

SESP: The State Energy Sector Partnership Program

The State Energy Sector Partnership Program (SESP) is a three year, six-million dollar American Recovery and Reinvestment Act (ARRA) grant awarded through the U.S. Department of Labor. The New Mexico Department of Workforce Solutions (NMDWS) administers the grant on behalf of the State Workforce Development Board (SWDB). Policy and oversight of the grant is the responsibility of the New Mexico Green Industry Council (GIC), which is a subcommittee of the SWDB

Training

A key goal of the SESP grant is to provide training in renewable energy/energy efficiency occupations that is responsive to business and worker needs. The New Mexico SESP grant has identified four priority industries for training workers to meet the needs of the state's green energy sector:

- Solar
- Wind
- Green Building/Energy Efficiency
- Biofuels

Training services are being provided through the State's local workforce development boards. If you are interested in finding out more about SESP training, visit <http://www.greenjobs.state.nm.us/sespEligb.html> or visit your local Workforce Connection Center. Your nearest Workforce Connection Center can be found by visiting <http://www.dws.state.nm.us/dws-offices.html>.

Additionally, in an effort to increase the capacity of the solar, wind, green building/energy efficiency and biofuels industry sectors, and to better meet the needs of existing and incoming businesses in New Mexico, NMDWS has awarded funds to four consortia of education providers, businesses, and workforce organizations to develop statewide "Centers of Excellence" programs. The purpose of these Centers of Excellence is to enhance and expand existing green sector training programs and develop new programs in emerging green industries. The funds will assist in the development and implementation of innovative collaborations between the business, workforce, economic development and educational systems.

Centers of Excellence

Biofuels Center of Excellence –

Santa Fe Community College – <http://biofuels.greentraining.sfcc.edu/>

Green Building/Energy Efficiency Center of Excellence –

Santa Fe Community College – <http://greenbuilding.greentraining.sfcc.edu/>

Solar Center of Excellence – Central New Mexico Community College –

<http://www.cnm.edu/campus/wtc/>

Wind Center of Excellence – Mesalands Community College –

<http://www.mesalands.edu/wind/default.htm>

Additional information about green jobs in New Mexico can be found at the NM Green Jobs Portal website www.greenjobs.state.nm.us

For more information about

- **Santa Fe Community College
Center of Excellence/Green Building & Energy Efficiency**

or

- **Central New Mexico Community College
Center of Excellence/Solar**

Go to <http://www.dws.state.nm.us/new/SESP/>

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Biofuels Center of Excellence (BCX)

Curriculum Overview

Purpose:

Provide classroom and laboratory training to workers/entrepreneurs entering Biofuels industry presented in one of four Biofuels modules: Algae; Biogas and Pyrolysis; Biodiesel; or Ethanol.

Provide health and safety training to workers/entrepreneurs entering the Biofuels industry.

Provide business plan, financing and marketing information to all BCX module trainings. Present potential workers/entrepreneurs with resource assessment tools for all Biofuels curriculum areas. Provide follow-up resources to students.

Objectives:

1. Provide required training necessary to issue Biofuels Center of Excellence Certification from the Santa Fe Community College to workers/entrepreneurs entering the Algae, Biogas and Pyrolysis, Biodiesel, or Ethanol Biofuels industry.
2. Provide required training necessary to issue OSHA General Industry Standards 10 hour Certification to workers entering the Biofuels industry.
3. Develop skills in Biodiesel production and laboratory testing methods necessary for analysis of biofuel and biofuel feed stock for optimum production potential.
4. Introduce potential employees/employers in the developing Biofuels industry to regulations applicable and resources available for fuel testing standards.
5. Introduce potential employees/employers in the developing Biofuels industry to regulations applicable and resources available for safety and health hazards.
6. Provide an overview of the history of the Biofuels industry and the current economics, opportunities and challenges of working in this emerging market for startup and existing corporate operations.

Course Description: Biofuels courses will be offered in classroom and laboratory format, simulating a hands on, work place environment of current Biofuels industry production facilities. Individual courses descriptions and hourly requirements as follows for each module in Algae; Biogas and Pyrolysis; Biodiesel; and Ethanol. Each module includes a prerequisite OSHA for Biofuels training class of 14.5 hours and a self contained Business Development component.

BCX Modules

OSHA 10 for Biofuels

Biomass Energy: Biogas & Gasification

Algae for Biofuels

Ethanol Production

Biodiesel Production

Business Development for Biofuels

Algae for Biofuels Module Overview

Purpose:

Provide Classroom and laboratory training to workers/entrepreneurs entering the Algae Biofuels industry.

Objectives:

1. Provide required training necessary to issue Biofuels Center of Excellence Certification from the Santa Fe Community College to workers/entrepreneurs entering the Algae Biofuels industry.
2. Provide information to potential employees/employers regarding large scale algal biomass production systems found in the Biofuels industry.
3. Develop skills in algal biological laboratory methods necessary to analyses and identify algal strains for optimum feedstock growth potential.
4. Introduce potential employees/employers in the developing Algae Biofuels industry to regulations applicable and resources available for safety and health hazards.
5. Provide an overview of the history of the algae industry and the current economics, opportunities and challenges of working in this emerging market for startup and existing corporate operations.

Course Description:

A minimum of 30 hours of classroom curriculum and lab training curriculum in 5 sessions. Classroom curriculum will include but not be limited to such topics as algae cell biology and physiology, lab experimental methodology, culture isolation, optimization and preservation, use of microscope, algae identification, design, maintenance and troubleshooting of photobioreactors, use of common analytical equipment, and economics of algae cultivation and marketing.

Applications for Algal Biofuel in Industry, Small Business, and Entrepreneurial Start-Ups

Algae have been one of the most important organisms on the planet for millions of years. Blue-Green algae are one of the most ancient organisms and are responsible for creating the Earth's atmosphere. The petroleum we use today is the result of planktonic algae having been compressed and heated deep underground for hundreds of millions of years. Despite their small size, algae can have huge impacts. For more than 30 years algae have been considered as a good source of renewable biofuel that can replace our dependence on a limited petroleum supply. Currently, research is being carried out which will achieve large-scale production of algal biomass to be used to create a variety of biofuels. This course is designed to provide students with a broad understanding of algal biomass production and common methods used.

This module introduces students to concepts and ideas that provide a framework for understanding algae biofuel and how it is developing as an industry. Algae are one of the best candidates for renewable biofuel. We will also cover a short history of research of algae for biofuel in the United States. The context here is demand for fuel and how that relates to interest in finding alternative fuels. The Aquatic Species Program conducted largely here in New Mexico, was the program that demonstrated that algae can be used successfully as a replacement for petroleum. Currently, funding is being provided and research and development carried out to achieve the goals of the National Algal Biofuels Technology Roadmap. As of 2012 a big push is occurring to make biofuel from algae a reality. This process is not simple, or it would already have been accomplished. There are many challenges to making algae biofuel happen, both technological and economic.

BCX Algae Module Learning Goals:

This course was developed to provide hands on training in the field of algae production for the workforce in the State of New Mexico. The Topics covered are broad and will establish a baseline of knowledge with which students can discover an area of work that suits their skills and interests. Topics include; algal physiology and ecology, biomass monitoring and economic analysis. Emphasis is placed on providing experience in the laboratory where students can practice new skills in a working environment. Students will design and carry out an experiment in algal biomass production and present their findings to the class.

BCX Algae Module Evaluation:

Student presentations need to consist of the following elements:

Description of experiment

- Goals
- Design
- Data Collection

Presentation of findings

- Graphs
- Tables
- Interpretations
- Recommendations

BCX Algae Module at a Glance: (syllabus)

	Lecture	Lab
Class I	Algal Biofuel Overview	Lab Tour, Economic Exercise, Algae Culture Demonstration
Class II	Algal Biology – Diversity and Ecology – Microscopy	Lab Etiquette and Safety, Microscopy - Wet mount viewing, Cell counts using a Hemacytometer, Algal Dry Weight Determination, Optical Density Measurement
Class III	Algal Biology – Physiology Culturing Measuring the Environment	Algal Biomass Monitoring Exercise, Environmental Monitoring Exercise, Algal Culturing
Class IV	Algal Biology – Experimentation	Design and Setup of Experiment and Data Collection
Class V	Large Scale Biomass Production	Demonstrations: NSE Bioreactor, Centrifugation; Continue Student Experiments
Class VI	Data Analysis – Presentation of Findings Course Conclusions	Present Student Experiments, Graphs, Tables, Interpretations

BCX Algae Module: Suggested Schedule

The curriculum is suited for two 3-day weekend workshop, meeting 5 hours a day with a lunch break

Day One (Friday)

Algal Biofuel Overview

Lecture hours required: 1.5 hours

Lab hours required: 3.5 hours

Day Two (Saturday)

Algal Biology –

Diversity and Ecology – Microscopy

Lecture hours required: 1 hour

Lab hours required: 4 hours

Day Three (Sunday)

Algal Biology – Physiology, Culturing, Measuring the Environment

Lecture hours required: 1 hour

Lab hours required: 4 hours

Day Four (2nd Friday)

Algal Biology – Experimentation

Lecture hours required: 0.75 hours

Lab hours required: 4.25 hours

Day Five (2nd Saturday):

Large Scale Biomass Production

Lecture hours required: 0.75 hours

Lab hours required: 4.25 hours

Day Six (2nd Sunday):

Data Analysis – Presentation of Findings, Course Conclusions

Lab hours required: 5 hours

BCX Algae Module Classroom Requirements:

Days: Suggested two 3-day weekend Laboratory workshops,

Hours: 6 a day (with a lunch break.)

6 x 5 hour classes in laboratory space

Space should include desks and chairs for a maximum of 20 seats, computer with Internet access for the instructor and a projector or screen for presentations and/or videos. Some classes may require electrical outlets and power strips for student laptop use.

Lab space for a maximum of 20 students with access to water and electrical connections and ventilation-- such as biology lab with hood or ventilation area and eye wash/ safety shower.

Algae for Biofuels lab activities may include use of Nutrient Ingredients for

- f/2: NaNO_3 , NaH_2PO_4 , $\text{Na}_2\text{SiO}_3 \cdot \text{H}_2\text{O}$, Trace Minerals, Vitamins;
- BBM: NaNO_3 , $\text{CaCl}_2 \cdot \text{H}_2\text{O}$, $\text{MgSO}_4 \cdot \text{H}_2\text{O}$, K_2HPO_4 , KH_2PO_4 , NaCl , Alkaline EDTA, Acidified Iron Solution, Boron Solution, Trace Metals , alcohol

Appropriate space for equipment to be safely operated.

- Autoclave
- Centrifuge
- Vertical 13 gallon photobioreactor
- Access to indoor/ outdoor space as required for larger equipment demonstrations.

BCX Algae Module

Hazard/Safety Overview: Equipment and Materials Requirements

Solutions used for this procedure are safe to handle as they are mixed in low concentrations. Make available nitrile gloves, eyewear and labcoats. Point out sinks, eyewash and shower.

Autoclave safety should consist of protective eyewear and autoclave gloves. Open the lid slowly and assume that everything is hot. Demonstrate proper use.

BCX Algae Module Materials List

Equipment required

- NSE Vertical Algae Growing System
- Centrifuge
- Spectrophotometer
 - Cuvettes
- Hemacytometers
 - Cover slips
- Microscopes: Phase optics
 - Camera
- Autoclave
 - Autoclave tape
 - Autoclave gloves
- pH meters
- DO meter
- Balances, second balance
- Drying oven
- CO₂ meter
- Pipetts: automatic, set
- Glassware: Volumetric flasks, Erlenmeyer flasks, culturing

- glassware, filter flasks, media bottles,
- Filter holders
- Vacuum
 - Vacuum tubing
- Dessicator
- Vortex
- Laminar Flow Hood

Supplies required

- Various Algae samples
- f/2 stock solutions
- Instant Ocean seawater
- DI water and squirt bottle
- Nutrient Ingredients for f/2: NaNO₃, NaH₂PO₄, Na₂SiO₃* H₂O, Trace Minerals, Vitamins; and BBM: NaNO₃, CaCl₂*H₂O, MgSO₄*H₂O, K₂HPO₄, KH₂PO₄, NaCl, Alkaline EDTA, Acidified Iron Solution, Boron Solution, Trace Metals Solution

- Microscope Slides
 - cover slips
- immersion oil
- Culturing
- Culture flask stoppers (Cotton, cheese cloth) , culturing flasks
- Alcohol
- Alcohol spray bottle
- Alcohol Lamps
- Dry weight Filters (47mm)
- Dry weight Weighting trays
- Kim wipes
- Parafilm
- Labeling tape
- Sharpies
- Aluminium foil

Materials

- Lab notebook
- Student Manual
- Teacher's Manual
- Data Sheets

BCX Algae Module

Equipment, Supplies and Materials needed for each lecture/lab:

Class I: Lecture and Lab I	Lecture: Algal Biofuel Overview	Student /Teacher Manual PowerPoint Slides (20 slides)
	Lab I: Techno-Economic Analysis. 2 Exercises	Student /Teacher Manual
Class II Lecture and Labs II-VI	Lecture: Algal Biology – Diversity and Ecology	Student Manual Teacher's Manual PowerPoint Slides (6 slides)
	Lab Procedure II (Exercise 1): Lab Etiquette and Safety	Lab notebook Student /Teacher Manual
	Lab Procedure III: Microscopy Exercise 1: Parts of a Microscope Exercise 1: Preparing a wet mount Exercise 1: Viewing a wet mount	Lab notebook Student /Teacher Manual Microscope, Microscope Slides cover slips, Vaseline Algae samples
	Lab Procedure IV: Cell Counts using a Neubauer Hemocytometer	Lab notebook Student /Teacher Manual Microscope, Hemacytometers cover slips, lens paper, formula provided with hemocytometer Algae samples, vortex or mixing plate, beaker, pipette
	Lab Procedure V: Algal Dry Weight Determination	Lab notebook Student /Teacher Manual Filter apparatus and holders *Vacuum Vacuum tubing 10-20 ml pipette

		Whatmen GFF filters (47mm) Aluminium Trays to hold filters beaker Dessicator *Drying oven Balance capable of 0.000g precision DI water in squirt bottle Vortex Algae sample *instructional manuals and personal protective equipment (ppe) for high heat
	Lab Procedure VI: Measuring Optical Density using a Spectrophotometer	Lab notebook Student /Teacher Manual *Spectrophotometer Cuvettes, DI water in squirt bottle, Algae samples, vortex or mixing plate, beaker, pipette *instructional manual
Class III Lecture and Labs VII, VIII	Lecture: Measuring the Environment	Student /Teacher Manual PowerPoint (5 slides)
	Lab Procedure VII: Exercise 1: Algal biomass Measurements Exercise 2: Environmental Monitoring	Lab notebook Student /Teacher Manual Algae samples, vortex or mixing plate, beaker, Pipette, DI water in squirt bottle <u>Cell Count:</u> Microscope, Hemacytometers cover slips, lens paper, formula provided with hemocytometer <u>Optical Density</u> *Spectrophotometer Cuvette <u>Dry Weight:</u> Filter apparatus and holders *Vacuum Vacuum tubing 10-20 ml pipette Whatmen GFF filters (47mm) Aluminium Trays to hold filters Gloves, tweezers for handling filters & trays Dessicator *Drying oven Balance capable of 0.000g precision Vortex *Vernier Unit and *Vernier Sensors: Salinity, pH, Dissolved Oxygen *instructional manuals and ppe for high heat
	Lab Procedure VIII Algal Culturing Exercise 1: Mixing 1 liter of f/2 Exercise 2: Mixing 1 liter of BBM Exercise 3: Transferring Algal Cultures	Lab notebook Student /Teacher Manual *Autoclave, Autoclave tape, Autoclave gloves <u>Nutrient Ingredients for f/2:</u> NaNO ₃ , NaH ₂ PO ₄ , Na ₂ SiO ₃ * H ₂ O, Trace Minerals, Vitamins <u>Nutrient Ingredients for BBM:</u> NaNO ₃ , CaCl ₂ *H ₂ O, MgSO ₄ *H ₂ O, K ₂ HPO ₄ , KH ₂ PO ₄ , NaCl, Alkaline EDTA, Acidified Iron Solution, Boron Solution, Trace Metals Solution 2 ml pipette 2 liter volumetric flask 2 liter media bottle Instant Ocean seawater (continued next pagea0 DI water Labeling tape (Exercise 3) Stock algae culture Sterile culture flasks with 50 ml growth medium and cotton plugs

	Lab Procedure VIII Algal Culturing (continued)	Labels *Laminar flow hood or sterile environment *Alcohol lamp, Spray bottle with alcohol Sterile pipettes Growing rack *instructional manuals and ppe for autoclave
Class IV Lecture and Lab IX	Lecture: Experimentation, Scientific Method, Testing a Hypothesis	Student /Teacher Manual PowerPoint (5 slides)
	Lab Procedure IX: Design and Setup of Experiment and Data Collection	Lab notebook Student /Teacher Manual Dependent on Design of Experiment All equipment, supplies and materials listed in Lab VIII should be made available
Class V Lecture Demonstrations, Lap IX (cont)	Lecture: Large Scale Algal Biomass Production	Student /Teacher Manual PowerPoint (5 slides)
	Demonstration: NSE Bioreactor	Lab notebook Student /Teacher Manual Various NSE Bioreactors depending on availability
	Demonstration: Centrifugation	Lab notebook Student /Teacher Manual Centrifuge Stock algae culture *instructional manuals and ppe for centrifuge
	Lab Procedure: Continue Student Experiments	Lab notebook Student /Teacher Manual Dependent on Design of Experiment All equipment, supplies and materials listed in Lab VIII should be made available including proper instructional manuals and ppe
Class VI Lecture Lab: Experiment Presentations	Lab Procedure: Data Analysis, Presentation of Findings	Lab notebook Student /Teacher Manual Student Presentations
	Lecture: Course Conclusions	Lab notebook Student /Teacher Manual Student Presentations

BCX Algae Module References and Additional Material

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- Raven, P. H., R. F. Evert, S. E. Eichhorn. eds. 1999. Biology of plants. 6th ed. W. H. Freeman and Company/Worth Publishers: New York, New York.
- Richmond, A. ed. 2004. Handbook of microalgal culture: biotechnology and applied phycology. Blackwell Science Ltd: Oxford.
- Stein, J. R. ed. 1973. Handbook of phycological methods: culture methods and growth measurements. Cambridge University Press: Cambridge.
- Wehr, J. D. and R. G. Sheath. eds. 2003. Freshwater algae of North America: ecology and classification. Academic Press: Amsterdam.

Introduction to Lab Procedures

Exercise 1: Lab Etiquette and Safety

- Keep your workspace clean.
- No eating or drinking in laboratory space.
- Keep aisles clear of chairs, equipment and personal items.
- Always leave workspace and equipment clean and stored properly for the next persons use.
- Do not put chemicals or trash down the sinks.
- Follow instructions and procedures when using equipment.
- Do not interfere with other's work or experiments.
- Take your time when working.
- Follow safety standards for fire safety, chemical safety and equipment safety.
- Place broken glass or sharp wastes in designated waste container.
- Know where safety equipment is located and how to use it.

Observe these guidelines to help ensure that the lab is a safe and enjoyable environment to work in.

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