

*Growing the Nation's
Bioeconomy Through Science*



Sustainable Development

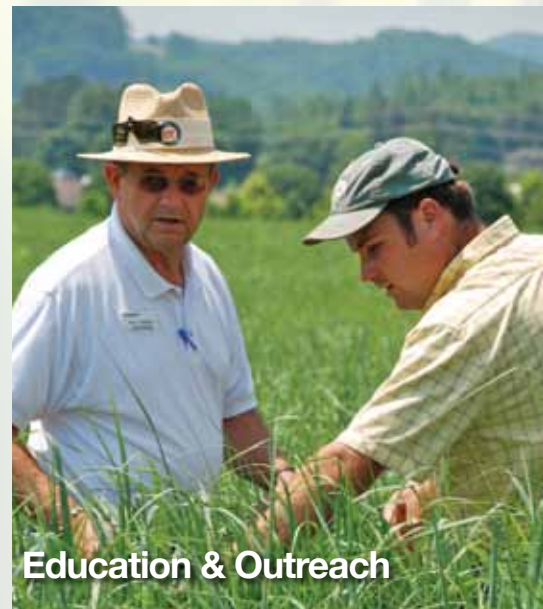


Feedstock Development



Pre-Processing






 SunGrant
INITIATIVE



Why Bioenergy?



We need energy. We need energy to turn on the lights. We need energy to fuel our cars, to move our planes, our ships, and our trains. We need energy to warm and cool our homes. As each day passes, we seem to need more and more. For this energy to be of any use, we have to be able to afford it. The energy we develop has to be here not only today, but also tomorrow and the day after that so we have to also protect and nurture our environment.

To Meet Our Nation's Energy Needs

The simple fact is that the amount of energy we can obtain through domestic oil production is leveling off and even declining while the amount of oil that we consume continues to grow. The dramatic gap between what we consume and what we produce means that we have to import oil and energy from other countries. Importing oil costs the U.S. dollars and jobs, contributes a great deal to our national debt, and makes us dependent on other nations. While bioenergy is not likely to meet all of our energy needs, it can play a critical role in providing high-energy liquid transportation fuels that now come only from a barrel of oil. The production of biofuels and biopower can help counterbalance increasingly volatile oil prices and help to stabilize international energy markets.

To Support Our Farms and Forests

One of the great things about bioenergy is that we grow it here at home. Plants capture and store energy from the sun. We harvest the plants and plant wastes to release the stored energy in forms we can use. This can provide new sources of income to farmers, ranchers and foresters.

To Support Our Rural Communities

In addition to providing new sources of income to agricultural and forest producers, developing bioenergy means more jobs in rural communities. It costs too much to move wet plant material very far before it is converted to lighter material with a higher concentration of energy. This means that smaller processing facilities can be deployed across the countryside instead of only using very large and centralized conversion and processing systems. The capital for building facilities and the jobs that are created can therefore be kept in rural communities.

To Protect and Sustain the Environment

Another benefit bioenergy is that it can be developed in ways that better protect the environment. When fossil fuels are burned, carbon is added to the atmosphere. Plants take carbon out of the air so that there is a cycle: carbon is released into the environment, but the plants also take it back up. While there are great opportunities to develop bioenergy in ways that better sustain the environment, some pathways are better than others. Bioenergy has to be developed thoughtfully and carefully in order to capture real benefits to the environment, and at the same time, make sure the bioenergy that we need to heat our homes is not competing with the food that we also need to be producing.

To Make it Work: A New Approach to Science

There are great opportunities provided by the development of bioenergy, but we need to move quickly if we are going to meet the need. There are real technical, scientific, and economic challenges to work through. One of the challenges of developing bioenergy is that the biomass feedstock (the plant material used for bioenergy production) varies greatly from one region of the country to another. Biomass research needs to be organized on a regional scale. Another challenge to bioenergy is the need to solve several problems simultaneously. Bioenergy research has to be organized to take a comprehensive and "systems" approach to the complete bioenergy production chain. To meet the challenge, new levels of collaboration will be needed between academics, the national laboratories, federal and state agencies, the private sector and public interest groups.



Sun Grant Initiative



Regional Solutions

Biomass is regional. Agricultural and forest crops are different from one region of the country to another because of differences in climate, soil types and natural vegetation. In the same way, the biomass products produced as "feedstocks" for bioenergy are also shaped by regional conditions. To best respond to these environmental and local resource differences, the Sun Grant Initiative organizes the nation's land-grant universities into five biogeographic regions. There is a lead Sun Grant Center in each of the five Sun Grant regions to facilitate and provide leadership for the development of regional biomass research. The Sun Grant Centers are located at the following universities.

- North Central: South Dakota State University
- Northeast: Cornell University
- South Central: Oklahoma State University
- Southeast: University of Tennessee
- West: Oregon State University
 - Pacific Subcenter: University of Hawaii

Because of the geographic uniqueness and relative distances from the mainland, a Pacific Subcenter has been developed in the West at the University of Hawaii to work with Alaska and the U.S. Territories in the Pacific. Each Center enhances its research efforts in bioenergy and bioproducts, and administers a regional competitive grants program to land-grant institutions. Multidisciplinary and multistate projects are emphasized. The Sun Grant Centers form an association to coordinate their respective efforts and to share their research results nationally.

Concept

The Sun Grant Initiative is a national network of land-grant universities and national laboratories partnering to help build a bio-based economy. Land-grant universities have over 150 years of experience in agricultural and natural resource research, with a network of field-based research sites in every major biogeographic zone in every state and territory of the country. The land-grants have a unique tradition of sharing the results of their research by working with farmers, ranchers and foresters through extension outreach in the community and classroom education efforts. The Sun Grant Initiative builds on this successful history and harnesses the land-grant network to tackle the new challenges of developing bio-based transportation fuels, biopower, and new bio-based products. The Sun Grant Initiative facilitates communication and partnership development between universities, national laboratories, federal and state governments, the private sector and public interest groups.

Mission

Through development, distribution, and implementation of bio-based energy technologies, the Sun Grant Initiative will:

- Enhance national energy security.
- Provide opportunities for rural economic development in America's traditional agricultural communities.
- Promote environmentally sustainable and diversified production opportunities for agricultural and forestry resources.
- Encourage further bioenergy research collaboration between government agencies and land-grant colleges and universities.

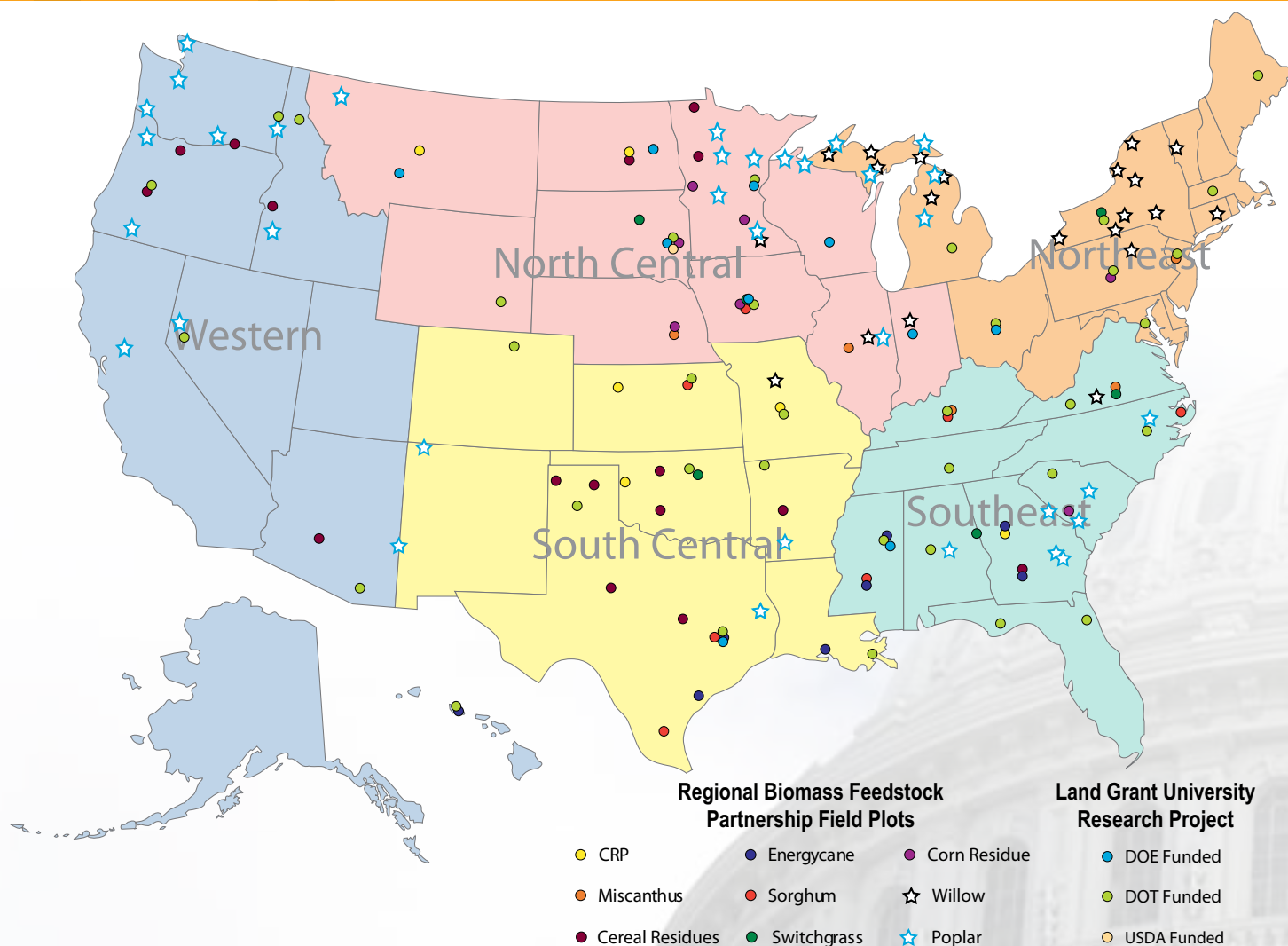
Establishment

Congress authorized the Sun Grant Initiative in the 2002 and 2008 Farm Bills. Sun Grant efforts are supported with funds from the U.S. Departments of Energy, Agriculture and Transportation.



Sun Grant-Supported Research

Over 130 projects on the ground with work underway in 90% of the states



Solving national challenges at the regional and local level with support for science from our federal partners.



United States Department of Transportation



United States Department of Energy

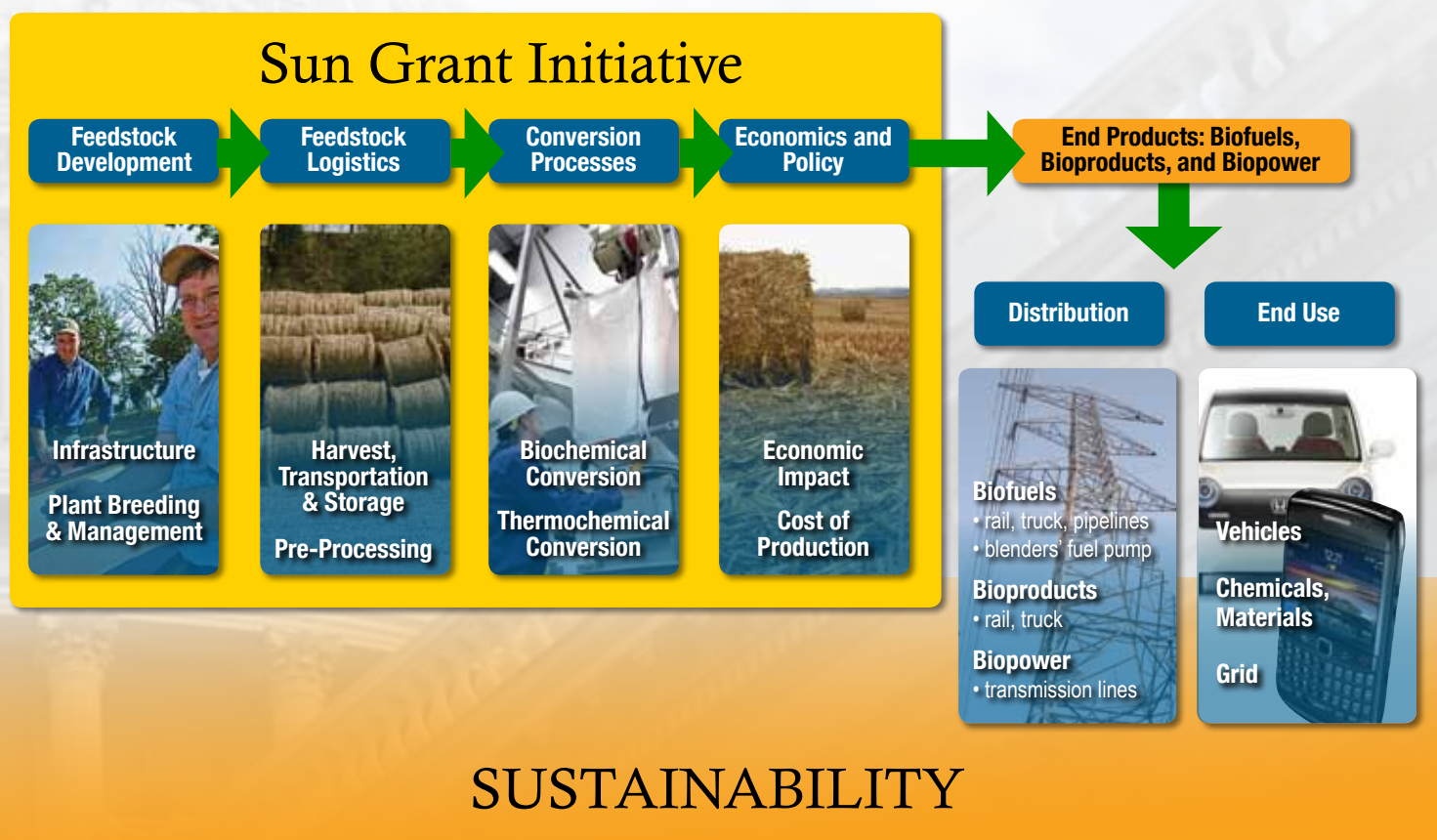


United States Department of Agriculture

A University-Federal Partnership

The federal agencies are tasked with addressing issues of national concern, but the development of bio-based energy and bioproducts requires an in-depth knowledge of each region's biogeographic conditions and local resources. Partnering with the Sun Grant Initiative provides the federal agencies with access to the regional and local expertise of the land-grant university research and outreach networks. Through this university-federal agency partnership, national priorities for bioenergy and bioproduct research and development are addressed at the regional and site-specific levels where the challenges can really be resolved.

The Sun Grant Initiative works with each federal agency to help address their respective missions and priorities in the development of bioenergy and bioproducts. The Department of Energy (DOE) collaborates with the Sun Grant Initiative to focus on the early assessment of bioenergy feedstock options and the initial testing of feedstock production potentials, as well as the logistics of preparing these feedstocks for conversion. Working with the Department of Agriculture (USDA), the Sun Grant Initiative is looking at how to ramp up the production of biomass feedstock production in ways that are sustainable and that do not compete with food production. Building on these efforts with feedstocks and logistics, the Sun Grant Initiative has teamed up with the Department of Transportation (DOT) to support the development of renewable bio-based transportation fuels.



In its collaboration with federal partners, the Sun Grant Initiative addresses the complete bioenergy production chain, building from its unique ability to address biomass feedstock development at the regional level, to developing new technologies to support the logistics of preparing and moving feedstocks, to supporting the development of new conversion technologies.



Sustainable Bioenergy Feedstock Development:



A Sun Grant/DOE Collaboration



Feedstock Development

Projections have been made that approximately 1.3 billion tons of cellulosic biomass could be available annually in the United States for the production of alternative liquid fuels, chemicals and power. To explore this possibility, the Department of Energy and the Sun Grant Initiative formed the Regional Feedstock Partnership. Each of the five Sun Grant regions conducted workshops with experts from academia, the national laboratories, federal and state governments, the private sector and public interest groups. In each region, the potential production of diverse biomass feedstocks was evaluated, obstacles and knowledge gaps were considered, and research needs and priorities were identified. Teams of the nation's leading scientists were then formed to further assess biomass feedstock potentials, to initiate field trials of the most promising options at the regional and national level, and to estimate and begin enhancing the nation's bioenergy production potential through the findings from this research and other data.



Crop Residue

- **Sun Grant Lead:**

Oklahoma State University
Oregon State University

- **Agency Lead:**

Department of Energy-
Idaho National Laboratory;
Department of Agriculture



Herbaceous Crops

- **Sun Grant Lead:**

South Dakota State University

- **Agency Lead:**

Department of Energy-
Idaho National Laboratory;
Department of Agriculture



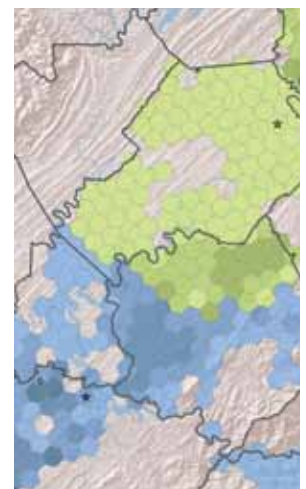
Wood Resources

- **Sun Grant Lead:**

The University of Tennessee

- **Agency Lead:**

Oak Ridge National Laboratory;
Department of Agriculture



GIS

- **Sun Grant Lead:**

Cornell University

- **Agency Lead:**

Oak Ridge National
Laboratory; Department
of Energy

Logistics

Continuing with the work of the biomass feedstock production and assessment teams, the Sun Grant Initiative works with DOE and the national labs to consider how biomass feedstocks can be best prepared to be moved from the field to conversion facilities. From "pre-processing" the biomass at the harvest site to reduce moisture and weight to mechanical, chemical and enzymatic preparations, the challenge is to develop the most cost-effective approaches for preparing feedstocks for conversion to fuel.

Sustainable Feedstock Development:



Building on the early assessment of biomass feedstocks developed with DOE through the Regional Feedstock Partnership, the Sun Grant Initiative is working with USDA to implement a national program of regional competitive grants to help ramp up the sustainable production of bioenergy feedstocks. Each Sun Grant Center has looked carefully at the USDA's feedstock production priorities and considered how to best support its goals in the context of their respective regions. The Sun Grant's regional competitive grants program has been designed to augment and complement other activities underway at USDA.

Large-Scale Field-Based Research

The DOE-Sun Grant Regional Feedstock Partnership has focused on eight feedstock systems that can be readily used in large volume production. The USDA-Sun Grant projects will leverage this work by ramping up to larger field-scale research in more locations and encompass feedstocks that have not been sufficiently addressed, most notably woody materials and waste materials. Large-scale field research is essential to assure potential processors that large volumes of feedstock can be produced consistently. Studies of this scale are also essential in order to assess life-cycle inventories and potential environmental impacts of feedstock production.

Diverse and Distributed Feedstocks

A singular solution to feedstock production is not the answer to sustainable feedstock production in any region. The Sun Grant projects will investigate a wider array of emerging bioenergy feedstocks that fit within USDA National Institute of Food and Agriculture (NIFA) priorities, including those with greater potential for supporting decentralized energy production opportunities and greater potential for economic development in rural communities.

Life Cycle Analysis and Sustainability

There has been some concern that the production of bioenergy feedstocks may displace the production of food crops and increase the price of food at the grocery store. Related concerns have been expressed that changing biomass production in the U.S. may impact production elsewhere in the world that can have indirect but harmful impacts on the global environment. The Sun Grant Initiative is supporting work on "Life Cycle Analysis" and "Industrial Ecology," which look at world's complex agricultural production and distribution systems to evaluate how bioenergy can be developed in ways that do not negatively impact food prices or the environment.



Industrial Ecology Project

Working with the U.S. Department of Agriculture, the Sun Grant Regional Centers are seeking to bring an industrial ecology framework to the development of agricultural-based biofuels and bioproducts systems by developing a database that captures the non-linear behavior of capacity in three core subsystems of biomass utilization: feedstock production, feedstock logistics and feedstock conversion. The Sun Grant Initiative is developing an interactive input/output modeling method for structuring and analyzing agricultural-based biofuels and bioproducts systems.

The database model will be an important step in realizing the vision of a fully integrated systems approach to bioenergy production. The Sun Grant Regional Centers are collecting detailed information on various aspects of the three subsystems. This information is necessary to conduct a whole life cycle analysis of various production systems in the different regions of the country. Each Sun Grant Regional Center will be generating a subset of the technology coefficients database, as well as capital, operating, and energy cost functions.

- The Western Regional Sun Grant Center at Oregon State University is focusing its efforts on the production and pre-treatment processing of grass and cereal grain straws.
- The South Central Regional Sun Grant Center at Oklahoma State University is providing data on production, handling logistics, and conversion of the four feedstocks identified in their Regional Feedstock Workshop, of which sorghum and switchgrass were the top candidates.
- The Southeastern Regional Sun Grant Center at the University of Tennessee is collecting data on the conversion of 750 acres of land from its current use to switchgrass biomass production. The data set includes production inputs and a detailed account of carbon balance.
- The North Central Regional Sun Grant Center at South Dakota State University is focusing its efforts on the feedstock conversion subsystem and the impacts of the end use of biochar on the carbon status of biofuels and bioproducts.
- The Northeast Regional Sun Grant Center at Cornell University is developing the simulation framework and input/output modeling. It is also collecting data for technology coefficients and energy/monetary cost functions associated with aqueous pretreatments.





Renewable Transportation Fuels



A Sun Grant/DOT Collaboration



Working with the Sun Grant Initiative, the Department of Transportation Research and Innovative Technology Administration (RITA) convened a team of federal agency specialists to identify the nation's leading research priorities to be addressed in order to develop renewable bio-based transportation fuels. DOT took a comprehensive "systems" approach, looking at the total bioenergy production process from feedstock development and logistics through conversion processes. DOT also looked at crosscutting issues, such as examining ways to produce and process bio-based transportation fuels to minimize the impacts of the transportation sector on the environment. To address these national research priorities in their regional and local contexts, with support from DOT, the Sun Grant Initiative has developed and implemented a national program of peer-reviewed regional competitive grants to conduct research on the development of bio-based transportation fuels.



Feedstock Development

- Plant Breeding
- Agronomic Management
- Sustainable Production
- Equipment Technology



Logistics

- Feedstock Production
- Harvest, Delivery, and Storage
- Transportation
- Pre-Processing



Conversion Processes

- Conversion Technologies
- Cost of Production
- Biological Conversion
- Thermochemical Conversion



Systems Analysis

- Industrial Ecology
- Feedstock Transport
- Biofuels Transport
- Delivery Infrastructure



Economics, Marketing and Policy

- Economics and Policy
- Impact on Food, Feed, and Fiber Markets
- Economic Return
- Production Economics



Environmental Impacts

- Life Cycle Analysis
- Greenhouse Gas Emissions
- Carbon and Energy Balance
- NOX Emissions

For More Information:
Email info@sungrant.org or visit www.sungrant.org

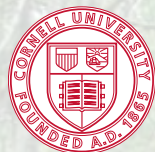
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Education and Outreach: Bioweb

The body of knowledge around biomass conversion for energy, fuels, and chemicals is extensive. However, its value is limited because information appears in diverse outlets and formats. The BioWeb project aims to consolidate that knowledge into a single location and a common format, effectively providing a central home for bioenergy and bioproducts information. Incorporating over 200 topical areas to date, BioWeb relies on several fundamental principles that make the product unique, including the following:

- Content is provided by leading scientists, and undergoes peer review for accuracy.
- Content is edited for readability, as well as consistent structure and feel.
- Three levels of detail are provided to increase appeal to a broader audience.
- Extensive search capability is available for refined information access.
- Content is updated and expanded to remain current.

Experience BioWeb by visiting bioweb.sungrant.org. Get involved with this endeavor by volunteering input.

