

MIDDLE SCHOOL
CURRICULUM

SOY SAVVY

NITROGEN FIXATION
& SOYBEANS

NITROGEN FIXATION & SOYBEANS



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I. Enduring Knowledge:

Because soybeans are a very important crop in the economy of Wisconsin, students will know that they are not only a food source for animals and humans, but that they play a vital role in preserving the valuable soil.

Learning Targets:

1. Students will know the role that George Washington Carver played in revolutionizing agriculture in the United States.
2. Students will know how nitrogen fixation serves to ensure and enhance the productivity of soil.

II. Teacher Background Materials:

George Washington Carver, world-renowned botanist and inventor, rose out of slavery and revolutionized the agricultural economy of the South. In the late 1890s, the soil in Alabama was becoming depleted because the same crop, cotton, was being raised in the same fields year after year. The fields became dry and brown and could no longer sustain crops. Dust filled the air as soil blew away because of erosion. Many white farmers moved west to farm new land, and the emancipated slaves were left to farm the depleted land.

After Carver earned a Masters Degree in bacterial botany and agriculture, he began working at Tuskegee Institute where he conducted a series of experiments to figure out a way to enrich the South's nutrient-depleted soil. He wondered if crop rotation might hold a key. He knew that plants like cotton needed certain vital nutrients to grow, such as nitrogen, which they got from the soil. But the soil contained a limited amount of nitrogen, so once plants used it up, it had to be replenished. He made the important discovery that fields could be fertilized naturally with nitrogen by rotating the planting of cotton every other year with legumes, such as soybeans, clover, alfalfa, peas, or peanuts. This process is called "nitrogen fixation."

Because soybeans are legumes, they form a symbiotic relationship (or beneficial partnership) with certain bacteria (*Rhizobium* bacterium) that convert atmospheric nitrogen into a form that plants can use. These bacteria enter the roots of the legume and form root nodules or bumps on the roots of the soybean. Inside the nodule, these tiny bacteria convert atmospheric nitrogen into ammonia, which is converted by other soil bacteria into forms of nitrogen the plants can use, like nitrate and nitrite. These bacteria need an oxygen-free environment to do their work, and the legume scoops up any oxygen that could slow down the work of the bacteria. So the legume gives the bacteria food with its roots and the right oxygen-free conditions inside the root nodule. In turn, the bacteria give the plant usable nitrogen so it can grow and reproduce. Some of the extra nitrogen even makes its way back into the soil surrounding the plant.

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The successful implantation of this discovery had the ultimate benefit of producing soybeans in abundance, which are now used in huge amounts for animal food, human food additives, and many industrial products.

Vocabulary:

1. **crop rotation:** the process of planting different crops in alternating years to enhance nutrients in the soil
2. **erosion:** the wearing away of the topsoil by water or wind
3. **legumes:** plants that bear nodules on the roots that contain nitrogen-fixing bacteria; includes important food and forage plants, such as peas, beans, or clovers.
4. **organic farming:** food produced without the use of chemical fertilizers, pesticides, or other artificial agents

III. Before Viewing the Video:

1. Ask students if they know a person named George Washington Carver.
 - If students know about him, ask for details about his life or discoveries.

IV. Viewing Guide:

1. Have students take notes on George Washington Carver:
 - note specific information on his personal life
 - note specific information about his discoveries

V. Discussion Guide:

1. As a group or individually, review the information students noted about George Washington Carver. Correct any misinformation students may have had. Ask students what questions they have now about his life or discoveries.
2. Directly teach the students about “nitrogen fixation.” Bring a sample rhizome into the classroom, or draw a picture of a main (radical) root of a legume plant and then point to the nodules. Have students copy your drawing. Then in pairs, have the students explain the process to a partner.

VI. Evaluation:

1. An informal assessment can be made of students' notes and participation in discussion.
2. Activities can be assessed using rubrics based on good research, presentation, and material construction.

Suggestions for extended learning:

The following provide opportunity for students to work individually or in small groups:

1. Have students research as many legumes as they can. See if they can determine how farmers choose which legumes to grow and why. (For example, farmers may grow alfalfa as a rotating crop with corn. Alfalfa has the benefit of providing food and hay for farm animals.)
2. Research the statistics on how many acres of soybeans are raised in Wisconsin, and then the whole country. Try to determine how much is exported. Research the prices for a bushel of soybeans and do some mathematical calculations on the value of the crops.
3. Research some of the discoveries of G. W. Carver that were not mentioned in the video. Report back to the class.
4. Looking at labels on food in your pantry and refrigerator, find out which contain some form of soy or soy additive. Make a display of labels or containers.
5. Find an agricultural specialist (check with your local extension office) or soybean farmer to come into your class and talk to the students.

The following Wisconsin Student Proficiency Standards can be met by teaching *Nitrogen Fixation & Soybeans*:

Geography: “Students in Wisconsin will learn about geography through the study of the relationship among people, places, and environments.”

- **8th grade:** A.8.1, A.8.3, A.8.10, A.8.11

History: “Students in Wisconsin will learn about the history of Wisconsin ... examining change and continuity over time in order to develop historical perspective, explain historical relationship, and analyze issues that affect the present and the future.”

- **8th grade:** B.8.1, B.8.7, B.8.8

Economics: “Students in Wisconsin will learn about production, exchange, and consumption so that they can make informed economic decisions.”

- **8th grade:** D.8.3, D.8.4, D.8.7, D.8.11



Wisconsin Teacher Standards which can be met with this curriculum, including rationale:

Standard 1: Subject matter

This curriculum provides information not readily available in other forms. A teacher using this material will be well informed about the subject matter.

Standard 3: Adapt instruction

This curriculum provides suggestions for learners with a variety of intelligences and levels of ability.

Standard 4: Instructional strategies

The curriculum includes the use of technology to gain information and suggestions for using research in extending learning.

Standard 5: Individual and group motivation

Both the use of prior knowledge and carefully designed group projects promote motivation for students to learn.

Standard 6: Verbal and nonverbal communications

Instructional media and technology that promotes active learning are key parts of this curriculum.

Standard 7: Organizes and plans systematic instruction

The curriculum is organized to support teacher knowledge, to draw on and motivate students to engage in active learning, and promotes active inquiry, collaboration, and supportive interaction in the classroom.

Standard 8: Formal and informal assessments

Suggestions for a variety of assessments, both formal and informal, are offered in the curriculum.

Standard 10: Fosters relationships

This curriculum could be used to create relationships with local soybean farmers through field trips or class speakers.