME, and quantitation of FAME using GCMS
- **BITC 2431 Cell Culture Techniques**
The Microalgal Culture Methods lab includes the following modules: media and vessel preparation, maintaining stock cultures and scaling up, growth kinetics and biomass metrics, i.e., hemocytometry (cells/mL), DW, AFDW, optical density (A680 and A750), and related calibration curves
- **BITC 2441 Molecular Techniques**
The DNA Barcoding Lab Modules: genomic DNA extraction, PCR, gel verification, product purification, sequencing, and analysis



Proposed ACC Degree Algae Biotechnology

Semester I

- BIOL 1414 Intro to Biotechnology 4 (light & algae lab)
- BIOL 1406 Cellular and Molecular Biology 4
- ENGL 1301 English Composition I 3
- MATH 1314 College Algebra 3

Semester II

- BIOL 1415 Introduction to Biotechnology II 4 (purification of phycobiliproteins from cultured microalgae lab)
- ENGL 2311 Technical & Business Writing 3
- CHEM 1311 General Chemistry I - Lecture 3
- CHEM 1111 General Chemistry I - Lab 1
- BITC 1340 Quality Assurance for the Biosciences 3

Semester III

- BITC 1491 Special Topics - Algal Biotechnology 1 course (online)
- CHEM 1312 General Chemistry II -- Lecture 3
- CHEM 1112 General Chemistry II - Lab 1
- SPCH 1321 Business and Professional Communication 3
- BITC 2350 Bioinformatics 3 (algal gene sequencing lab)

Semester IV

- BITC 2411 Biotechnology Laboratory Instrumentation 4 (isolation of astaxanthans and purification by HPLC lab)
- BITC 2441 Molecular Biology Techniques 4 (algae as Test Organism)
- ECON 2301 Principles of Macroeconomics 3
- Languages, Philosophy, & Culture/Creative Arts 3

Semester V

- BITC 2487 Internship-Biology Technician/Biotechnology Laboratory Technician II 4

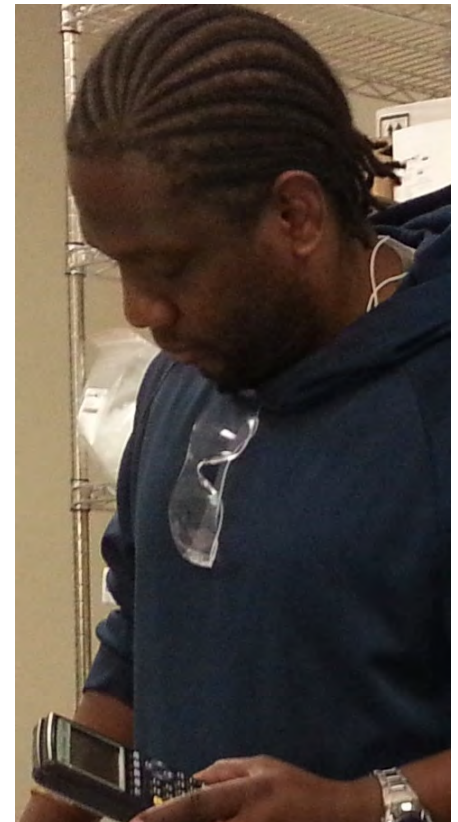


Integrating algae training

First-year

Introduction to Biotechnology I. Including a lab module on culturing algae, framed by a research question, such as the effect of light intensity, color of phycobiliprotein production in cultured microalgae.

Introduction to Biotechnology II. Including a lab module on purification of phycobiliproteins from cultured microalgae.



Integrating algae training



Second-year

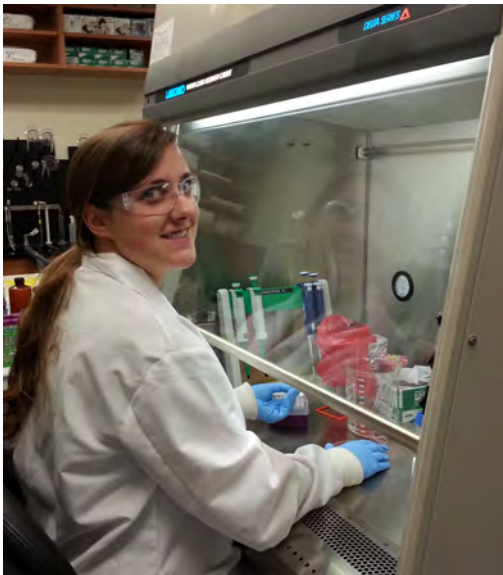
Bioinformatics. Including a comparison of phycobiliprotein gene sequences and identification of binding sites of phycobilins in proteins.

Biotechnology Instrumentation. Including a lab module on the isolation of astaxanthans and purification by HPLC.

Cell Culture Techniques. Comparison of photobioreactor performance in scale-up. (for the biomanufacture-focused course, when offered)
Isolation, culturing, and cryopreservation of environmental isolates (for the lab technician- focused course)

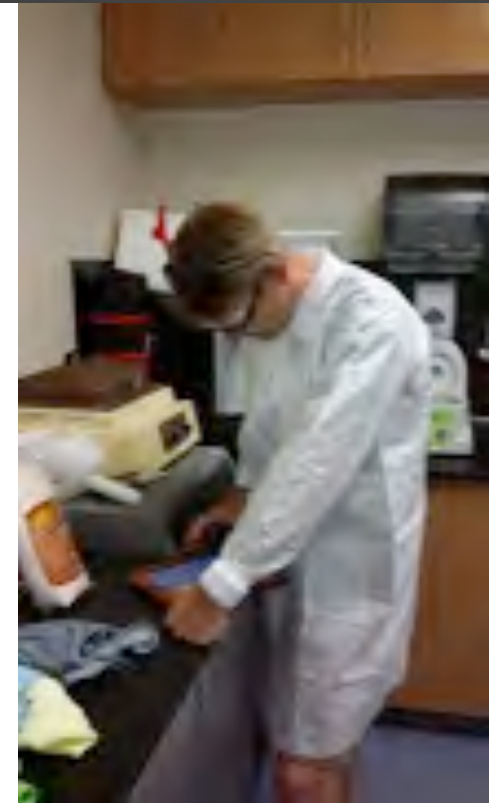
Molecular Biology Techniques. Include a DNA barcoding module for identification of microalgae in environmental isolates.

Making it happen



Small changes in the lab module selections of existing courses can easily adjust the biotechnician training program to serve the algae technician workforce.

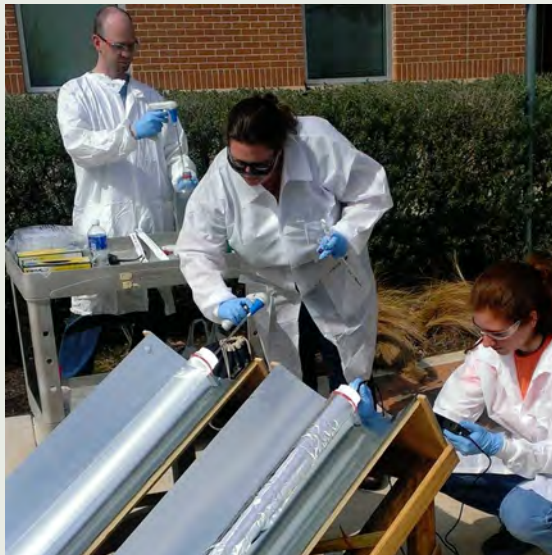
Support from the online algae biotechnology 1 courses can assist in the flexibility of the biotechnology program in rapidly meeting the changing needs of industry.





Biotechnology Program

What works for students at Austin Community College



Grant support

- **Linnea Fletcher, Biotechnology Chair**
 - PI, NSF ATE grant: “AC2” Austin Community College Bio-Link Regional Advanced Technological Education Center for Biotechnology and Life Sciences (2015, ongoing)
 - PI, Texas Emerging Technology Fund for building wet labs (2014, ongoing)
 - PI, Texas Education Commission for educating high school biotechnology instructors (2010-2014)



Grant support

- Sulatha Dwarakanath, Professor
- Co-PI NSF ATE grant: “Bio-Link” Educating the Biotechnology Workforce, regional center
- Co-PI DOL grant: biotechnology technician education



Dr. Elaine Johnson, Bio-Link Executive Director & Principal Investigator

Dr. Sulatha Dwarakanath demonstrates lab technique to ACC students.



Degrees and Certificates

- **One-year Certificate:** A certificate program that can be completed in one year for entry-level positions.
 - **Associates Degrees:** Most associates degrees can be completed in two years. Community and technical colleges offer two general kinds of associates degrees.
 - **Transfer degrees** are designed for students who wish to transfer to a four-year college or University. These kinds of degrees include AA (Associate of Arts) and AS (Associate of Science) degrees.
 - **Applied degrees** are designed for students who wish to enter the workforce immediately after graduation. Examples of these degrees are AAS (Applied Associate of Science), and other types of Applied Associates degrees.
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Degrees and Certificates

- **Post-baccalaureate certificate:** These certificates are designed for students with a bachelors degree in a given subject.
- As many as 2/3 of our students already have a bachelor's degree. These students cannot get jobs without more hands-on experience and training.
- As many as 1/10 of our students already have a graduate level degree and are changing careers. For example, from chemistry to biotechnology.



Courses

First-year

Introduction to Biotechnology I. Overview of molecular biology and lab techniques which prepare the student to master solution preparation, safe handling of hazardous material, nucleic acid isolation, recombinant DNA cloning, PCR and ELISA.

Introduction to Biotechnology II. An emphasis on protein structures, functions and uses in biochemical functions, with laboratory techniques such as protein and enzyme assays, column chromatography, FPLC, PAGE and Western Blotting.

Quality Assurance for the Biosciences. An online course in quality assurance principles and applications, including GXP, ISO9000, Lean and Six Sigma as they apply to the biotechnology, biopharmaceutical, bioscience, and biomedical device industries.

Bioinformatics. An online course in

Courses

Second-year

Bioinformatics. An online course in computational biology, including methods for high-throughput data collection, storing, and accessing biological data. Covers programs and algorithms used to analyze data.

Biotechnology Instrumentation. Theory, applications, and operation of various analytical instruments with an emphasis on protein purification in an R&D pilot scale laboratory and a focus on quantitative and qualitative analyses by chromatography, centrifugation, spectrophotometry, immunochemistry and fluorescence.

Cell Culture Techniques. Emphasizes the principles and practices of initiation, cultivation, maintenance, and the preservation of cell lines including applications such as transfection and project management. Aseptic techniques. Independent project.

Courses

Second-year (continued)

Molecular Biology Techniques. Include nucleic acid isolation and analysis, recombinant DNA cloning, primer design, endpoint and real time PCR and the use of bioinformatics tools to identify, analyze and publish a novel gene sequence in a national database. An emphasis on scientific written and oral communication.

Internships.

Internal: often for students wanting an experience in undergraduate research and are headed for a research career.

External: for student placement in an industry or academic lab, depending on students' career plans.
