Algae Technology Educational Consortium's (ATEC) Algal-based Education and Training and Opportunities

Ira Levine

Gef Flimlin

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Algae Technology Educational Consortium’s (ATEC) Algal-based Education & Training Programs & Opportunities

Ira Levine, Ph.D.
Gef Flimlin
Algae Foundation
University of Southern Maine

January 17, 2020
Belfast, ME
Relevance

**Goal Statement:** Create and distribute algal-based curricula to develop a skilled workforce

**Algal Industry Jobs:**
- Recent ATEC graduates earned university scholarships, national lab internships, and algal company positions
- 17% of Algal MOOC participants received pay raise or promotion
- 62% of Algal MOOC participants received tangible benefit
- Qualitas’ Texas farm VP indicated desire to hire the entire 2019 ATEC graduating class
- ATEC’s Intro to Algae Massive Open Online Course participation by existing staff was mandated by Cyanotech
- ATEC will provide training for crossover applications in wastewater, fermentation, and biotechnology industries
- Owner of 100 acre algal farm in Columbus, NM indicated a preference for ATEC graduates
Austin Community College
Santa Fe Community College
Trained Workforce and Entrepreneurs

NREL | ATEC | thealgaefoundation

MASSIVE OPEN ONLINE COURSE
“Introduction to Algae”

Algae Academy
K-12 Student Interest Generator

Community College Biotechnology Degree
*Austin Community College*

Algae Cultivation Extension Short-Courses

Community College Farming Degree
*Santa Fe Community College*

Trained Workforce and Entrepreneurs

JOBS
Algae Academy

5-Day Curriculum
- Algae 101 – basic and applied
- Cultivation
- Sampling
- Microscopy
- Data Visualization and Analysis
- Entrepreneurship

Aligned with National NGS

We are currently accepting applications for the 2019-2020 Academic Year!

Apply at tinyurl.com/AlgaeAcademy2020

Algae Academy pilots curriculum in Aviara Oaks Middle School

Curriculum adapted to elementary and high school levels. Kits distributed twice an academic year.

Algae Academy curriculum is taught in 40 California, Michigan and Ohio Middle Schools

11,000 Students in Spring 2020
17% received a pay increase or promotion
62% received a tangible career benefit from this course

### Student Status

<table>
<thead>
<tr>
<th>Status</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Full-time student</td>
<td>35%</td>
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<tr>
<td>Part-time student</td>
<td>6.4%</td>
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<tr>
<td>Not a student</td>
<td>59%</td>
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Based on data from 405 learners. Estimates accurate to ± 4.9 percentage points.

### Highest Education

<table>
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<th>Degree</th>
<th>Percentage</th>
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<td>Doctorate degree</td>
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<tr>
<td>Professional school degree</td>
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<tr>
<td>Master's degree</td>
<td>26%</td>
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<tr>
<td>Bachelor's degree</td>
<td>32%</td>
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<tr>
<td>Associate degree</td>
<td>4.4%</td>
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<tr>
<td>Some college but no degree</td>
<td>12%</td>
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<tr>
<td>High school diploma</td>
<td>9.7%</td>
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<tr>
<td>Some high school</td>
<td>3.4%</td>
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### Employment Status

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<td>Employed full-time</td>
<td>43%</td>
</tr>
<tr>
<td>Employed part-time</td>
<td>7.9%</td>
</tr>
<tr>
<td>Self-employed full-time</td>
<td>5.8%</td>
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<tr>
<td>Self-employed part-time</td>
<td>5.5%</td>
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<tr>
<td>Unemployed and looking</td>
<td>17%</td>
</tr>
<tr>
<td>Unemployed and not looking</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>10%</td>
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</table>
Trained Workforce and Entrepreneurs

Community College Biotechnology Degree
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JOBS

K-12 Student Interest Generator
Algae Academy

Massive Open Online Course
"Introduction to Algae"

ATEC

NREL

Biorenewable Energy Technologies Office
ATEC & Community College Collaboration

- Formalized ATEC relationships (signed mou):
  - Austin Community College (Texas)
  - Fresno State University (California)
  - Hawaii Community College (Hawaii)
  - Lenoir Community College (North Carolina)
  - Linn-Benton Community College (Oregon)
  - Lone Star College (Texas)
  - Midland College (Texas)
  - Santa Fe Community College (New Mexico)
  - Shoreline Community College (Washington)
  - Solano Community College (California)
  - South Texas College (Texas)
  - University of Texas, Austin
  - University of Texas, Rio Grande Valley
Algae Cultivation Badges

1. **Algal Culture badge: biomass inoculation**
2. **Algal Culture badge: biomass analysis**
3. **Algal Culture badge: biomass scale-up**
4. **Operation and Maintenance badge: Microfarm**
5. **Operation and Maintenance badge: Algae Harvesting**
6. **Operation and Maintenance badge: Pumps and Motors**
7. **Algal Culture badge: Internship (or) Operations & Maintenance badge: Internship**

---

### Algae Cultivation Skill Standards Matrix
7 Micro Badges

<table>
<thead>
<tr>
<th>Media preparation, sterile techniques, microscopy</th>
<th>ALTF 161 Intro to Algae Cultivation</th>
<th>ALTF 261 Advanced Algae Cultivation</th>
<th>ALTF 262 Algae Harvesting</th>
<th>PLMB 141 Pumps &amp; Motors</th>
<th>BIOL 111 Intro to Biology (for plants)</th>
<th>BIOL 111L Intro to Biology Lab (for plants)</th>
<th>WATR 166 – Microbiology for Water Operators</th>
<th>Bioinformatics for Algae Short course (No Lab)</th>
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<tr>
<td>Culture inoculation</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>Scale-up: petri plate to 10L</td>
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<td>Monitoring procedures for media and biomass analysis</td>
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<td>X</td>
<td>X</td>
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<td>Quality control analysis</td>
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<td>X</td>
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<td>Data Collection and operational awareness</td>
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<td>Biomass analysis and quality assessment</td>
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<td>Biomass storage techniques</td>
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<td>Lab and farm safety</td>
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<td>Operations and maintenance</td>
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<td>Heterotrophic and fermentation</td>
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<td>X</td>
<td>X</td>
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<td>Wastewater treatment utilization</td>
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<td>Harvesting operations</td>
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<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Pump and motor operations</td>
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</table>
Skills linked to current job listings

173 Job Openings for “Algae”

Top Locations
1. Lenexa, KS
2. Los Alamos, NM
3. Golden, CO

Salary Ranges
- $100,000 +
- $80-90,000
- $50-79,000
- $30-49,000
- Less than $30,000

Top Employers
1. Corbion
2. Los Alamos National Laboratory
3. Rentokil
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NREL
National Renewable Energy Laboratory

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JOBS
### NEW COURSES

- ALGE 111 – Introduction to Algaculture
- BIOL 252 – Algae Biotechnology 1
- ALGE 211 – Advanced Algaculture
- BIOL 250 – Introduction to Algal Science
- ALGE 221 – Algae Harvesting & Processing
- BIOL 253 – Algae Bioprospecting Informatics
- ALGE 298 – Algaculture Capstone
- PLMB 141 – Pumps and Motors
- MOOC - Introduction to Algae

### LEARNING OUTCOMES AND SKILL SETS for each class and program as a whole

| Media preparation | Sterile technique | Microscopy | Culture inoculation | Scale up: colony to 10L | Scale up: 10L to >500L | Monitoring procedures for biomass analysis | Lab and farm safety | Operations and maintenance | Harvesting operations | Biomass analysis and quality assessment | Biomass storage techniques | Heterotrophic growth and fermentation | Algae identification | Pathogen/predator identification | Treated wastewater utilization | Quality control analysis | Data collection and analysis | Internship | Pump and motor operations | Hydraulic sizing | Electrical demand requirements | Mechanical properties of water | 1 |
|-------------------|-------------------|------------|--------------------|-------------------------|--------------------------|----------------------------|-------------------|-----------------------------|----------------------|-----------------------------|-------------------------|-------------------------------|----------------|-----------------------------|-------------------------|-------------------|-----------------------------|----------------|-----------------------------|----------------|-----------------------------|----------------|-----------------------------|---------------------|---|---|
Providing a skilled workforce to meet the needs of the rapidly-growing bioeconomy.

Comprehensive education that combines concepts with hands-on training in our A.A.S. in Controlled Environment Agriculture and embedded Algae Cultivation Certificate.

- Biological Technician
- Plant Technician
- Lab Technician
- Engineer
- Project Developer

CERTIFICATE
ALGAE CULTIVATION

Algae production provides a sustainable source of biomass for bio-based products, feed, fuel and foods, creating high-quality jobs for an educated workforce. This web-blended program provides that education and combines concepts with hands-on training. The Certificate in Algae Cultivation counts toward the Associate in Applied Science in Controlled Environment Agriculture.

CAREER OPPORTUNITIES INCLUDE
Biological Technician, Engineer, Entrepreneur, Lab Technician, Plant Technician, Project Developer

LEARN MORE
www.sfcc.edu
505-428-1641
Biotechnology AAS Degree Plan

Semester I
• BIOL 1414 Introduction to Biotechnology I

Semester II
• BIOL 1415 Introduction to Biotechnology II
  RESEARCH PROJECT ON MANUFACTURE OF AN ALGAL BIOTECHNOLOGY PRODUCT
• BITC 1340 Quality Assurance

Semester III
• BITC 2350 Bioinformatics (generated the sequences from 2441)
• BITC 2441 Molecular Techniques
  DNA BARCODING LAB and SEQUENCE ANNOTATION (ALGAL STRAINS FROM UTEX)
• BITC 2411 Laboratory Instrumentation
  TOTAL LIPID EXTRACTION
  TOTAL SAPONIFIABLE LIPIDS (FAME) ANALYSIS

Semester IV
• BITC 2431 Cell Culture Techniques ALGAE AS TEST ORGANISM
• BITC 1491 Special Topics in Biological Technology/ Technician: BioManufacturing
  MICROALGAE CULTURING METHODS: GROWTH KINETICS & BIOMASS METRICS (Summer 2018)

Semester V
• BITC 2487 Biotechnology Internship
New Curriculum: Heterotrophic Algae Cultivation

• New module under development to be inserted into BIOT 057 Synthetic Biology and Algae Biotechnology at Solano Community College
  • Bill Barclay (formerly of Martek and DSM)
  • Jim Dekloe (Solano Community College)
• Coursework to include:
  • History and applications of heterotrophic algal biomass production
  • Commercialization of heterotrophic algal production
  • Cultivation and downstream processing of key strains
• Expected to be incorporated into SCC curriculum in 2020
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
BIOENERGY TECHNOLOGIES OFFICE

ONREL
NATIONAL RENEWABLE ENERGY LABORATORY

ATEC

thealgaefoundation

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JOBS

Trained Workforce and Entrepreneurs
Algae Culture Extension Short-course
Macroalgae

www.algaefoundationatec.org
~ 400 participants in 3 months
Aquaculture Introduction

- Overview: What is aquaculture, why is it important
- Dana Morse “What is Aquaculture?”
- International Mariculture of Seaweeds; An introduction to Seaweed Aquaculture. Dr. Charles Yarish
- From Sea to Table, University of Connecticut Research Benefits
- Seaweed Culture in New England: Overview of Seaweeds and Their Uses
- Seaweed in New England: A Seaweed Visionary. Interview with Shep Erhart, Maine Coast Sea Vegetables

Economically important species
- Seaweed culture in New England: Kelp, Gracilaria, Chondrus, Porphyra, Palmaria (Dulse), Kappaphycus and Eucheuma

Seaweed Aquaculture: Nursery
- Elements of a Seaweed Lab
- Introduction to Sugar Kelp Nursery Methods. University of New England

Seaweed Aquaculture: Leasing
- Permits/Leases/Regulations. Jon Lewis, Maine Dept. of Marine Resources

Seaweed Farm design and gear
- A Simple Method of Setting Seaweed Long Lines, Tollef Olson, President, Ocean’s Balance

Outplanting seaweed seed:
- Field clips of outplanting seaweed lines with Maine Sea Farms

Seaweed Husbandry:
- Winter on a Kelp Farm, Ocean Approved

Seaweed Aquaculture: Farming
- Seaweed Farms of Maine
- Maine Sea Farms Explains Kelp Farming
- Seaweed Farming, Tollef Olson, Oceans Balance Inc.

Harvesting:
- Pulling Seaweed Lines (Ocean Approved)
- Harvesting Kelp with Maine Sea Farms, spring 2018

Seaweed Processing/marketing:
- Greenhouse drying of seaweed with Maine Sea Farms
- Seaweed Product Forms, Lisa Scali, Ocean Approved Inc
ACES Intent

- Develop a short course to **educate people in techniques** needed to move into the microalgae biomass and seaweed farming industry.
- The short-course is for **Workforce Development** through a no cost online focused program.
- The course sections are **developed in appropriately timed modules**. This **keeps the students’ attention** and allow breaking when needed, to return later.
How to find it

Google: ATEC ACES Algae
Let’s take a look!

http://www.algaefoundationatec.org/aces/aces.html

http://www.algaefoundationatec.org/aces/aces2_micro.html
Acknowledgements

ATEC Team Members

<table>
<thead>
<tr>
<th>First name</th>
<th>Last name</th>
<th>Organization</th>
</tr>
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<tbody>
<tr>
<td>Ike</td>
<td>Levine</td>
<td>Algae Foundation</td>
</tr>
<tr>
<td>Marissa</td>
<td>Nalley</td>
<td>Algae Foundation</td>
</tr>
<tr>
<td>Tom</td>
<td>Dempster</td>
<td>Arizona State University</td>
</tr>
<tr>
<td>Linnea</td>
<td>Fletcher</td>
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<td>Poornima</td>
<td>Rao</td>
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<tr>
<td>Brendan</td>
<td>Scott</td>
<td>Enkidu Engineering</td>
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<tr>
<td>Tiffany</td>
<td>Cannis</td>
<td>Global Algae</td>
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<tr>
<td>Valerie</td>
<td>Harmon</td>
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<tr>
<td>Danny</td>
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<td>Cindy</td>
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<tr>
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<td>Gef</td>
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<td>Rutgers University</td>
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<td>Luke</td>
<td>Spangenburg</td>
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<tr>
<td>Steve</td>
<td>Gomez</td>
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<tr>
<td>Jeff</td>
<td>Granger</td>
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<tr>
<td>N. Jan</td>
<td>Chalupny</td>
<td>Shoreline Community College</td>
</tr>
<tr>
<td>Jim</td>
<td>DeKloe</td>
<td>Solano Community College</td>
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<tr>
<td>Steve</td>
<td>Mayfield</td>
<td>University of California, San Diego</td>
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<td>Charlie</td>
<td>Yarish</td>
<td>Univ of Connecticut</td>
</tr>
<tr>
<td>Schonna</td>
<td>Manning</td>
<td>University of Texas at Austin</td>
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ATEC Industrial Advisory Board

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<tr>
<td>Jacques</td>
<td>Beaudry-Losique</td>
<td>Algenol, Biotech, LLC.</td>
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<tr>
<td>Martin</td>
<td>Sabarsky</td>
<td>Cellana, Inc.</td>
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<td>Charles</td>
<td>O’Kelly</td>
<td>Cyanotech, Inc.</td>
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<td>Ross</td>
<td>Zirkle</td>
<td>DSM Nutritional Products</td>
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<tr>
<td>Amha</td>
<td>Belay (Chair)</td>
<td>Earthrise Nutritionalals, Inc.</td>
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<td>Dave</td>
<td>Hazelbeck</td>
<td>Global Algae Innovations, Inc.</td>
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<td>Smith</td>
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<td>John</td>
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BETO

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<tr>
<td>Christy</td>
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<tr>
<td>Shaina</td>
<td>Aguilar</td>
<td>BETO Intern</td>
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This presentation was developed in part, based upon funding from the Alliance for Sustainable Energy, LLC managing and operating contractor for the National Renewable Energy Laboratory for the U.S. Department of Energy’s Bioenergy Technologies Office.