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NATIONAL RENEWABLE ENERGY LABORATORY

DOE Bioenergy Technologies Office (BETO) 2019 Project Peer Review

ATEC
ALGAE TECHNOLOGY EDUCATIONAL CONSORTIUM

WBS 1.3.5.201 Algae Technology Educational Consortium (ATEC)

Advanced Algal Systems

March 7, 2019

Ira “Ike” Levine, Algae Foundation, University of Southern Maine [USM]

Cindy Gerk, National Renewable Energy Laboratory [NREL]

Goal Statement: Create and Distribute Algal-based Curricula to Develop a Skilled Workforce

Goal: Develop and implement collaborative educational programs ranging from K-12 to community college degrees and extension short courses.

Outcomes: Formation of the Algae Technology Educational Consortium (ATEC) to develop curriculum assets utilized by the ATEC network to educate and train the next generation of algal technicians to fill U.S. job openings supporting algal commercialization.

Relevance: Support algal industry growth through the development of ATEC curricula and the formation of a national network of participating community colleges and aquaculture extension agents providing unique training opportunities. Additionally, ATEC supports BETO's mission for education and workforce development.

U.S. DOE BETO exhibit booth at Algae Biomass Summit

Quad Chart Overview

Timeline

- Start: FY2016
- Merit review cycle: FY2016-2019
  - will be pursuing the effort beyond FY19
  - Merit review June 2019
- 86% complete of review cycle

	Total Costs Pre FY17	FY17 Costs	FY18 Costs	Total Planned Funding (FY19-Project end date)
DOE Funded	$286K	$560K	$614K	$600K

ATEC Partners

Algae Foundation	Shoreline Community College
NREL	Solano Community College
Algae Biomass Organization	South Texas College
Arizona State University	University of California, San Diego
Austin Community College (ACC)	University of Connecticut
Hawaii Community College	University of Maine
Linn-Benton Community College	University of New England
Lone Star College	University of Southern Maine
Rutgers University	University of Texas, Austin
Santa Fe Community College (SFCC)	University of Texas, Rio Grand Valley

Barriers addressed

- Aft-A Biomass Availability and Cost
  - Geographically expand algae cultivation and reduce employee training costs
- Aft-B Sustainable Algae Production
  - Provide skilled workers
- Aft-H Integration
  - Provide interdisciplinary expertise
- At-D Identifying New Market Opportunities for Bioenergy and Bioproducts
  - Domestic production
- At-G Social Acceptance and Stakeholder Involvement
  - Transfer bioenergy technologies to the private sector

Objective

Develop and implement collaborative educational programs ranging from K-12 to community college degrees and extension short courses

End of Current Merit Review (FY 2016-2019) Project Goals:

Online Education: 5,000 Participants

Extension Training: 1,000 Aquaculturists

Community College Programs: 150 Students

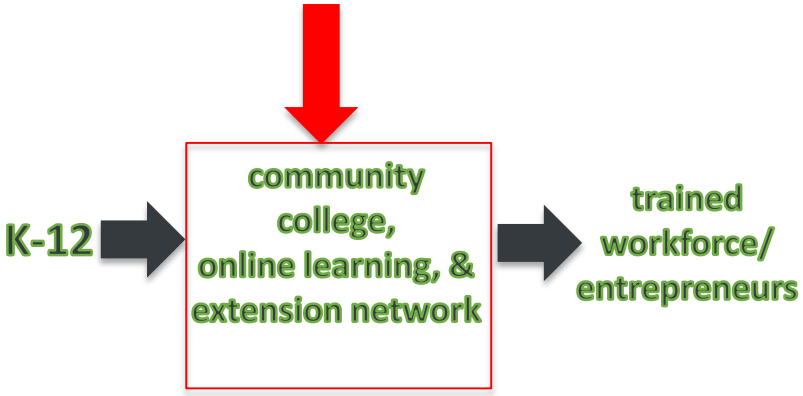
Project Overview

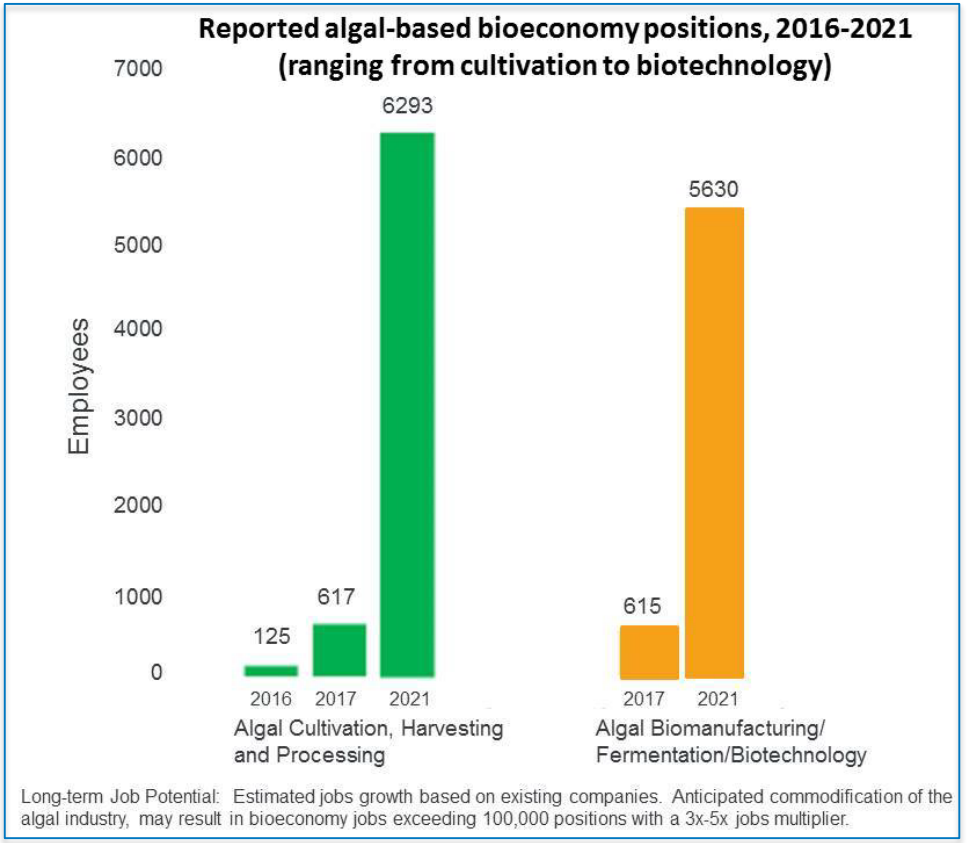
Current Situation:

- Projected shortage of bioeconomy technicians. Anticipated ~12,000 jobs* by 2021
- Costly and time-consuming post-hire training
- Limited algal-based:
  - community college degree/certificate programs
  - extension short-courses
  - online education opportunities

Challenge:

We are missing this step!





* 2016 Industry Jobs Survey

Project Overview

Solutions:

Design Specialized Training Programs

- Collaborate with Industrial Advisory Board to determine learning outcomes and industrial skills
- Develop two community college programs (Algal Cultivation and Algal Biotechnology)
- Construct Algae Cultivation Extension Short-courses (ACES)
- Produce Algal Massive Open Online Courses (MOOC)

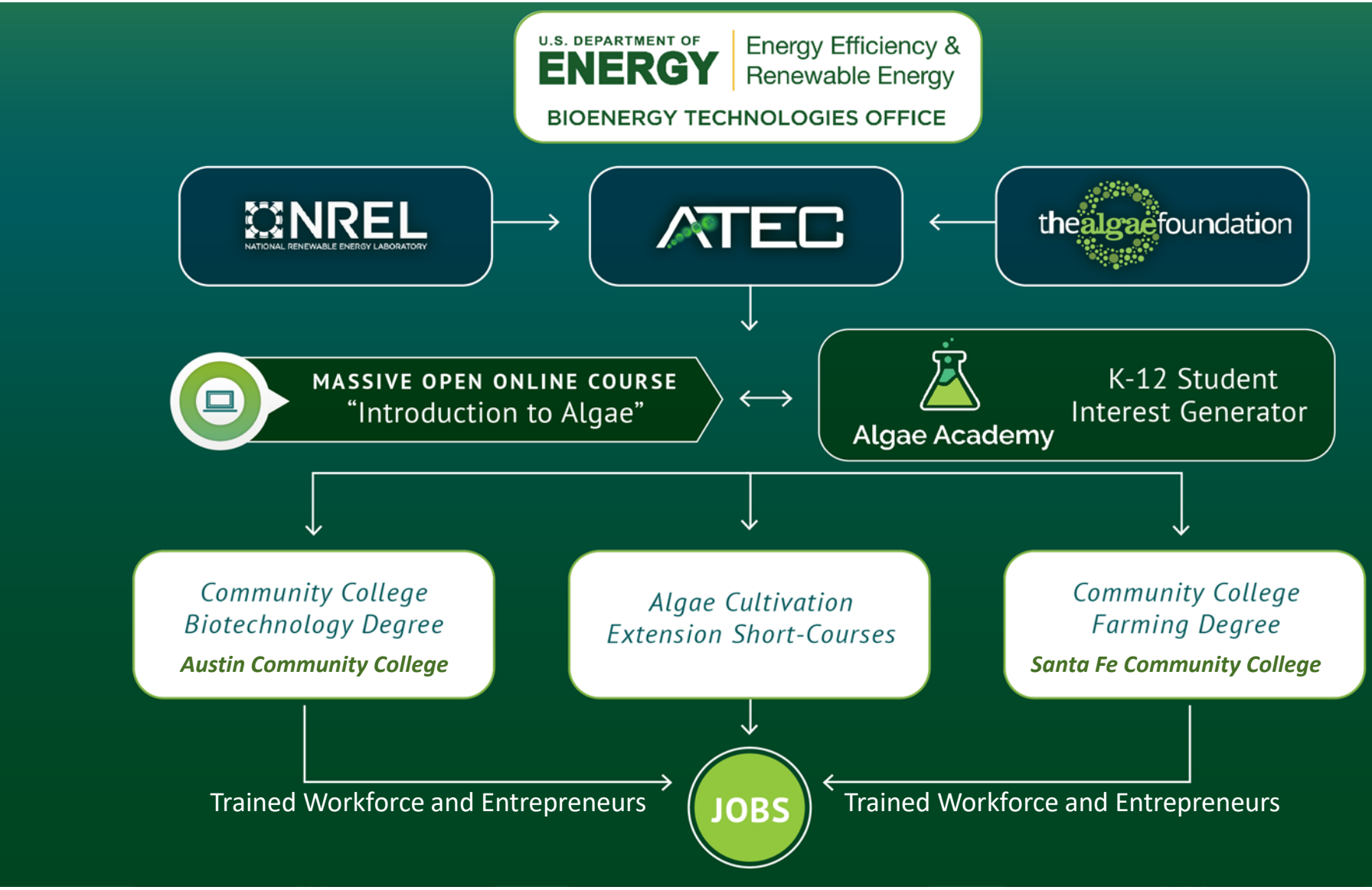
Recruit National Network of Educational Collaborators

- Establish two lead institutions (Santa Fe Community College - Cultivation, Austin Community College - Biotechnology)
- Assemble collaborative national network of educational partners (Arizona, California, Hawaii, Maine, New Mexico, Oregon, Texas, and Washington)

Provide Training for Technicians to Meet Required Industrial Skill Sets

- 30+ Learning outcomes customized to commercial skill requirements
- Ongoing external evaluation and updating of curriculum

Approach - Management



Approach - Management

NREL
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Project management

thealgaefoundation

Technical management

ATEC
ALGAE TECHNOLOGY EDUCATIONAL CONSORTIUM

Industrial Advisory Board
(representing > 90% of U.S. produced algal biomass)

Algae Academy

UNIVERSITY OF SOUTHERN MAINE

STEM education initiative

SFCC
SANTA FE COMMUNITY COLLEGE

NMFR
NEW MEXICO FILM RESOURCE

educational curriculum

AUSTIN COMMUNITY COLLEGE DISTRICT

UTEX Culture Collection of Algae at The University of Texas at Austin

educational curriculum

AzCATI
Arizona Center for Algae Technology and Innovation

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field labs/ internships

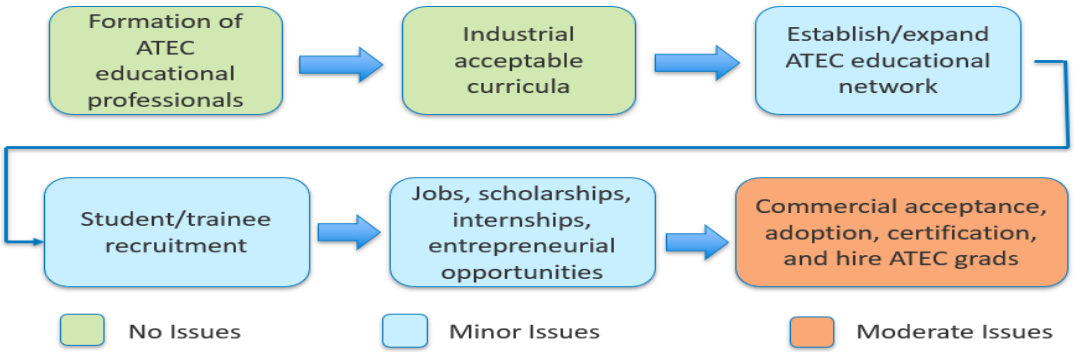
Cal-CAB
CALIFORNIA CENTER FOR ALGAE BIOTECHNOLOGY

UC San Diego

thealgaefoundation

online education

Approach - Technical



Critical Success Factors	Challenge	Strategy
ATEC curriculum development	Design industrial based algal curricula for training and education	Recruit professional educators to design programs subject to review and formal adoption
Recruit national education network	Establishment of new degree / certificate programs, national learning standards accreditation	Collaboration with NSTA and Bio-Link, document success of trainee opportunities at national labs, companies, & universities
Educate and train future algal professionals	Illustrate availability of internships, scholarships and jobs, ease of access to training programs	Face-to-face, blended, and online options. Organize intern program, industrial endorsement, participant success disseminated to future recruits
Industrial collaboration, endorsement, and recruitment of trainees	Acceptance of learning outcomes and job skills, determination of job ready graduates	Collaboration with ATEC Industrial Advisory Board; formation of badges program; disseminate corporate, national labs, & university opportunities

Approach - Technical

Algae Interest Generator (K-12)

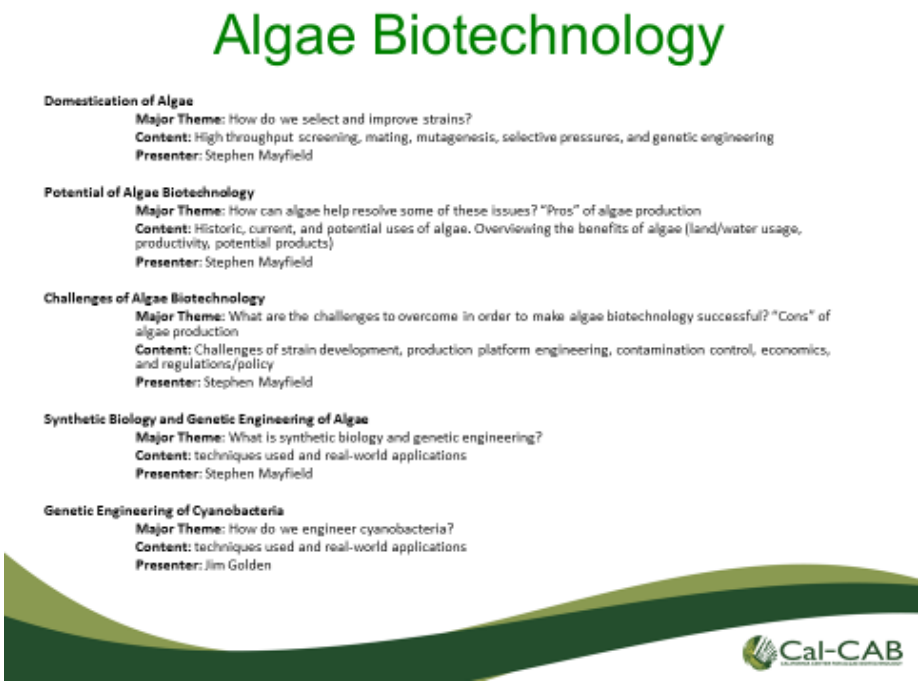
- Algae Academy K-12 Algal-based STEM training
- Summer Science Institute (Teacher Training Program)
- Grades 11-12 “Algae as a Career”

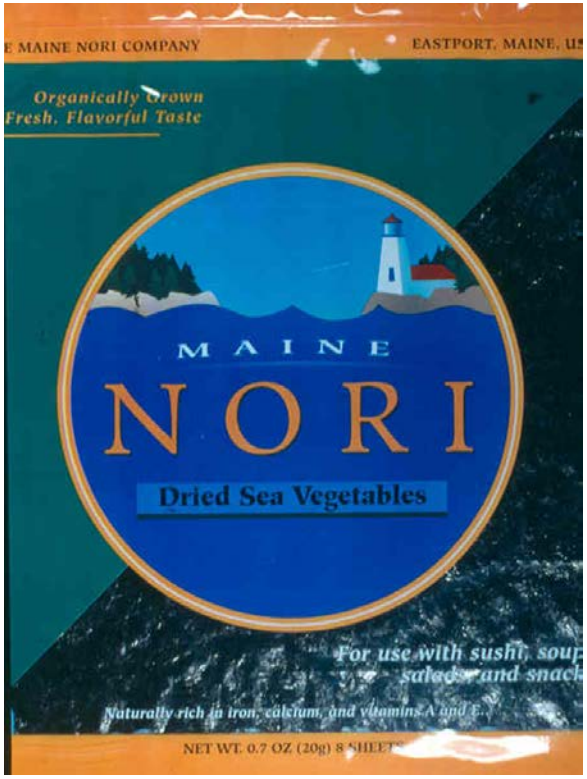
Algae Summer Science Institute
Algae Academy & USM
July 2018
National Training 2019

Approach - Technical

Online Education

- Introduction to Algae, Massive Open Online Course (Algal MOOC) February 2018
- Introduction to Algal Biotechnology, Massive Open Online Course (Algal Biotechnology MOOC) Available June 2019
- Community College Courses





Approach - Technical

National Adoption by Community Colleges

- Originate in-person/blended/online courses
  - STEALTH STEM learning philosophy
  - Learning outcomes based on commercial skill set requirements
- Develop intensive, in-person laboratory courses
  - Reinforcement of commercial skill set requirements and blended course learning outcomes
- Review and update of curriculum in partnership with Industrial Advisory Board and commercial interests
- External assessment of degree programs by independent educational assessment teams

Approach - Technical

Support BETO's Education and Workforce Development in collaboration with national aquaculture extension program

- Develop industry approved micro & macroalgal extension short-courses
- Target existing aquaculture employees and self-employed aquafarmers
- Free access to learning modules
- Provide training and program access for integrated multitrophic aquaculture

Technical Accomplishments/Progress/Results

ATEC & Community College Collaboration

- Santa Fe CC initiates Cultivation Degree Program by SFCC (Fall 2016)
  - First graduates 2018
  - Stealth STEM approach enhances student retention rates
  - Scholarships to University of New Mexico and New Mexico State
  - Two new algal companies formed
  - Algal farms are recruiting graduates
  - Seven in-person courses and one completed online course (all others to follow)
  - ATEC cultivation curriculum located in supplemental slides

- Austin CC initiates Algae Biotechnology Curriculum (Fall 2017)
  - Five insertable lab and lecture modules
  - Intensive lab courses
  - ATEC biotechnology curriculum in supplemental slides
  - 100 participating students

Technical Accomplishments/Progress/Results

ATEC & Community College Collaboration

- Formalized ATEC relationships (signed mou):
  - Austin Community College (Texas)
  - Hawaii Community College (Hawaii)
  - Linn-Benton Community College (Oregon)
  - Lone Star College (Texas)
  - Santa Fe Community College (New Mexico)
  - Shoreline Community College (Washington)
  - Solano Community College (California)
  - South Texas College (Texas)
  - University of Texas, Rio Grande Valley (Texas)

ATEC Impact from coast-to-coast

Technical Accomplishments/Progress/Results

Online Learning Opportunities

- ATEC enhances BETO's visibility in education & workforce development
- Introduction to Algae Massive Open Online Course (Algal MOOC)
  - Offered February 15, 2018
  - Algal MOOC (~ 3,500 students, 4.7 of 5 student course evaluation, 98% approval rating)
  - 17% received a pay increase or promotion
  - 62% received a tangible career benefit from this course

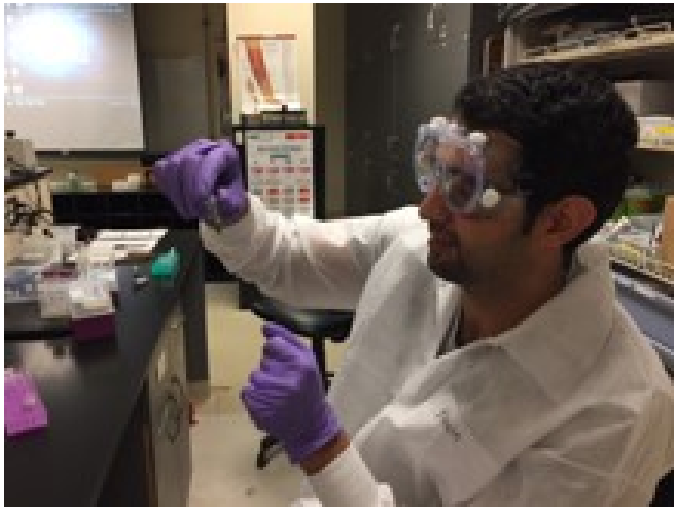
- Introduction to Algae Biotechnology Massive Open Online Course (Algal Biotech MOOC)
  - Scheduled release third quarter FY2019

- Santa Fe Community College Online Program
  - Algaculture 1 online scheduled for Fall 2019 semester
  - Developing online options for all SFCC algal cultivation classes

Technical Accomplishments/Progress/Results

ATEC Progress

- Completion of Aquaculture Extension Short-Courses (ACES)
  - Part 1. Seaweeds
  - Part 2. Microalgae
- External curriculum assessment committee evaluation of Cultivation Program
  - Received excellent reviews from assessment committee, industry, & students
  - Easily adoptable suggestions for program enhancement
- Developing relationships with universities:
  California Polytech University, Florida Polytech University, Oklahoma State University, University of California–San Diego, University of New Mexico, University of Southern Maine, University of Texas-Austin, University of Texas-Rio Grand Valley



Technical Accomplishments/Progress/Results

ATEC Progress

- Algae Academy included within ATEC
- Summer Science Institute – Teacher training program
- Grades 11 & 12 offer algae as a career path option

K-12 Initiative: The Kits and Curriculum

- 5-Day Curriculum
  - Uses of Algae
  - Cultivating Algae
  - Identifying Algae/Microscopy
  - Calculating Growth Rates
  - Algal Ecology & Environmental Extraction Services
- Kits are "drop-in" ready, delivered to the schools
- $250/kit – FREE to Schools
- 3-year Pledge

K-12 Initiative

Algae Academy

LEARN THE POWER OF ALGAE

To educate & excite K-12 students on the Power of Algae

Algae Academy rollout
2017 ~5000 4th-11th grade students in CA, MI, OH
2018 ~ 20,000 students in CA, ME, MI, NM, OH, TX,

Relevance

"Algae are emerging as a leading solution for some of the world's toughest challenges, from combating climate change to feeding future generations. Fortune 500 companies in agriculture, water, energy and manufacturing are deploying algae technology today -- with even bigger plans for the future. Meeting the rapidly growing demand for algae -- and achieving its full potential -- will require a new generation of algae farmers and technicians. The Algae Foundation is rising to the occasion, crafting curricula and creating career paths to unlock the industry's remarkable promise."

Matt Carr
Executive Director
Algae Biomass Organization

Relevance

"The value of the technical work and curriculum being offered by ATEC will meet many demands we face currently in sustainable algae production as well as in future expansion of algae production. **This program, and the students being developed in this program, are the future of our industry."**

Rebecca White
Vice President, Operations
Qualitas Health, Inc.

Relevance

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

Algal Industry Jobs:

- ATEC curricula and network of community colleges, universities, and extension programs provide the opportunities to generate a skilled workforce to fill emerging U.S. algal bioeconomy positions including related fields (wastewater treatment, fermentation, biotechnology, multitrophic aquaculture, greenhouse horticulture, plant nurseries) [Barrier Aft-B]
- Create near-term job potential: Upon completion of the ATEC curriculum, graduates created new companies, providing opportunities for additional future graduates
- 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

Relevance

Relevance of ATEC to BETO Mission:

- Texas farm VP indicated desire to hire the entire SFCC 2019 ATEC graduating class [Barrier Aft-A]
- ATEC's Intro to Algae Massive Open Online Course participation by existing staff was mandated by Cyanotech [Barrier Aft-A]
- ATEC's Algae extension program will provide training for existing shellfish farmers to farm seaweed, supporting the kelp farming renaissance in coastal and offshore waters (63 new kelp farms in Maine) [Barrier Aft-D]
- ATEC will provide training for crossover applications in wastewater, fermentation, and biotechnology industries [Barrier Aft-H]
- Owner of 100 acre algal farm in NM indicated a preference for ATEC graduates [Barrier Aft-H]

Future Work

Expansion of ATEC Educational Network

- Community colleges
  - Five additional community colleges adopting ATEC curricula
  - Anticipate students census doubling each of the next 3 years
- K-12 schools
  - 2018-2019 ~20,000 students; 2019-2020 ~ 30,000 anticipated students served
    - Goal to secure 1% of juniors and seniors to continue with algal training
  - Algae Summer Science Institutes (training 25 teachers per session)
    - 2019 two sessions, 2020 four sessions, 2021 eight sessions
- Online learning community
  - Complete Introduction to Algal Biotechnology Massive Open Online Course (MOOC)
  - Expand social media campaign to attract younger audience to Algal MOOCs
  - Anticipated students: 2019 – 7000, 2020 – 11,000, 2021 – 15,000
- Extension programs
  - Market and distribute ACES training short-courses
    - Part 1: Macroalgae – Seaweeds
    - Part 2: Microalgae - Phytoplankton

Future Work

External Certification and Endorsement Programs

- ATEC badge program
- Algae Biomass Organization endorsement
- Curriculum assessment review & evaluation

Curriculum development

- Expanded focus and new classes: fermentation and heterotrophic systems
- Complete transition from face to face instruction to online offerings
- Offer Introduction to Phycology

Expand collaborative relationships with national organizations

- Bio-Link
- National Science Teacher Association (NSTA)

Complete phase II job assessment survey

- Plan to integrate next job survey into BETO's Jobs and Economic Development Impact (JEDI) model. Direct technical jobs, indirect and induced secondary job growth will be examined

Internship clearing house

- Providing student opportunities at national labs, companies, & universities

Summary

Approach: ATEC develops novel in-person, blended, and online curricula offering national, sustainable educational opportunities to a new generation of algal bioeconomy professionals

Progress:

- Introduction to Algae Massive Open Online Course (~ 3,500 students)
- Algae Cultivation Extension Short-Courses
- Community college degree/certificate curricula (Cultivation & Biotechnology majors)
- Algae Academy K-12 Algal STEM Initiative (~ 25,000 total students educated)

Relevance: Bioeconomy workforce development; creating skilled workforce to fill ~12,000 anticipated positions customized to industry's skill requirements, increasing algal production and reducing scale-up barriers. 17% of Algal MOOC students received pay raise or promotion

Future work:

- Complete and publish - Introduction to Algae Biotechnology MOOC
- Complete transition from face-to-face to online learning communities
- Distribute Algae Cultivation Extension Short-courses, Parts 1 and 2
- Develop intensive, regional face-to-face laboratory courses
- Expand curriculum to include algal fermentation

K-12 → **community college &/or online learning** → **trained workforce/ entrepreneurs**

Acknowledgements

ATEC Team Members

First name	Last name	Organization
Ike	Levine	Algae Foundation Univ of Southern Maine
Marissa	Nalley	Algae Foundation
Tom	Dempster	Arizona State University
Linnea	Fletcher	Austin Community College
Poornima	Rao	Austin Community College
Brendan	Scott	Enkidu Engineering
Tiffany	Cannis	Global Algae
Valerie	Harmon	Harmon Consulting
Danny	Kainer	Lone Star College
Cindy	Gerk	NREL
Phil	Pienkos	NREL
Rebecca	White	Qualitas Health
Jakob	Nalley	Qualitas Health
Gef	Flimlin	Rutgers University
Ondine	Frauenglass	Santa Fe Community College
Luke	Spangenburg	Santa Fe Community College
Steve	Gomez	Santa Fe Community College
Jeff	Granger	SFCC Online
N. Jan	Chalupny	Shoreline Community College
Jim	DeKloe	Solano Community College
Steve	Mayfield	University of California, San Diego
Charlie	Yarish	Univ of Connecticut
Schonna	Manning	University of Texas at Austin

ATEC Industrial Advisory Board

First name	Last name	Organization
Jacques	Beaudry-Losique	Algenol, Biotech, LLC.
Martin	Sabarsky	Cellana, Inc.
Charles	O'Kelly	Cyanotech, Inc.
Ross	Zirkle	DSM Nutritional Products
Amha	Belay (Chair)	Earthrise Nutritionals, Inc. Algae4ALL, LLC
Dave	Hazelbeck	Global Algae Innovations, Inc.
Bren	Smith	GreenWave, Inc.
John	Benemann	MicroBio Engineering, Inc.
Rebecca	White	Qualitas Health, Inc.

BETO

First name	Last name	Organization
Christy	Sterner	BETO Technology Manager
Colleen	Tomaino	BETO Technical Monitor
Shaina	Aguilar	BETO Intern

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BIOMASS TECHNOLOGIES OFFICE

ATEC's lasting benefit of educating the algal workforce will enable a thriving bioeconomy and help to secure an independent American energy future

ATEC
ALGAE TECHNOLOGY EDUCATIONAL CONSORTIUM

Thank You

www.nrel.gov

https://www.nrel.gov/bioenergy/algal-biofuels.html

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NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Supplemental Slides

Response to Reviewers' Comments 2017

Responses to BETO Peer Reviewer Feedback
Algae Technology Educational Consortium (ATEC)

Project Approach Section:

Focus on degree only, and not training or continuing education of existing work force.

The Algae Cultivation Extension Short-courses (ACES) and its learning modules for both seaweed and microalgal cultivation are intended to be the ATEC continuing education and training.. These efforts are focused both on retraining existing aquaculturists (shellfish, finfish, and shrimp) or to expand or refine skills of existing algal-based employees. Multi-trophic aquaculture (polyculture) expertise makes any individual more valuable to their own farming efforts or as current or potential employee.

Low industry involvement (have advisory board but no partners names for development of curriculum).

The P.I. of this grant was the owner of the largest algae farm in the USA for nearly ten years (122 acres) and continues to be part of farms in Asia. His 30+ years of corporate algal farming experience has taken center stage for the curriculum development. Secondly, the P.I. has travelled extensively and has interviewed the management of both micro and macroalgal farms and biotechnology companies for their inputs. Lastly, at the next Algae Biomass Summit scheduled for October 2017, the ATEC group has a special evening session planned to assemble the commercial algal management interests and use the time to review ATEC's existing commercial job skills and farming degree learning outcomes and develop a skill and learning standards matrix for the Algae Farming Degree, Algae Biotechnology Degree and the ACES learning modules.

The Management Approach is unclear.

The ATEC management plan is more fully understood through the review of the supplemental slides. Slide 20 represents a flow chart detailing the ATEC organizational hierarchy as well as the responsibility centers. Slide 21 offers additional insights into the leadership of each effort, e.g. project oversight (Ira Levine and Cindy Gerk), Program Leaders: Farming degree (Tom Dempster (ATP^3 education co-director), Luke Spangenburg (Santa Fe Community College Biofuels Program Director), Biotech degree (Schonna Manning (ATP^3 education co-director) and Linnea Fletcher (Chair, Austin Community College Biotechnology Department), and the ACES program (Gef Flimlin, Extension Professor Emeritus and President of the U.S. Aquaculture Society).

The Management Approach represents a horizontal management system, where by the program leaders and the project oversight team discuss all major matters of effort, concern and uncertainty until a consensus is reached. This management style, while a bit less efficient than a classical vertical management approach yields enhanced outputs, better learning modules, and a more engaged team.

The Algae Technology Educational Consortium meets semi-annually. The fall meeting coincides with the Algae Biomass Summit which provides the ATEC members access to the industry wide event, professional presentations, poster sessions and student awards competition. The second meeting in the spring is located at an ATEC leading member school to allow access to the developing centers of excellence for our farming and biotechnology degrees.

We have a milestone centric approach which is supported through weekly conference calls, monthly reports, and quarterly milestone reviews. The P.I. personally reaches out via telephone, emails and constant site visits (coordinated with community college recruitment efforts) to maintain a clear, concise, and transparent flow of information, data exchange, program review and discussions.

Relevance Section:

This is not directly one of the MYPP goals.

This project indirectly addresses several of BETO's MYPP strategic goals including providing a sustainable feedstock supply and preparing for commercially viable biofuel production. The ATEC educational curriculum provides companies with trained technicians that can make an effective and positive impact on their bottom line. Completion of the ATEC curriculum promotes the Demonstration and Market Transformation goals by transitioning algal feedstock technologies immediately to industry. Additionally, there are many strategic communications goals that are met with the ATEC curriculum directly by supporting education of algae regarding the economic opportunities, environmental, and social benefits of biofuels and bioproducts in the growing bioeconomy.

Specifically, this this project directly addresses the BETO Strategic Plan for education and workforce development programs (BETO Strategic Plan, page 34)

Future Work Section:

Critical to consider who will train the trainers in order to ensure that new courses are being taught by qualified faculty:

We couldn't agree more. ATEC has taken a two pronged approach to this challenge. The first generation of adopting community colleges all have existing, extensive infrastructure to support their respective degree programs (farming or biotechnology). Along with this capital infrastructure exists experienced faculty who are capable to offer the classes. Instructors may desire an intensive prep course to more fully be prepared to offer the ATEC curriculum. Both SFCC (farming) and ACC (biotech) have offered to assist with the intensive instructor training workshops. Secondly, the ATEC curriculum will offer online lecture courses which will be offered through either SFCC or ACC whose faculty will have already taught the classes in person and in blended formats, so the need for site bound instructors will be minimized in our second generation adopting schools. Additionally, the Algae Foundation is preparing a series of intensive, one week laboratory classes at regionalized centers of excellence to allow students from around the country to experience, in person, hands on learning opportunities. The regionalized intensive lab courses also reduce the number of experience instructors needed at the second generation adopting community colleges.

Response to Reviewers' Comments 2017

Would like to see work for continuing education or job training for existing employees if possible.

This response is also addressed in the Project Approach Section. The Algae Cultivation Extension Short-courses (ACES) and its learning modules for both seaweed and microalgal cultivation are intended to be the ATEC continuing education and training modules. These efforts are focused both on retraining existing aquaculturists (shellfish, finfish, and shrimp) who would like to expand their abilities into the primary producers. Multitrophic aquaculture (polyculture) expertise makes any individual more valuable to their own farming efforts or as a potential employee.

Overall Impressions Section:

ATEC is grateful to the reviewers for their insightful comments and suggestions. We thank the reviewers for their support and encouragement as ATEC moves forward in achieving more successes, generating additional momentum from academia, and produces the first class of graduates to enter the workforce in the growing algae industry.

It would be wonderful addition if this project could modify its curriculum or promote its MOOC to extend to continuing education or job training for existing employees.

The ATEC flowchart (slide 20) clearly indicates that the MOOC is the "interest generator" for the entire ATECs program. We have always envisioned the MOOC would come first for all participants including our two community college degrees, ACES learning modules or alternative existing programs including ATP^3, UCSD Edge Program, or Maine Kelp Farming educational efforts. The Algae Foundation fully intends to disseminate and advertise the MOOC in our publications, professional presentations, social media and in all our degrees and ACES efforts.

Providing Training to current companies that don't necessarily have the resources to train their own.

The concept of pre-training employees is the very essence of the ATEC philosophy. As the owner of an algal farm, two of three new hires didn't last more than one week. Either they were ill prepared or we were poor teachers. Either way, the existing of the ATEC farming degree would have been invaluable to our operational efficiencies and budget.

ATEC degree programs are built around understanding the skills and mindset expected in new employees and we instill these experiences and values into our training and educational program.

Publications

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Presentations

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- Cannis, T., I. Levine, G. Mitchell, J. Nalley, and R. White, 2018. Algal-based Education K-14 and Beyond. Algae Biomass Summit. Plenary Lecture. October 15-17, 2018. The Woodlands, TX.
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OUR FOCUS

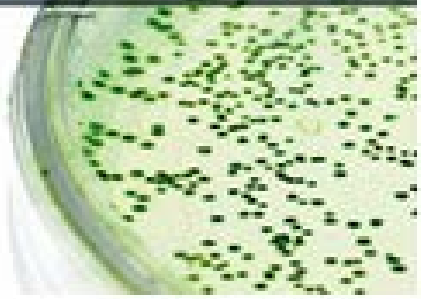
promote education

ATEC

ATEC
ALGAE TECHNOLOGY
EDUCATIONAL CONSORTIUM

K-12 STEM initative

technical standards



all about algae

ALL ABOUT
algae
.COM

student scholarships

Founded in early 2013 as a 501(c)(3) non-profit Educational Foundation

Objectives:

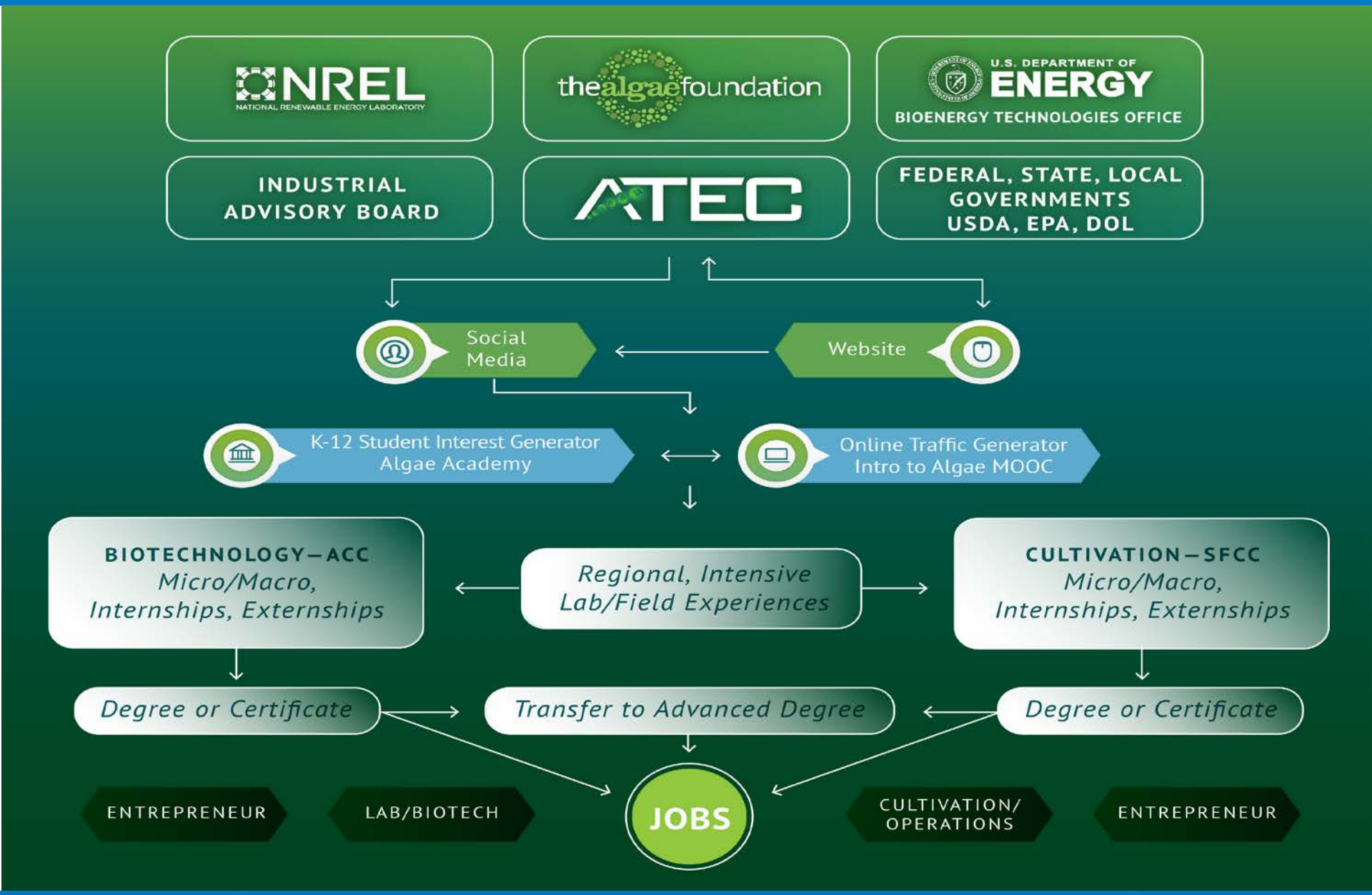
1. Develop an educational-based effort to support DOE-BETO's vision of algae's future.

2. Implement two community college degrees in Algal Cultivation and Biotechnology.

3. Establishment of an Algae Cultivation Extension Short-courses (ACES) for both seaweeds and microalgae

ATEC Team

Detail Level



Approach (Management)

- Algae Technology Educational Consortium (ATEC)
  Ira Levine (Algae Foundation and University of Southern Maine)
  Phil Pienkos and Cindy Gerk (NREL)
  Brendan Scott (Enkidu Engineering)
  Jake Nalley (Algae Foundation)
- Massive Open Online Course (MOOC)
  Steve Mayfield and Ira Levine (UCSD)
- Algal Cultivation Community College Degree/Certificate
  Luke Spangenburg, Steve Gomez, Ondine Frauenglass, Gene Mederos, (SFCC)
  Tom Dempster (ASU)
  Charlie Yarish (UCONN)
  Tom Mumford (Friday Harbor Marine Lab)
- Algal Biotechnology Community College Degree/Certificate
  Linnea Fletcher, Poornima Rao (ACC)
  Danny Kainer (Lone Star College)
  Schonna Manning (UTex)
  James DeKloe (Solano CC)
  Michael Persans (Univ of Texas, Rio Grande Valley)
- Algae Cultivation Extension Short-courses (ACES)
  Gef Flimlin (Rutgers University)
  Dana Morse (University Maine Extension)

Completed ATEC Milestones (FY 2016, 2017, 2018)

FY 2016	
Establish ATEC collaborative team	12/31/2015
Initiate the design of a curriculum and support materials for an algae aquaculture college degree	3/31/2016
Identify publisher or move forward with self-published support materials	6/30/2016
Design of a curriculum and support materials for an algae aquaculture extension certificate	9/30/2016
FY 2017	
Initiation of ATEC curriculum in one community college (SFCC)	12/31/2016
Prepare and publish lab manuals and lecture support reading modules for Algaculture 1 (SFCC), Biotechnology (ACC)	3/31/2017
Production of Introduction to Algae: Massive Open Online Course (MOOC) 6 modules	6/30/2017
Complete draft of lab manual for Algaculture 1	9/30/2017
FY 2018	
Prepare and publish lab manuals and lecture support reading modules for Algaculture 1 (algae farming degree, SFCC), Introduction to Biotechnology (algae biotechnology degree, ACC)	12/31/2017
Completion of ATEC MOOC modules and the ATEC Introduction to Algae Massive Open Online Course (MOOC) and offer the MOOC online in partnership with UCSD with a registered 1000 participants and a 15% completion rate (national average for MOOCS ~ 8%). Sign up Five ATEC community college partners. Additional community colleges that offer the ATEC curriculum will expand the ATEC exposure and training of technicians to geographically meet industry needs.	3/31/2018
Completion of the second ATEC Survey to determine if curriculum needs any adjustments to meet industry needs and to ensure that workers have the necessary training and skills. This survey will be distributed to over 100 industry participants.	6/30/2018
Sign up five community college partner institutions	9/30/2018

Current ATEC Milestones (FY 2019)

Milestone Name/Description	End Date
Distribute ATEC survey to biotech and waste water industries to determine biomanufacturing job potential	12/31/2018
Develop one online algae cultivation extension short-course to be offered via Coursera or the national extension network	3/31/2019
Formation of the Biomanufacturing Technology Educational Consortium (BTEC) to develop the mission, vision and educational outline that will form the basis for the curriculum	6/30/2019
ATEC will organize and distribute the Algae Academy's algal-based STEM curriculum kits to 50 classrooms reaching 4000 students	9/30/2019
[Stretch] ATEC curriculum to be offered in one additional community college by the fall semester of 2019	9/30/2019

Community Colleges Expressing Interest in the ATEC Curriculum

ATEC Community College Recruitment Efforts

Institution	City	State	Signed Commitment Letter	Developing Commitment Letter	ATEC Member	Expressed Interest in ATEC Degree	Expressed Interest in ATEC Certificate	Expressed Interest in ATEC Course	Algae Biology & Cultivation Degree	Algal Biotechnology Degree
Arizona State University	Phoenix	AZ			X					
Austin Community College	Austin	TX	X		X	X	X			X
Bristol Community College	Fall River	MA				X	X	X	X	
Cal Poly University	San Luis Obispo	CA				X	X	X		X
Del Mar College	Corpus Christi	TX				X	X	X		X
Delgado Community College	New Orleans	LA				X	X			X
Florida Polytechnic University	Lakeland	FL				X	X	X		X
Hillsborough State College	Tampa	FL				X		X		X
Hilo Community College	Hilo	HI	X		X	X	X	X	X	
Indian River State College	Ft. Pierce	FL						X	X	
Kauai Community College	Lihue	HI			X	X	X		X	
Linn-Benton Community College	Albany	OR	X		X	X	X		X	
Lone Star College	Monroe	TX	X		X	X	X	X		X
Miracosta College	Oceanside	CA			X					X
Santa Fe Community College	Santa Fe	NM	X		X	X	X			
Shoreline Community College	Shoreline	WA	X					X	X	X
Solano Community College	Fairfield	CA	X		X	X	X			X
South Texas College	McAllen	TX		X		X	X	X	X	
Southern Maine Community College	South Portland	ME						X	X	
University of California	San Diego	CA			X					
University of Connecticut	Storrs	CT			X					
University of Puerto Rico	San Juan	PR				X	X	X	X	
University of Southern Maine	Lewiston	ME			X					
University of Texas, Austin	Austin	TX			X					
University of Texas, Rio Grande Valley	Brownsville	TX		X		X	X	X	X	

Jobs Survey 1

Algal Employment Assessment Survey

The Algae Foundation launched the Algae Technology Educational Consortium (ATEC) project, recognizing algal commercialization will provide a sustainable source of biomass for bio-based products, feed, fuel and foods creating high quality jobs for an educated workforce. Through algal education students learn practical applications of farming and biotechnology, developing the skills for the next generation of algal-based jobs.

ATEC is presently comprised of seventeen members based throughout the United States who collectively have more than 100 years in algal-based education, research, and commercial experience. ATEC is currently supported by a U.S. Department of Energy/NREL grant to produce a novel two year degree in Algae Biology, Technology and Cultivation. The ATEC team members include professionals from the following organizations:

Algae Foundation	Algae Biomass Organization
Univ. of California, San Diego	National Renewable Energy Lab
University of Texas, Austin	Arizona State University
University of Southern Maine	Santa Fe Community College
Austin Community College	Rutgers University
Univ. of Maine Aquaculture Ext.	University of South Florida

The following request for information is critical for ATEC's effort to successfully determine the potential algal-based employment potentials locally, regionally, and nationally. The data will be used to support the adoption of the new degree program by community colleges throughout the United States. Community College administrators have all stated their requirement for employment potentials as a critical step in the adoption of a new degree program.

Please take the time to complete this survey, using your best estimates as to the potential of algal-based expertise needed in future positions. Our degree program has two concentrations: algal-based biotechnology and algal-based cultivation/farming. If you have any additional thoughts please add them at the end of this form. If you have any questions concerning our program or this assessment don't hesitate to contact me.

Please email your response to ilevine@maine.edu . Thank you in advance.

Ira Levine, Ph.D.
ATEC P.I.

1. How many positions does your company presently have that a graduate with a two year degree in Algae Biology, Technology, and Cultivation would be considered qualified for? ____
2. How many algal cultivation, harvesting, & extraction positions will be needed next year? ____
3. How many algal cultivation, harvesting, & extraction positions will be needed next 5 years? ____
4. How many Biomanufacturing (Fermentation/Heterotrophic) positions will be needed next year? ____
5. How many Biomanufacturing (Fermentation/Heterotrophic) positions will be needed five years? ____
6. How many R&D and Biotechnology technicians will you need in the next year? ____
7. How many R&D and Biotechnology technicians will you need in the next five years? ____

8. Do you predict any new emerging trends in workforce needs (e.g., algal-based photosynthetic, heterotrophic cultivation, fermentation, bio-based products, biofuel seed stocks, wastewater remediation, commercial waste digestion, bioinformatics, stem cell production) in the next year? In the next 5 years?

9. Please add any additional thoughts you may have on the potential employment options for a graduate with a two year degree in Algae Biology, Technology, and Cultivation.

NOTES:

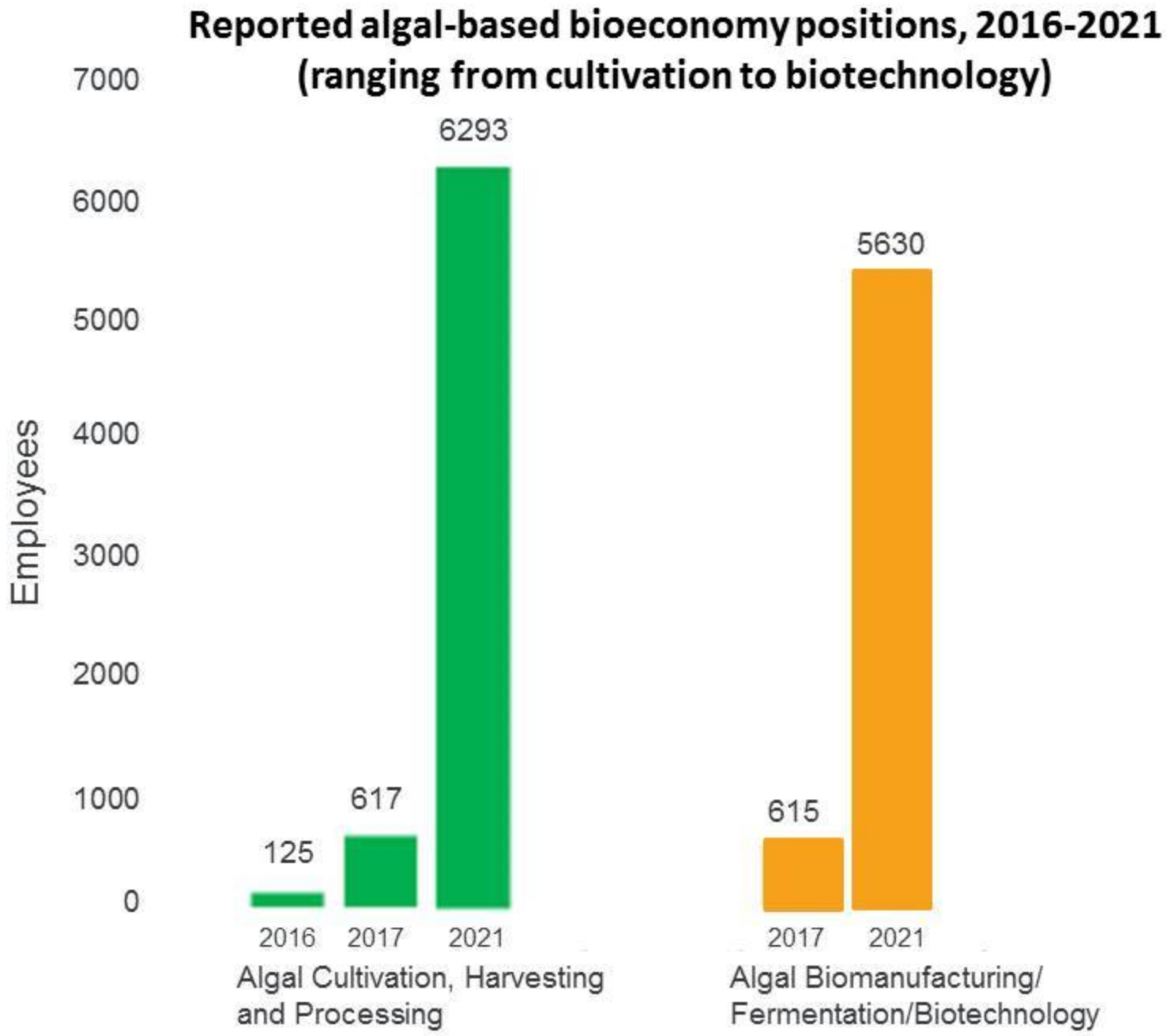
a) **Cultivation, harvesting, & extraction positions**: Cultivation - strain selection, basic lab analytics, micro/macro algae, monoculture, polyculture production in photosynthetic systems including indoor/outdoor, closed/open cultivation systems, including ocean, ponds and lakes. Water resources- fresh, salt water, municipal, industrial and agricultural effluent treatment. Harvesting systems - membrane, flocculation, centrifuge, DAF, & novel evolving systems. Extractions, feedstock conversion and postharvest processing (animal feed, biofuels, bioplastics, biochar, cosmeceuticals, nutraceuticals, soil conditioners and enhancers).
b) **Biomanufacturing (Fermentation/Heterotrophic systems) positions:** pilot to commercial scale fermentation systems; designer bio-based products, nutraceuticals, cosmeceuticals, soil conditioners and enhancers.
c) **R&D and Biotechnology positions**: Cultivar isolation, identification, culture and enhancement (molecular genetics, mutations, protoplast fusion), bioinformatics, laboratory analyses (GC-mass spec, AA, spectrophotometers, balances, cryopreservation, pH, dissolved oxygen, robotics)

Name _____

Company or Institution _____

Phone # _____

Email _____



Long-term Job Potential: Estimated jobs growth based on existing companies. Anticipated commodification of the algal industry, may result in bioeconomy jobs exceeding 100,000 positions with a 3x-5x jobs multiplier.

Jobs Survey 1: Respondents

50 of 76 Algal Companies Responded and listed here
66% response rate

Earthrise
Duke Energy Corp
Arabian Shrimp Co.
Hiroaki Hara - Field Energy
Agcore Tech
Clearas Water
Algix LLC
Grupo Alimenta -
Algaeon, Inc.
NOLA Microfarm
Matrix Genetics
Ouroborous Biorefinery
Texas A&M
PHYCO2
MicroBio Engineering, Inc
Baylor University
Harmon Consulting
Wayne Brown
Cerule (formerly called Desert Lake Technology)
eePARC/ZONS
Triton Health and Nutrition
Algenisis
Agrifuels
Commercial Algae Mgmt.
Diversified Technologies

Qualitas Health, Ltd
Proteos Inc.
Bigelow Laboratory
Delaware Aquaculture Resource Center
Kuehnle AgroSystems, Inc.
Smart Microfarms
Accelergy
El Dorado Biofuels
New Solutions Energy
Santa Fe Community College
Ecoponex Systems International
ATP3
GE Water Processing and Technologies
Ocean Approved
Phyco Biosciences
Orlando Utilities Comm.
Susan Schoenung
AFS Bio oil
Searen LLC
Intelligent Biotechnologies
AFS Biooil
Algal Scientific Corporation
Global Algal Innovations
Cellana
Synthetic Genomics

Job Survey 1: Commercial Job Skills & Farming Degree Learning Outcomes

- Media preparation, sterile techniques, microscopy
- Culture inoculation,
- Scale-up - petri plate to 10 L
- Monitoring procedures for media and biomass analyses
- Lab and farm safety
- Operations and maintenance of algal cultivation systems.
- Scale-up - 10L to 1000 – 50,000L algae production systems.
- System maintenance
- Harvesting operations
- Biomass analysis and quality assessment
- Biomass storage techniques
- Heterotrophic and fermentation techniques
- Wastewater treatment utilization
- Quality control analysis
- Data collection and operational reports
- System troubleshooting and operational awareness
- Pump and motor operations,
- Hydraulic sizing and electrical demand requirements
- Mechanical properties of water

Job Survey 2: Biotechnology

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ATEC | ALGAE TECHNOLOGY EDUCATIONAL CONSORTIUM

Algal Employment Assessment Survey II
Biotechnology Potential

The Algae Foundation launched the Algae Technology Educational Consortium (ATEC) project in 2015, recognizing that algal commercialization will provide a sustainable source of biomass for feeds, foods, fuels and other bio-based products. Additionally, algae can provide ecological services including nutrient recovery and remediation of municipal and agricultural effluents. This creates additional needs and opportunities for an educated workforce with knowledge of algal biology, biotechnology, ecology, and cultivation. Through ATEC's algal-based educational program, students can learn practical applications of biotechnology, developing the skills for the next generation of bioeconomy-based jobs.

ATEC members, who are employed at universities, community colleges, industry, and algal organizations collectively have more than 200 years in algal-based education, research, and commercial experience. ATEC is supported by the U.S. Department of Energy and the National Renewable Energy Lab (NREL) to develop a novel two-year degree and certification program in Algae Biotechnology.

The following request for information is critical for ATEC's effort to determine the current and future potential value of students trained in algal-related biotechnologies. The data will be used by ATEC to help develop new courses as a supporting tool for biotechnology companies. Community College administrators have all stated their requirement for employment potential as a critical requirement for the successful development of new academic or workforce programs. **Your input is truly important.**

Please take a few minutes to complete this short 10-question survey and return to cindy.gerk@nrel.gov, using your best estimates as to the potential of our students helping fill future positions at your facility. If you have any additional thoughts, please add them at the end of this form. Do not hesitate to contact me if you have any questions.

Thank you in advance for your survey responses.

Ira Levine, Ph.D.
ATEC P.I.
ilevine@maine.edu

SURVEY QUESTIONS:

1. On a scale of 1 to 5, where 1 = no benefit at all to your organization and 5 = essential to institutional mission. Please place a value on your technicians having some form of algal biotechnology experience including but not limited to genetics, culture, laboratory techniques, fermentation, harvesting, processing, and/or product development.
2. Do you predict any new emerging trends in workforce requirements (e.g., algal-based photosynthetic, heterotrophic cultivation, ecological extraction services, fermentation, bio-based products, biofuel feedstocks, wastewater remediation, commercial waste digestion, bioinformatics, stem cell production, etc.) in the next five years?
3. Please add any additional thoughts you may have on the potential employment value for a graduate with a biotechnology degree having taken one or more courses or earned a certificate in Algae Biotechnology.
4. Do you believe you or your company will require a minimum of algal-oriented knowledge or experience as part of their requirements or preferences in their formal job description by 2023?
5. How many positions does your company presently have that a graduate with an associate degree or certificate in biotechnology would be considered qualified for?
6. How many additional such positions are envisioned to be needed in 2023?
7. How many Bioeconomy (e.g. Fermentation/Heterotrophic culture, etc.) technicians are presently employed by your company or organization?
8. How many additional Bioeconomy (e.g. Fermentation/Heterotrophic culture, etc.) technicians will be needed within the next 5 years?
9. How many positions at your company presently require expertise with regard to some form of algal biotech, laboratory, cultivation, harvesting, &/or extraction?
10. How many positions at your company do you expect to include some form of algal biotech, laboratory, cultivation, harvesting, &/or extraction standard operating technologies or responsibilities by 2023?

Definitions:

a) **Cultivation, harvesting, & extraction positions**: **Cultivation** - strain selection, basic lab analytics, micro/macro algae, monoculture, polyculture production in photosynthetic systems including indoor/outdoor, closed/open cultivation systems, including ocean, ponds and lakes. Water resources- fresh, salt water, municipal, industrial and agricultural effluent treatment. **Harvesting** systems - membrane, flocculation, centrifuge, DAF, & novel evolving systems. **Extractions**, feedstock conversion and postharvest processing (animal feed, biofuels, bioplastics, biochar, cosmeceuticals, nutraceuticals, soil conditioners and enhancers).
b) **Biomanufacturing (Fermentation/Heterotrophic systems) positions:** pilot to commercial scale fermentation systems; designer bio-based products, nutraceuticals, cosmeceuticals, soil conditioners and enhancers.
c) **R&D and Biotechnology positions**: Cultivar isolation, identification, culture and enhancement (molecular genetics, mutations, protoplast fusion), bioinformatics, laboratory analyses (GC-mass spec, LC-mass spec, AA spectroscopy, spectrophotometry, mass balance, cryopreservation, robotics, and/or analytical measurements - pH, dissolved oxygen, etc.)

Additional Comments: Please add any additional thoughts you may have on the potential employment options for a graduate with a two-year degree in Algal Biotechnology. Let us know if you like further information on ATEC algae certificate programs and classes being developed.

Name _____

Company/Institution/Agency _____

Industry _____

Phone # _____

Email _____

Job Survey 2: Wastewater

thealgaefoundation

ATEC | ALGAE TECHNOLOGY EDUCATIONAL CONSORTIUM

Algal Employment Assessment Survey II
Wastewater Treatment Opportunities

The Algae Foundation launched the Algae Technology Educational Consortium (ATEC) project in 2015, recognizing that algal commercialization will provide a sustainable source of biomass for feeds, foods, fuels and other bio-based products. Additionally, algae can provide ecological services including nutrient recovery and remediation of municipal and agricultural wastewaters, from oxidation ponds to advanced treatment processes. This creates additional needs and opportunities for an educated workforce with knowledge of algal biology, ecology, and cultivation. Through ATEC's algal-based educational program, students can learn practical applications of algal cultivation and applications in the wastewater treatment industry.

ATEC members, including from universities, community colleges, wastewater treatment industry, and algae organizations collectively have more than 200 years in algal-based education, research and commercial experience. ATEC is supported by the U.S. Department of Energy and the National Renewable Energy Lab (NREL) to develop novel two-year degree and certificate programs in technician training in industrial-scale algae cultivation. This past May 2018, Santa Fe Community College's first graduates were awarded their certificates

The following request for information is critical for ATEC's effort to determine the current and future potential value of students trained in algal-related technologies to qualify for wastewater treatment facility jobs. The data will be used by ATEC to help develop a new course including algae as a supporting tool for wastewater treatment technologies. Community College administrators have all stated their requirement for employment potentials as a critical step in the adoption of a new curriculum program. **Your input is truly important.**

Please take a few minutes to complete this short 6-question survey and return to cindy.gerk@nrel.gov, using your best estimates as to the potential of our students helping fill future positions at your facility. If you have any additional thoughts, please add them at the end of this form. Do not hesitate to contact me if you have any questions.

Thank you in advance for your survey responses.

Ira Levine, Ph.D.
ATEC P.I.
ilevine@maine.edu

NOTE: The ATEC developed professional algae and wastewater classes will include the following experiences:

1. Laboratory standard methods analysis (VSS, nutrients, turbidity, pH, coliforms COD/BOD, etc.)
2. Microalgal and microbial mono- and poly-cultures /species used in wastewater treatment processes
3. Culture management of indoor/outdoor, closed/open cultivation systems, including oxidation ponds
4. Municipal, industrial and agricultural effluent treatment processes; harvesting of algal biomass
5. Biomass/biosolids conversion to fuels (anaerobic digestion, fermentations, thermal processes, etc.)
6. Environmental extraction services (bioremediation of excess nutrients and effluents)
7. Basic process operations and maintenance (pumps, motors, electrical, plumbing and piping, etc.)

SURVEY QUESTIONS:

1. How many water/wastewater treatment technicians/operators does your facility currently employ?
2. A. How many water/wastewater treatment technicians/operators will you need to hire next year?

   B. In the next 5 years?
3. What are the primary factors affecting changes in the numbers of technicians/operators (e.g., retirement, increase or decrease in gallons treated per day, implementation of new technologies, etc.)?
4. How many of these positions do you anticipate will be filled by a graduate with a certificate (one year) or two-year community or technical college degree?
5. A. On a scale of 1 to 5, where 1 = unnecessary and 5 = invaluable experience, please rate how important: a working knowledge of algal-based wastewater treatment is for your current workforce?

   B. In the next five years?
6. What new or emerging trends in workforce needs (e.g., thermophilic digestion, algal-based photosynthetic or heterotrophic cultivation for tertiary treatment, fermentation, wastewater treatment of industrial waste digestion, etc.) in the next five years?

Please add any additional thoughts you may have on the potential employment options for a graduate with a two-year degree in Wastewater Technology and Algae Cultivation. Let us know if you like further information on ATEC algae certificate programs and classes being developed.

Name _____

Company/Institution _____

Address _____

Phone # _____

Email _____

Algae Technology Educational Consortium (ATEC)

Massive Open Online Course – Introduction to Algae

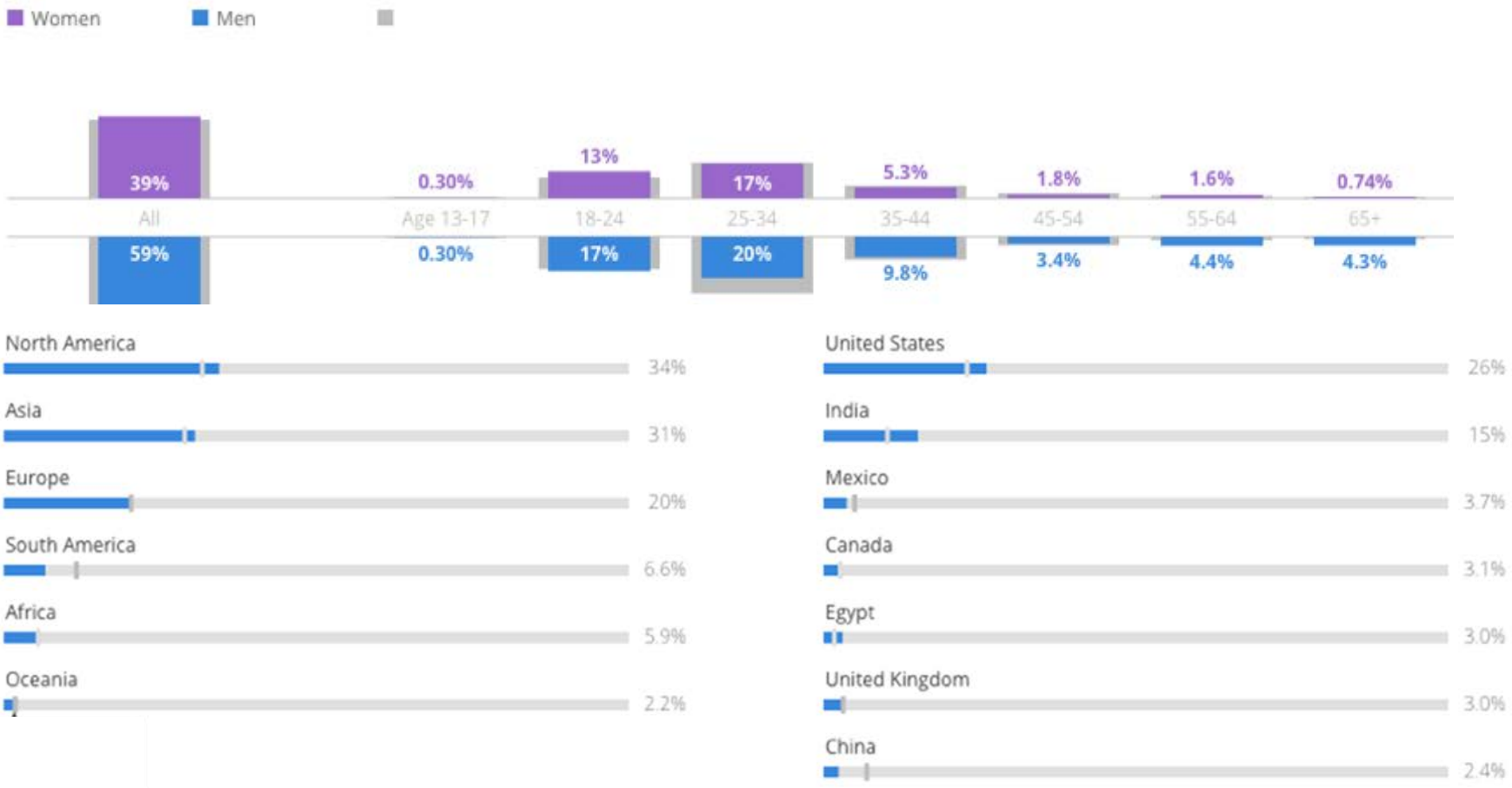
- Algae Basics
- Algal Diversity
- Algal Ecology
- Algae Biomanufacturing Part 1
- Algae Biomanufacturing Part 2

Introduction to Algae Massive Open Online Course
Algal MOOC Published February 15, 2018
~3000 Students have taken the course

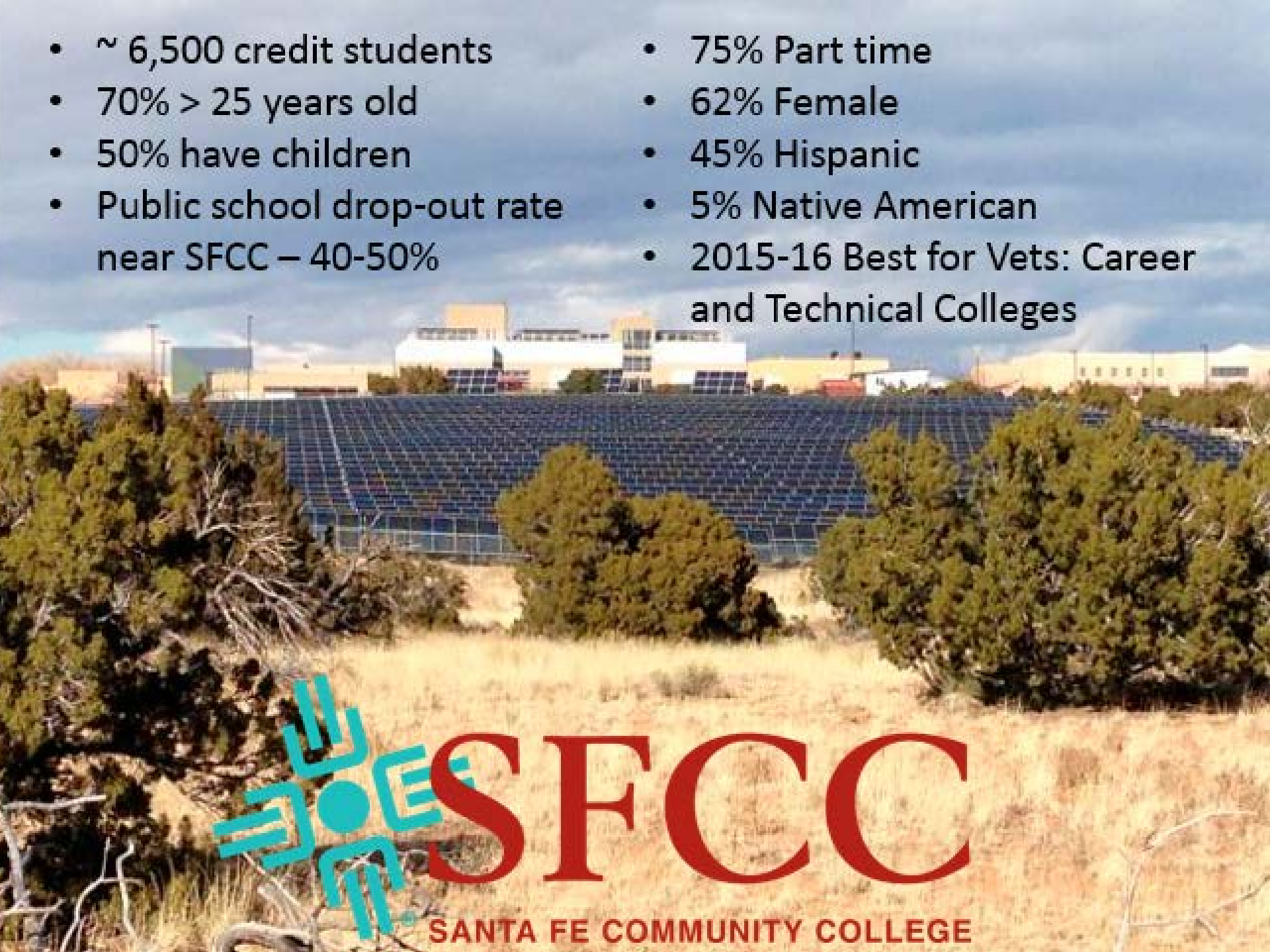
https://www.coursera.org/learn/algae

98% like the course

4.7 out of 5 star reviews



- ~ 6,500 credit students
- 70% > 25 years old
- 50% have children
- Public school drop-out rate near SFCC – 40-50%
- 75% Part time
- 62% Female
- 45% Hispanic
- 5% Native American
- 2015-16 Best for Vets: Career and Technical Colleges



SFCC

SANTA FE COMMUNITY COLLEGE

Algae Technology Educational Consortium (ATEC)

Algae Cultivation

- ALTF 161 – Introduction to Algae Cultivation (+ online)
- ALTF 271 – Biology of Algae (+ online)
- ALTF 261 – Advanced Algae Cultivation (+ online)
- ALTF 262 – Algae Harvesting (+ online)
- ALTF 268 – Algae Capstone
- ALTF 298 – Biofuels Internship
- PLMB 141 – Pumps and Motors (+ online)
- WATR 166 – Microbiology for Water Operators

- BLDG 111 – Construction Safety

Algae Technology Educational Consortium (ATEC)

Algal Culture Extension Short-course (ACES)

- Macroalgae
- Seaweed Culture
- Seaweed Lab Culture and Seaweed Farming
- Seaweed Farms Around the World
- Seaweed Farming Techniques
- Integrated Multitrophic Aquaculture
- Seaweed Business

Algae Cultivation Extension Short-courses (ACES) Part-1 Seaweeds

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), Kappyphycus 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

Algae Technology Educational Consortium (ATEC)

CERTIFICATE IN ALGAE CULTIVATION

CERTIFICATE IN
ALGAE CULTIVATION
(32 hrs. min.) CIP: 01.0301
School of Trades, Advanced Technologies and Sustainability, 505-428-1664

This program covers the basic science and technology of algae cultivation. This certificate provides students with the skills required to work in the algae cultivation (algaculture) industry or create their own algaculture business. Students will learn the controlled environment requirements for successful cultivation of various algae species. The program emphasizes training in algal cultivation technologies, including algaculture extension training. Knowledge acquired will prepare students for jobs as Greenhouse/Agricultural Workers, Plant Technicians, Plant Managers, Laboratory Technicians, Sales Managers, Public Relations and Outreach, Process Coordinators, Extension Service and/or Business Owners/Managers.

Students can earn the following degree related to this certificate:
• A.A.S. Controlled Environment Agriculture

PROGRAM LEARNING OUTCOMES
Upon completion of this program, students will be able to:
• Create and maintain a safe working environment.
• Design, install, maintain and operate sustainable algaculture systems.
• Identify wasteful practices and recommend sustainable alternatives.
• Measure and describe energy and its relationship to sustainable systems.
• Articulate the principles of entrepreneurship and creating a sustainable small business.

Algae Technology Educational Consortium (ATEC)

CERTIFICATE IN ALGAE CULTIVATION

Core Requirements

CORE REQUIREMENTS: (32 HRS. MIN.)
ALTF 161 Introduction to Algae Cultivation (3)
ALTF 261 Advanced Algae Cultivation (3)
ALTF 262 Algae Harvesting (3)
ALTF 268 Algae Capstone (1-3)
[or]
ALTF 298 Biofuels Internship (1-3)
BLDG 111 Construction Safety (3)
ENVR 112 Introduction to Sustainable Energy Technologies (3)
GRHS 121 Greenhouse Operation and Management (4)
HRMG 118 Sanitation and Safety (2)
PLMB 141 Pumps and Motors (2)
WATR 160 Applied Chemistry for Water Treatment Operators (4)
WATR 166 Microbiology for Water Treatment Operators (4)

First Year Student Success (3 hr.) If required — See NOTE
STEM 111 Introduction to Science, Technology, Engineering and Mathematics (3)
NOTE: See First-Year Student Success Course Requirement on Page 8.

TOTAL 32 CREDITS MIN.

SFCC Approach

Intro to Algae Cultivation
- Basic biology
- Basic chemistry
- Scientific method
- Algae cultivation –
  - Colony isolation to 10 L PBR

ALTF 161 – Introduction to Algae Cultivation

Adv. Algae Cultivation
- Adv. Analytical Tech.
- Data Collection
- Data analysis
- Algae cultivation –
  - 10 L PBR to >500 L PBR

ALTF 261 – Advanced Algae Cultivation

Algae Harvesting
- Harvesting Tech.
- Value-added products
- Quality control
- Algae Project –
  - Algae farm proposal

ALTF 262 – Algae Harvesting

Algae Internship
- Internship with business.
- Independent research projects

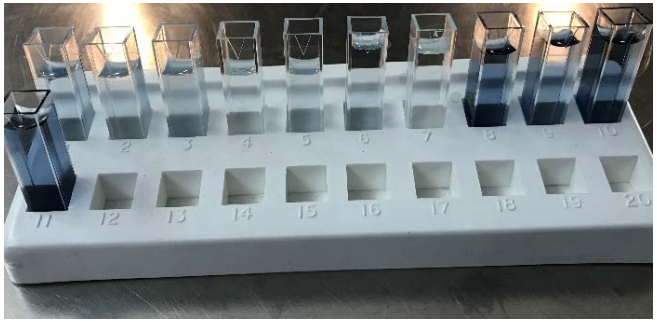
ALTF 268 – Algae Capstone
ALTF 298 – Biofuels Internship

Pumps and Motors
- Pump technologies
- Pump sizing
- Troubleshooting
- Basic electric motors

PLMB 141 – Pumps and Motors

Safety
- OSHA 30-hour safety course

BLDG 111 – Construction Safety



Plant-based Biology
- Introductory Biology Plant/algae cells and Photosynthesis

BIOL 111/L Intro Biology

Prerequisites
- ENGL 109
- MATH 102

PLAN B

Aquatic Microbiology
- Microbiology of water systems

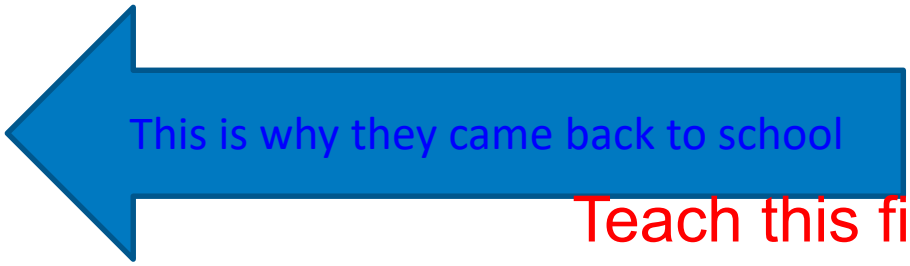
WATR 166 – Microbiology for Water Treatment Operators

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

		ALTF 161	ALTF 261	ALTF 262	ALTF 268 ALTF 298	PLMB 141	BIOL 111	BIOL 111L	WATR 166	ALTF (Phyc)	Bioinfomatics	BLDG 111	Short course
1	Media preparation	x	x					x	x				x
2	Sterile technique	x	x					x	x				x
3	Microscopy	x	x					x	x				x
4	Culture inoculation	x	x					x	x				x
5	Scale up: colony to 10L	x											x
6	Scale up: 10L to >500L		x										x
7	Monitoring procedures for biomass analysis	x	x	x					x				x
8	Lab and farm safety	x	x	x		x			x			x	x
9	Operations and maintenance	x	x	x		x			x				x
10	Harvesting operations			x					x				x
11	Biomass analysis and quality assessment		x	x					x				x
12	Biomass storage techniques		x	x									x
13	Heterotrophic growth and fermentation		x	x					x	x			x
14	Algae identification	x	x	x					x	x			x
15	Pathogen/predator identication	x	x	x					x				x
16	Treated wastewater utilization		x	x					x				x
17	Quality control analysis	x	x	x					x				x
18	Data collection and analysis	x	x	x				x	x				x
19	Internship				x								
20	Pump and motor operations					x			x				
21	Hydraluic sizing					x							
22	Electrical demand requirements					x			x				
23	Mechanical properties of water					x			x				

Stealth STEM

- Students re-entering the community college system DO NOT want an “education”
- They want a good-paying stable JOB!!!!!
- The traditional academic system does not serve their needs:
- Traditional order in college programs:
  1. General education courses
  2. Core courses
  3. Specialized courses
  4. Degree



Teach this first!!

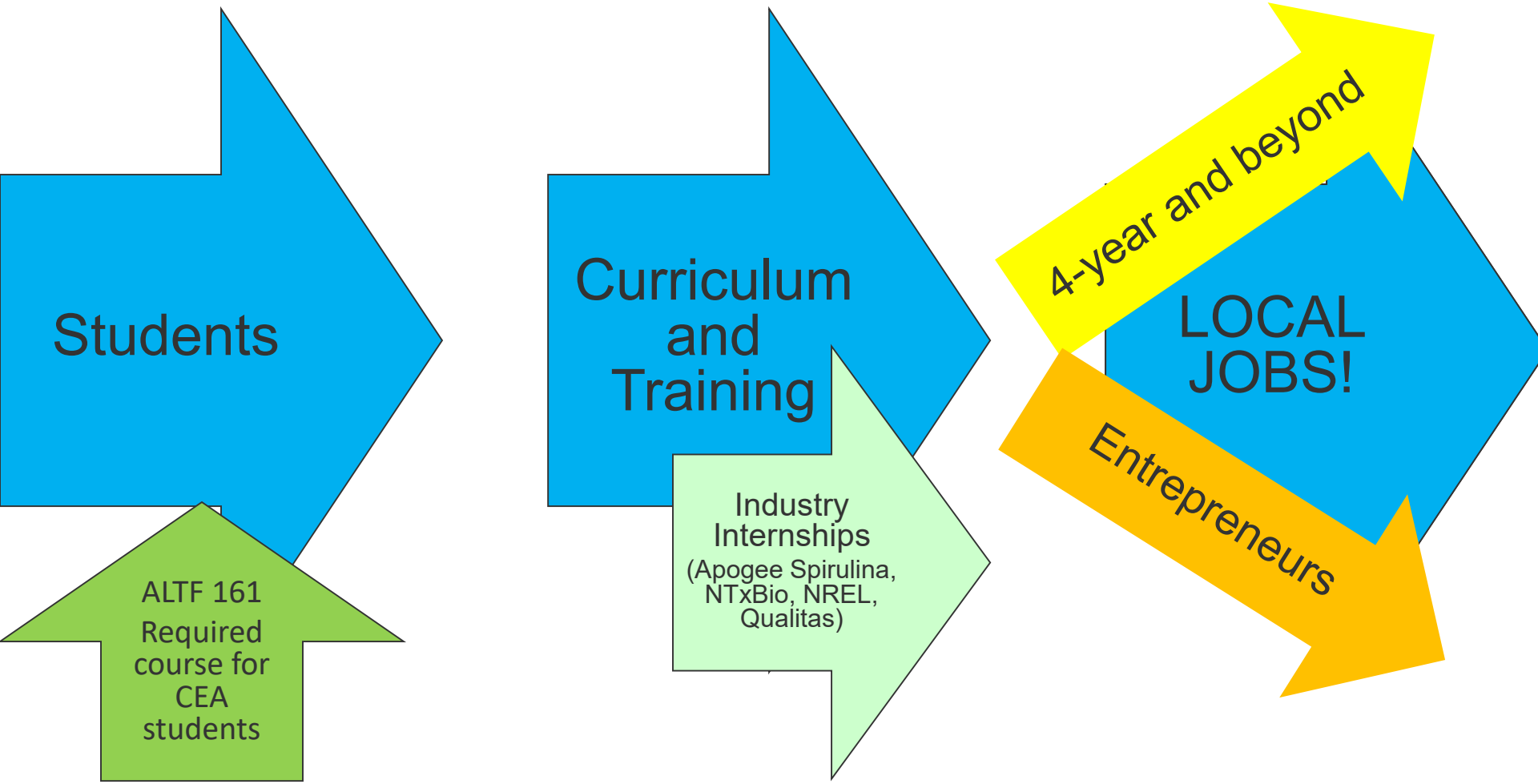
Stealth STEM

1st Semester

- New students
  - "I don't need biology to learn how to grow algae"
  - "I can't do math"
  - "Why do I need chemistry? I just want to grow plants."
- Put the students in the lab
- Let them work on the topics they came back to school to learn
- Give them enough rope to hang themselves

2nd Semester

- Continuing students
  - "Dr. Gómez, the chemistry class is full. What do I do?"
- Students who "discover" they need STEM courses do much better than students who are "told" they need STEM courses
- Paid internships are the best retention tool
  - "You mean I can get paid to do this?"


Students
ALTF 161
Required course for CEA students
Curriculum and Training
Industry Internships
(Apogee Spirulina, NTxBio, NREL, Qualitas)
4-year and beyond
LOCAL JOBS!
Entrepreneurs

Status of Algae Cultivation Certificate

- Approved by HED – Feb. 15, 2018
- First Graduates – May 12, 2018

Santa Fe Community College

The Board
upon the recommendation of the
Faculty of Santa Fe Community College
hereby confers upon
Sample Sample Sample
the Degree of
Certificate
Algae Cultivation
with all the Rights, Responsibilities, Privileges and Honors thereunto appertaining.
Conferred at Santa Fe, New Mexico, this eighteenth day of May, two thousand seven.

NEW MEXICO HIGHER EDUCATION DEPARTMENT

SUSANA MARTINEZ
NEW MEXICO GOVERNOR

BARBARA DAMRON
CABINET SECRETARY

New Mexico Higher Education Department
Planning and Research Division
2044 Galisteo St., Suite 4
Santa Fe, NM 87505-2100

February 15, 2018

Barbara Griego
Director of Institutional Research
Office of Planning and Institutional Effectiveness
Santa Fe Community College
6401 Richards Avenue
Santa Fe, NM 87508

Dear Ms. Griego

This letter confirms the following program CIP code(s) for Santa Fe Community College has been approved by the New Mexico Higher Education Department on February 15, 2018. These additions are included in eDEAR.

Program(s)

Instcamp	CIP Code	Program Level	CIP Title
1711	01.0301	2	Agricultural Production Operations, General

Please feel free to contact us if you need further assistance.

Sincerely,

Dina Advani

Dina Advani, Director of Planning and Research

Degree and Certificate Training

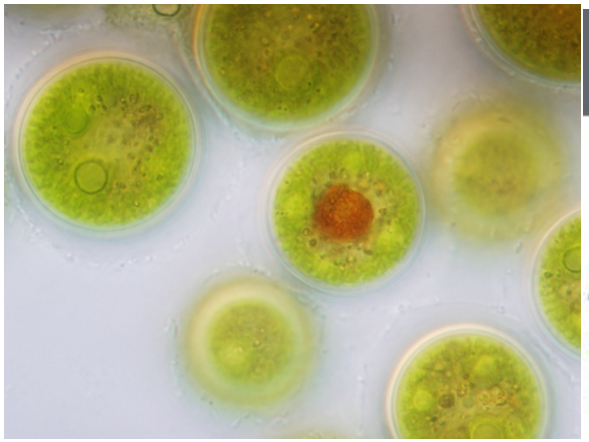
SFCC
SANTA FE COMMUNITY COLLEGE
CENTER OF EXCELLENCE
BIOFUELS

- Algae
- Biodiesel
- Gasification
- Anaerobic Digestion
- Water/ Wastewater

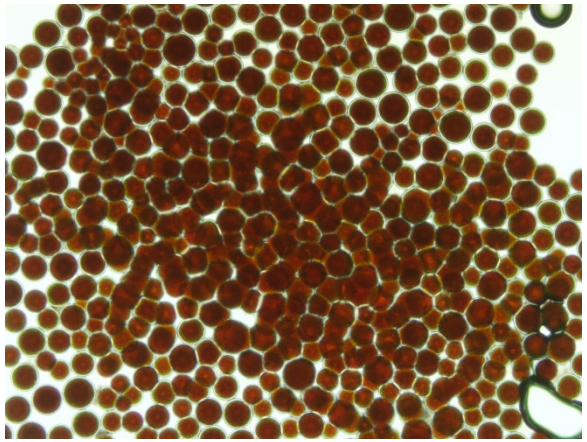
BIOFUELS@SFCC.EDU

Algae Biotechnology @ Austin Community College and Beyond

Linnea Fletcher, ACC
Schonna Manning, UT-Austin

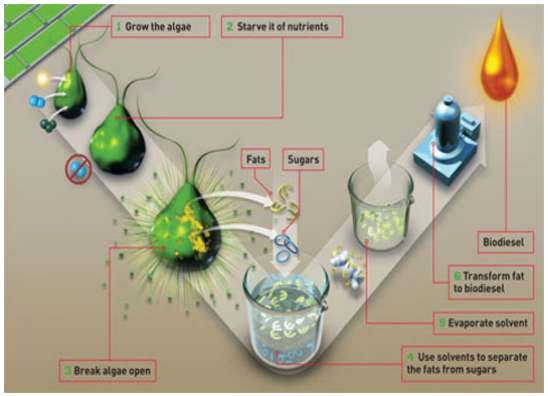


ATEC
ALGAE TECHNOLOGY EDUCATIONAL CONSORTIUM

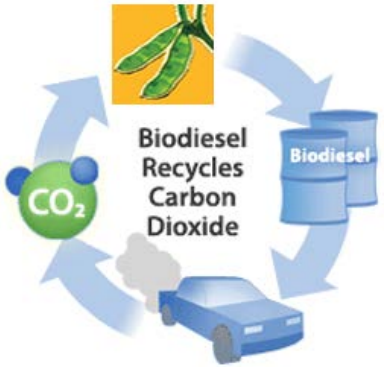


Algae in Biotechnology

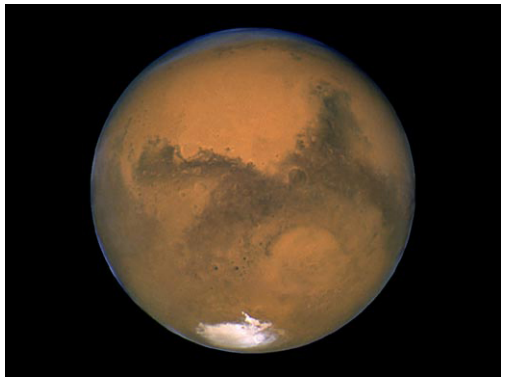
Algae-to-Oil



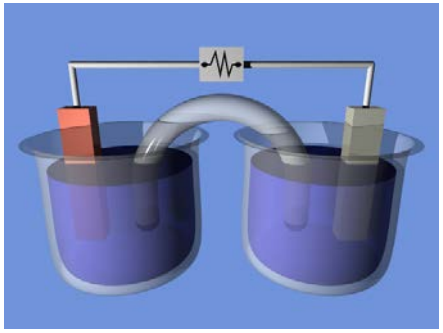
Oil-to-Biodiesel



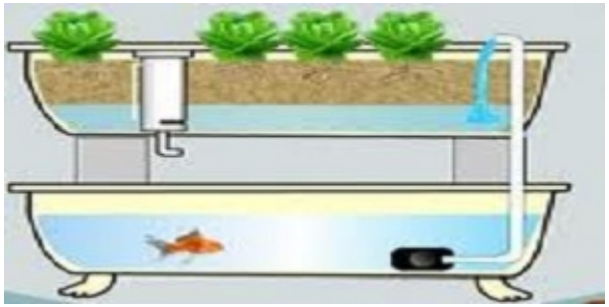
Biological Solutions for Life on Mars



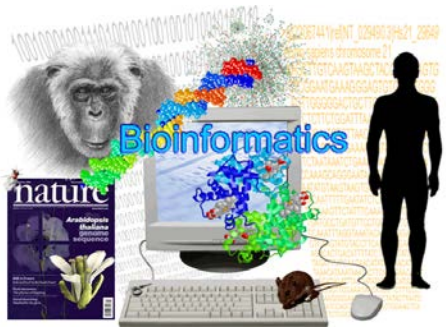
Microbial Fuel Cells



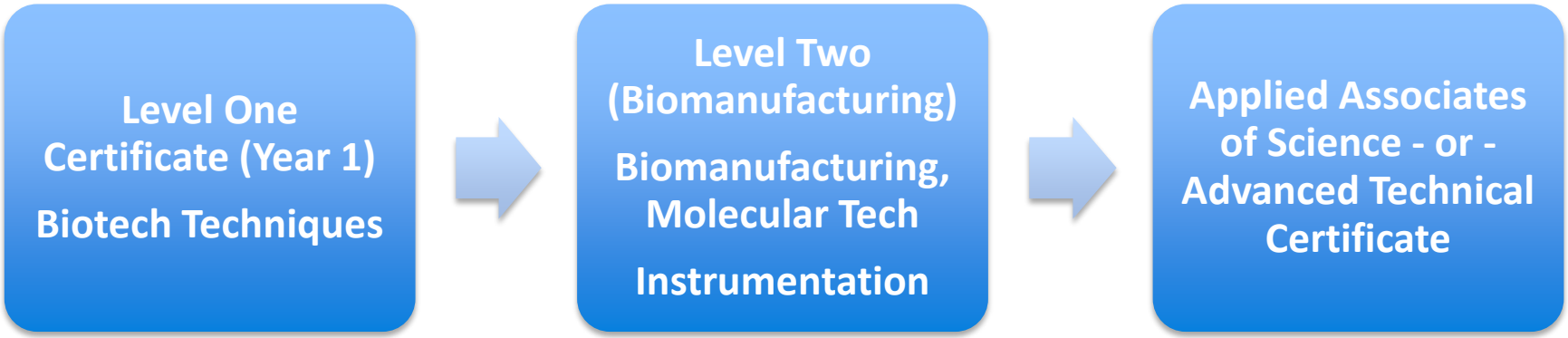
Aquaponics

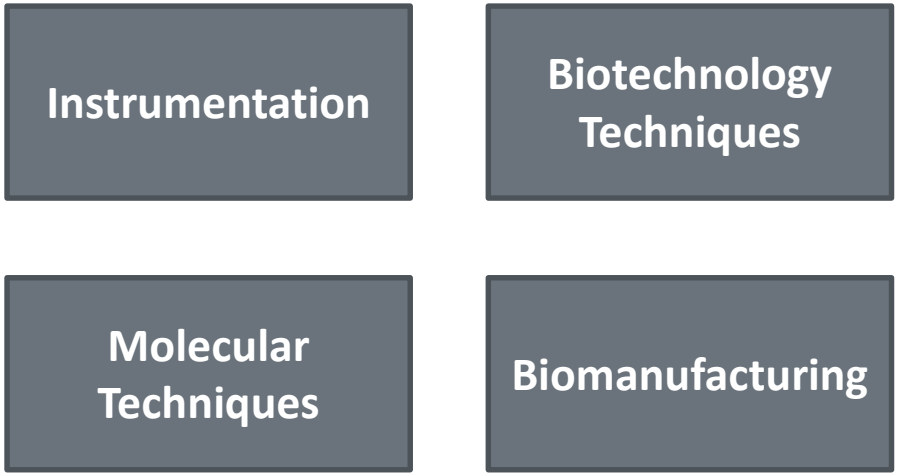


Bioinformatics



ACC Biotechnology Degrees and Certificates





thealgaefoundation

ACC
AC2 BIO-LINK
REGIONAL CENTER
NSF DUE 1501207

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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
  (may not have enough time to do the bioinformatics)
- ***BITC 2411 Laboratory Instrumentation***
  TOTAL LIPID EXTRACTION
  TOTAL SAPONIFIABLE LIPIDS (FAME) ANALYSIS

Semester IV

- ***BITC 2431 Cell Culture Techniques (had to remove because of stem cell culturing needs)***
- ***BITC 1491 Special Topics in Biological Technology / Technician: BioManufacturing***
  MICROALGAE CULTURING METHODS: GROWTH KINETICS & BIOMASS METRICS

Semester V

- BITC 2487 Biotechnology Internship

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NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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

Algae Biotechnology Laboratory Intensive

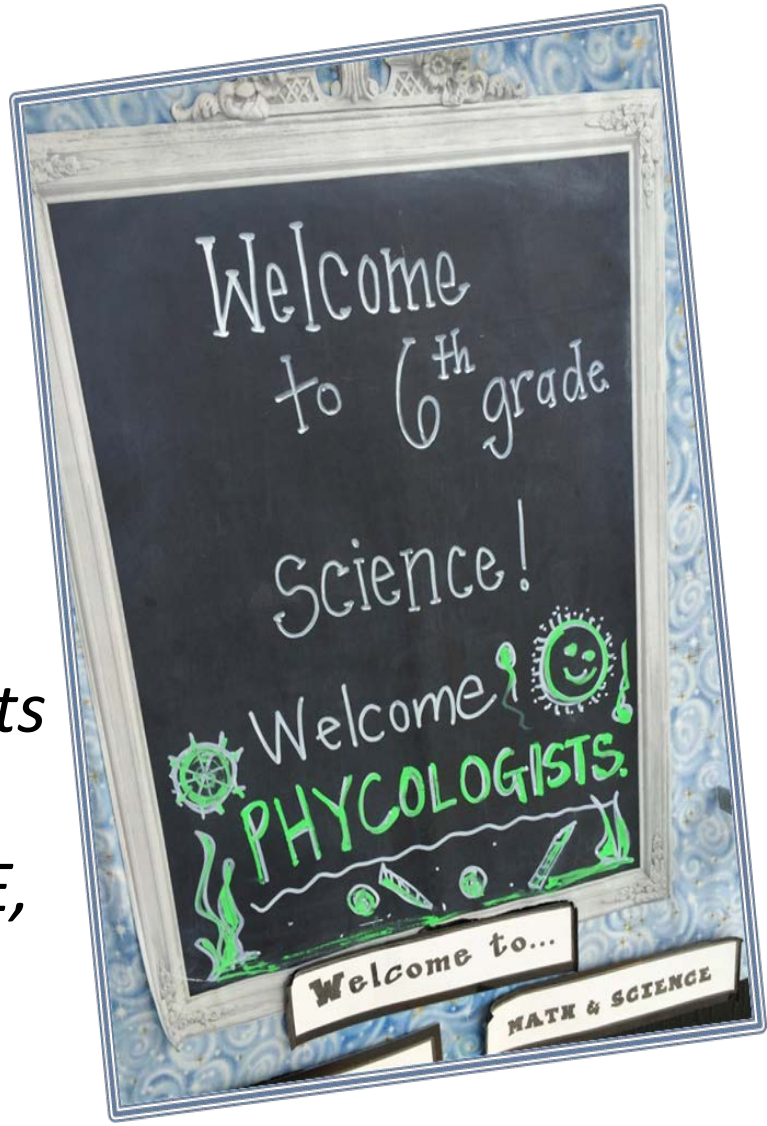
Monday	Tuesday	Wednesday	Thursday	Friday
Culture Maintenance media preparation, sterile technique, microscopy, and spectrophotometry	Gravimetric Analysis wet weight, dry weight, ash-free dry weight, % moisture and % solids,	DNA Part I Isolation of DNA and RNA, PCR barcoding, and preparing samples for Sanger sequencing	DNA Part II gel electrophoresis, sequence analysis, and an introduction to bioinformatics	**Overview of Laboratory Skills - and - Lab Practical**
Genetic engineering I Plasmid construction, transformation	Genetic engineering II Plasmid construction, transformation, and screening	Biochemical Analysis I Total lipids, proteins, and carbohydrates, and analysis of lipids by TLC	Biochemical Analysis II Instrumentation and analysis of fatty acids and amino acids by GCMS	**Overview of Laboratory Skills - and - Lab Practical**

80 hours of content and training, 2 comprehensive lab practicals

K-12 Initiative

To educate & excite K-12 students on the Power of Algae

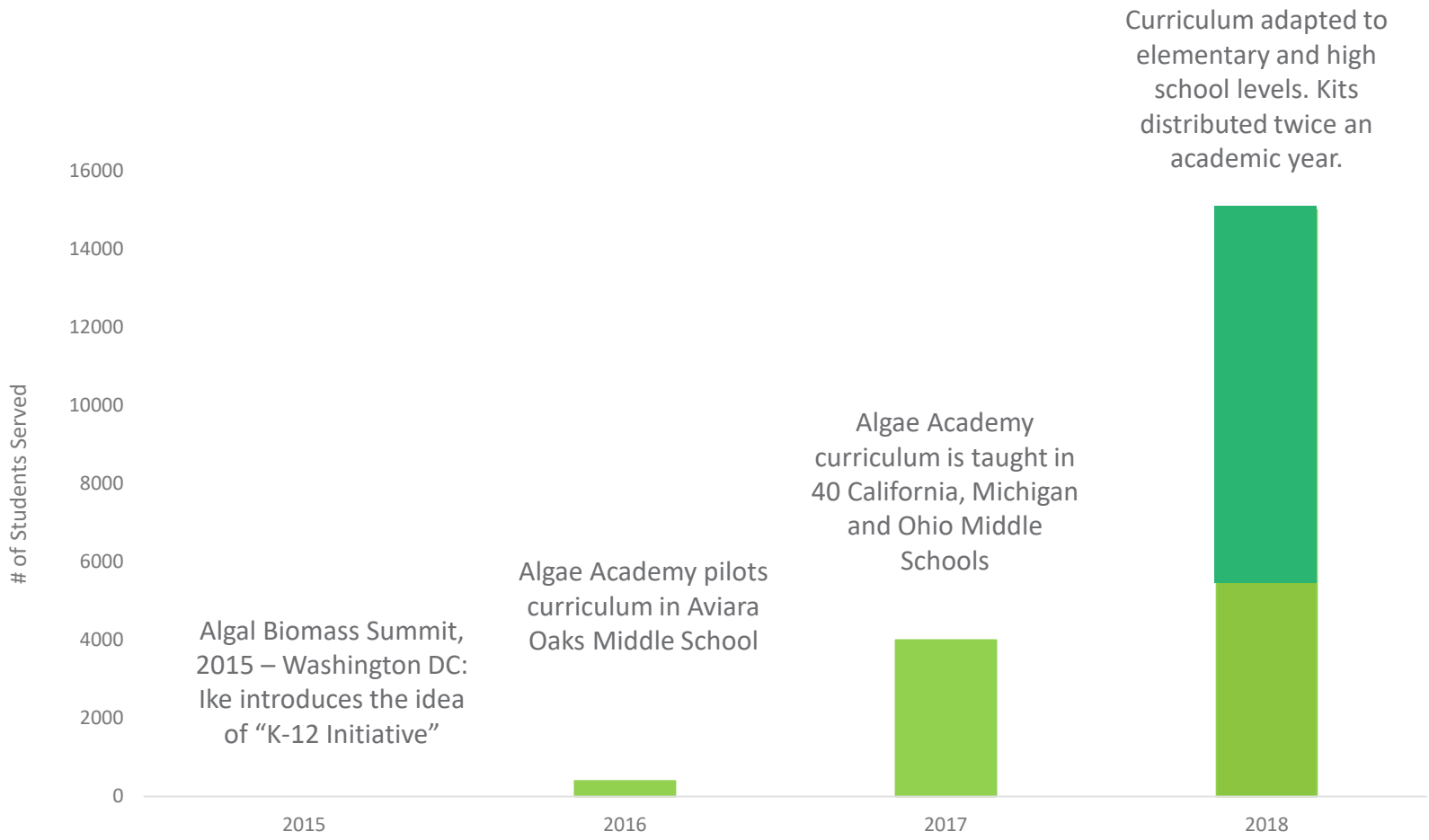
Algae Academy rollout
2017 ~5000 4th-11th grade students in CA, MI, OH
2018 ~ 20,000 students in CA, ME, MI, NM, OH, TX,



K-12 Initiative: The Kits and Curriculum

- 5-Day Curriculum
  - Uses of Algae
  - Cultivating Algae
  - Identifying Algae/Microscopy
  - Calculating Growth Rates
  - Algal Ecology & Environmental Extraction Services
- Kits are “drop-in” ready, delivered to the schools
- $250/kit – FREE to Schools
- 3-year Pledge

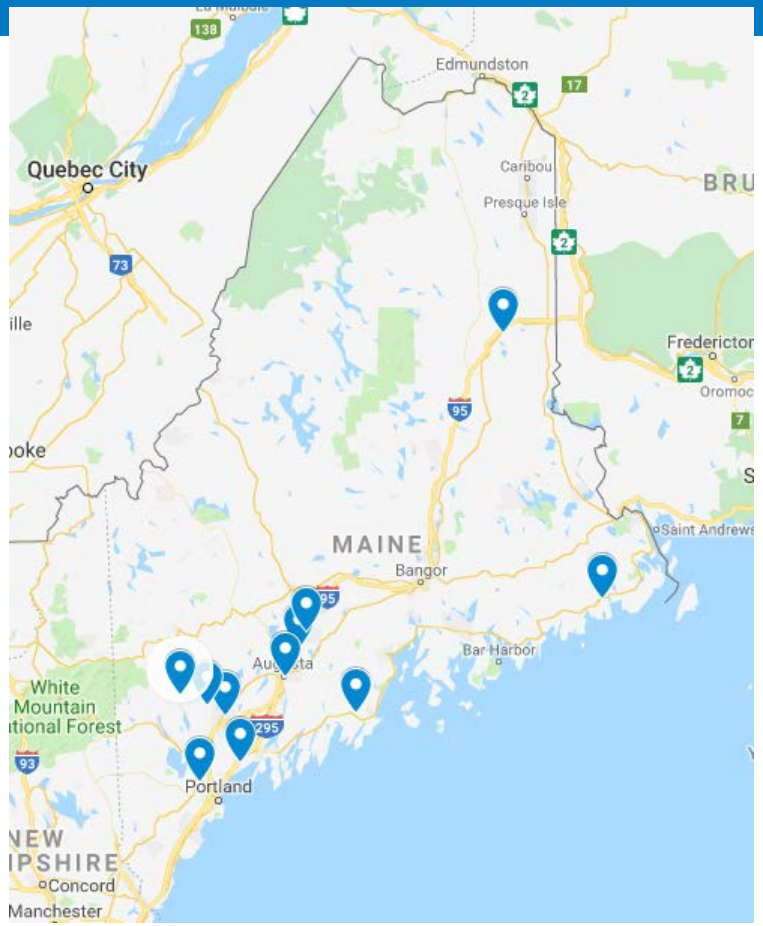
K-12 Initiative: History



Algae Academy

Maine's Algae Summer Science Institute

- 5-day Science Institute
  - 2.5 Days Teaching the Teachers
  - 2.5 Days Teachers Teaching Students
  - Plenary Presentations
- Hosted by the University of Southern Maine
- 14 Maine Teachers
  - 5th-11th Grade
  - Acquire 4 Continuing Education Units (CEUs)
- 12 Students at the Institute
- ~1800 students Fall 2018



Algae Academy

K-12 Initiative: Algae Summer Science Institute

Algae Summer Science Institute

Algae Academy & USM
July 2018
National Training 2019

Abbreviations and Acronyms

ABO – Algae Biomass Organization
ACC – Austin Community College
ACES – Algae Cultivation Extension Short-courses
ASU – Arizona State University
ATEC – Algae Technology Educational Consortium
BETO – Bioenergy Technologies Office
CC – Community College
DOE – Department of Energy
FY – Fiscal Year
MOOC – Massive Online Open Course
NOAA – National Oceanographic Atmospheric Administration
NREL – National Renewable Energy Laboratory
SFCC – Santa Fe Community College
STEM – Science, Technology, Engineering, and Mathematics
UCONN – University of Connecticut
UCSD – University of California, San Diego
US – United States
USM – University of Southern Maine
UTEX – University of Texas, Austin