Interdisciplinary, Research-based Bioenergy Minor at Oregon State University (OSU)

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Oregon State University

Funded by a USDA-NIFA grant

Part of the AHB Bioenergy Education Pipeline

- Family and Community Programming
- Pre-College Programs
- Community and Technical College Workforce Development
- Bioenergy College Transition Program
- Undergraduate Bioenergy Education
- Masters-level Programs

The US needs sustainable alternatives to fossil fuels

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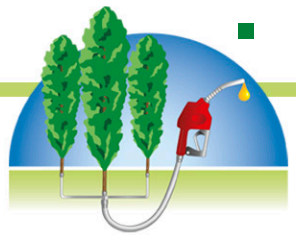
One of four vitally important, complex societal problems ranked by the National Research Council as:

- *having potentially large rewards,*
- *able to inspire people and drive scientific advances, and*
- *amenable to **multidisciplinary approaches**.*

NRC, Committee on a New Biology, 2009

Achieving the nation's bioenergy goals could produce:

- *new jobs in a revitalized rural and agricultural economy,*
- *increased energy independence, and*
- *a reduction in global warming*



A variety of skills will be needed to develop a sustainable energy economy

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- discovery science,
- feedstock development and production,
- logistics,
- pilot-scale and commercial-scale industrial conversion,
- business and marketing,
- social sciences,
- ***The ability to integrate skills and work in multidisciplinary teams to create innovative approaches***

We designed OSU's Bioenergy Minor to address the need for sustainable energy

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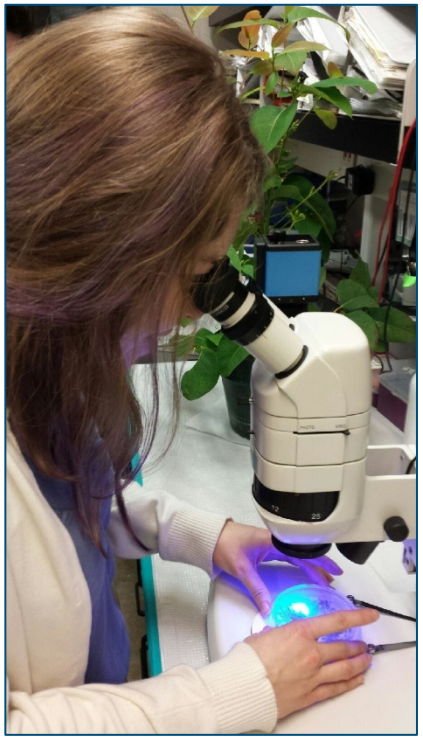

Our program outcome is to produce:

Broadly-trained graduates capable of cross-disciplinary problem solving and innovation to meet current and future needs of the biofuels, bioproducts, renewable energy and related industries

The Bioenergy Minor is based on a successful existing research-based major, BioResource Research (BRR)

Oregon State University OSU College of Agricultural Sciences

- 22-year-old interdisciplinary major in OSU's College of Agricultural Sciences
- 14-credit, 2 year research project, thesis and public seminar
- High 6-year graduation rate
- Good placement of students into jobs, graduate and professional programs

Inputs into the Bioenergy Minor include core concepts and knowledge, skills

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INPUTS:

Sustainability

Energy Policy

Energy fundamentals → **Core Concepts and knowledge** ← Feedstocks and Conversion

PROGRAM OUTCOME: Graduates capable of cross-disciplinary problem solving and innovation to meet current and future needs of biofuels, bioproducts, renewable energy and related industries

Cross-disciplinary collaboration → **Skills training** ← Project management

Communication

Research

INPUTS:

Inputs of the Bioenergy Minor include core concepts and knowledge, and skills

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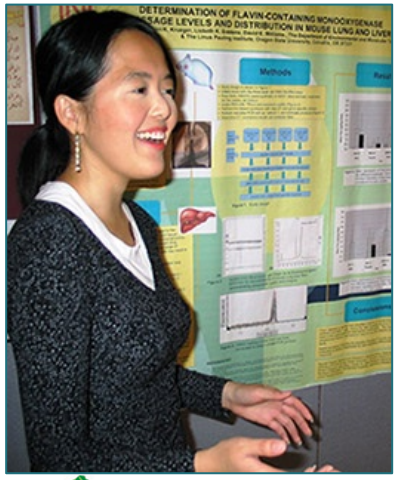

INPUTS:

Core concepts and knowledge: largely from courses

- Energy fundamentals
- Feedstocks
- Conversion
- Sustainability
- Energy Policy
- Business and Innovation

Skills: largely from research project, thesis, seminar

- Analysis, problem solving, critical thinking
- Project management
- Cross-disciplinary collaboration, teamwork
- Communication

Bioenergy Minor Overview

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- Interdisciplinary, 29-credit, research-based **Bioenergy Minor** just finished its second year
  - Open to students from any major
  - With USDA-NIFA funding, we provide Bioenergy Scholarships as incentives
- New courses (but mostly takes advantage of existing courses)
- Student Learning Center and advisor offices

Bioenergy Minor Requirements
(29 credits)

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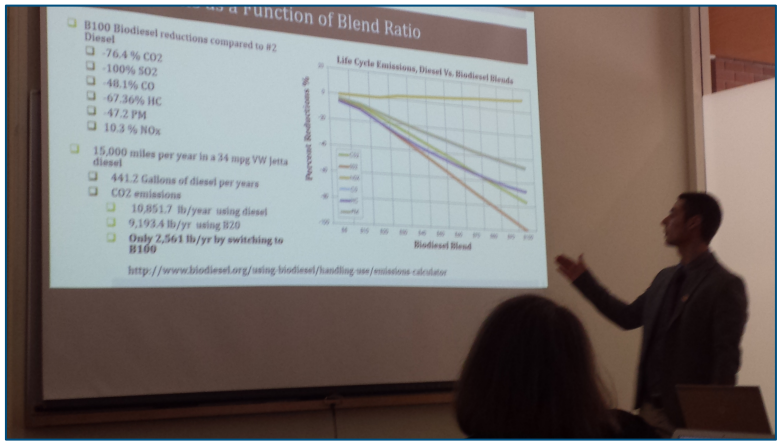
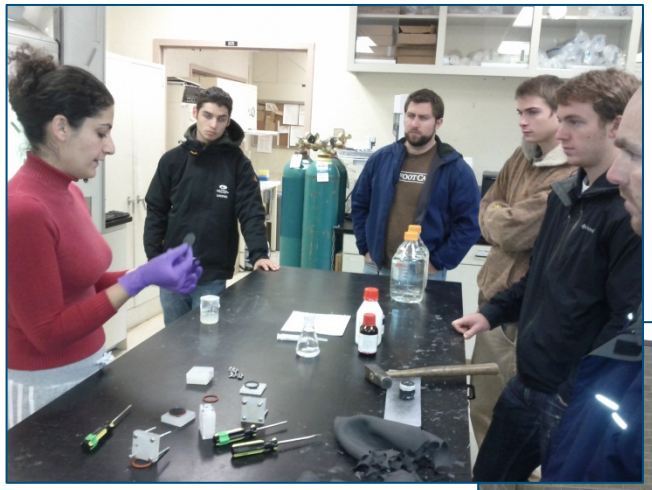
- **1st-year core**:
  - Introduction to Regional Bioenergy (BRR 350; Fall, 2 credits)
  - Introduction to Bioenergy Research (BRR 450; Winter, 2 credits)
  - Bioenergy and Environmental Impact (WSE 473; Spring, 3 credits)
- **Electives** from 3 categories (2-4 credits each):
  - Technical
  - Environmental
  - Social/Economic/Policy
- **Research** (10 credits) with a mentor
- **Thesis** (3 credits)
- **Public Seminar** (1 credit)



Introduction to Regional Bioenergy:
Course Highlights

- Bioenergy Core Concepts
  (Energy fundamentals, Feedstocks, Conversion, Sustainability, Energy Policy, Business and Innovation)
- Multidisciplinary Team Projects
- Field Trips to Bioenergy sites:
  - Pacific Biodiesel
  - GreenWood Resources
  - Corvallis Wastewater Treatment Plant
  - Coffin Butte Landfill
  - Stahlbush Farm (anaerobic digester)



Introduction to Bioenergy Research:
Course Highlights

- Research Concepts
- Students Analyze Guest Lectures by Researchers
- Proposal Writing
- Field Trips to Research Sites:
  - Liu Microbial Fuel Cell Lab
  - Strauss transgenic poplar lab

Undergraduate Research:

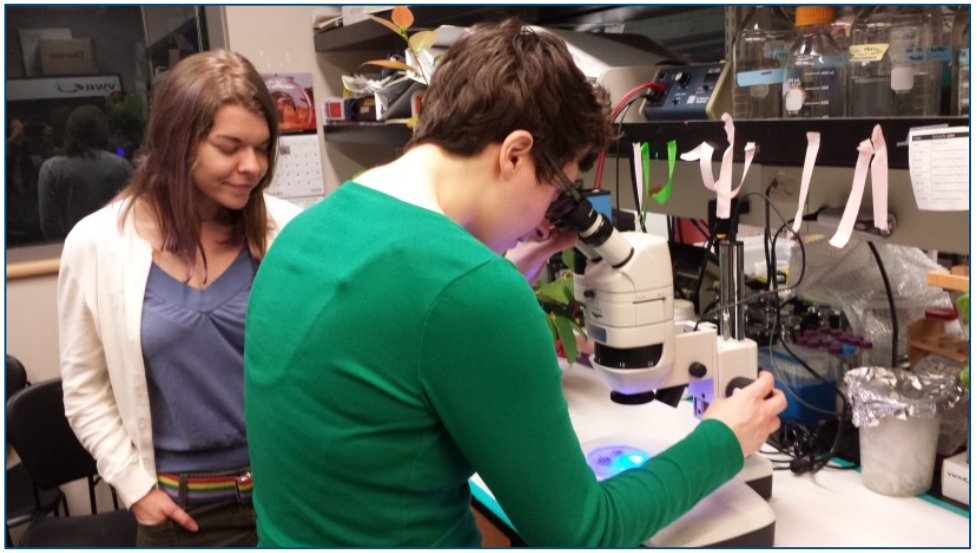
Involves:

- Reading appropriate literature
- Asking a researchable question
- Designing some part of the project
- Using reproducible research techniques
- Communicating significant findings orally and in writing

Student Gains:

- **Increased self-efficacy**
- Ability to work both **independently** and as **part of a team**
- **Critical thinking** and **problem solving**
- **Professional skills**:
  - project management,
  - organization,
  - communication,
  - networking
- **Technical skills**
- Clarification and enhanced **preparation for career and/or graduate school goals**

Examples of Undergraduate Research Projects



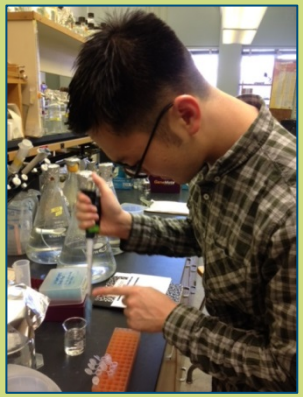
Shanti Johnson, Chemical Engineering

Research: Investigating ways to lower the cloud point of biodiesel so it can be used at lower temperatures without gelling

Crystal Oldfield, BioResource Research

Research: Extracting tannins & lignin from pecan shells

Bioenergy Student Profiles



- **Brian Dougherty**, Ecological Engineering major (College of Engineering). Researching biochar; novel applications to manure management.
- **Charlie Ta**, BioResource Research/ Microbiology double major (Colleges of Science and Ag Science). Researching nitrifying bacteria to improve modeling capabilities for implementation.
- **Sam Delano**, Renewable Materials major (College of Forestry). Researching potential applications of anaerobic digesters for hops growers.

Sean Atkins, OSU Senior, Bioengineering Major & Bioenergy Minor, 2012-2014 Bioenergy scholarship recipient

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- SMILE Program Bioenergy Teacher Workshop Summer 2013
- Bioenergy Summer Bridge Program mentor Summer 2013
- Completing research project Spring and Summer 2014

What drew me to the program?

- Undergraduate research in a field related to Bioengineering
- Introduction into a growing industry from the Northwest
- Multidisciplinary program

Recruitment and Incentives

Students:

- Scholarships ($1000-4000/year)
- Internship funding (up to $4000 total)

Research Mentors: $1000 per student per year to help offset the cost of research

Faculty: Summer funding for developing and teaching courses

Graduate Students: Teaching assistantships

Assessment

Oregon State University

Assessment Team: Darlene Russ-Eft, Laia Robichaux, Micki Halsey Randall

- **Surveys initiated at the end of Year 2**
  - Based on specific objectives and learning outcomes
  - Enable us to modify and improve program
  - Changes already made to track changing bioenergy landscape

What our students say:

Oregon State University

Describe three strengths of the Bioenergy minor program:

- It is very interdisciplinary, which will be critical for solving energy production issues in the future.
- There is a lot of flexibility to study our own areas of interest which is great. I would not participate if I had to limit my research to only one type of bioenergy production (only cellulosic biomass for example). The list of electives is extensive and allows us to learn about the areas we feel are most important.
- The minor is research based which allows us to get experience with doing a research project without or prior to going to grad school.

What our students say:

Oregon State University

Describe three strengths of the Bioenergy minor program:

- The number one strength would be its focus on research in a new and exciting area.
- Another would be its ability to reach out and connect mentors with students for various opportunities.
- Lastly would be due to it being so new it has the ability to be flexible with other minors and/or majors in regards to scheduling and formalities.

What our students say:

Oregon State University

Describe three strengths of the Bioenergy minor program:

- Fostering of interest in Bioenergy and retrofitting of common technology for the bioenergy industry
- Provide survey of the many industries in which bioenergy has applications and effects
- Networking and increased confidence level in the ability to communicate complex ideas, current technologies, and vast implications of sustainability and bioenergy.

What our students say:

Oregon State University

Describe three strengths of the Bioenergy minor program:

- The program is diverse,
- allows for multidisciplinary projects, and
- provides education in research techniques that I might not get out of my major program.

Common Themes:

- **interdisciplinary**
- **research**
- **flexible; students can tailor the program to suit their interests**

Ongoing Work and Future Plans

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- Convert current and future classes to **Ecampus.**
- **Enlarge scope** to add energy components to more programs
- **Delphi study**: interview experts on essential concepts and framework for Bioenergy education; compare input from industry and academia (Kimi Gryzb PhD project)
- **Assessment:** Finish interviews and surveys, data analysis, feedback
- **Communication**: Regional and national presentations and publications; meetings with community colleges; articulation

Ecampus class example:

FUNDAMENTALS OF CONVERSION

What are the common denominators?

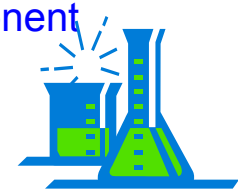
Part of a lesson from *Introduction to Bioenergy* Ecampus course. Each 20-minute lesson will be both part of an Ecampus course for credit, and available independently on OSU's open access web site.

Thermal

1. Combustion
2. Gasification
3. Pyrolysis & Liquefaction

Chemical

1. Biomass breakdown to components
2. Biomass component conversion
3. Oil & Syngas conversion



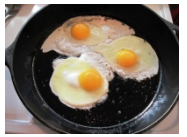
Biological

1. Fermentation: microbes without oxygen
2. All other microbes, plants, animals, generating products

Mechanical

1. Crushing, shredding, pressing and densification
2. Separations, sorting

Everyday Examples



Cooking food is a thermal conversion

Eating and digesting food is a chemical conversion

Olive oil and vinegar are biological conversion products

Recycling is separating and sorting

Thank you!

We are grateful for funding from USDA-NIFA:

“System For Advanced Biofuels Production From Woody Biomass In The Pacific Northwest”.

Regional Approaches to Sustainable Bioenergy
Regional Coordinated Agricultural Project (CAP)