GROWING AMERICA

Macromolecules in crops

Focus questions	What are the differences in macromolecules of different crops? What effect do those differences have on their uses?
Learning target	Students will compare the relative amounts of protein, sugar and starch and lipids in different crops.
Vocabulary	Monosaccharide, starch, protein, lipid

MS-LS1-7: From Molecules to Organisms: Structures and Processes

Performance expectation MS-LS1-7	**Classroom connection:** Students discover the differences between different crop seeds, in order to understand that photosynthesis results in food that is rearranged through chemical reactions forming new molecules within organisms.

Science and engineering practices

Constructing Explanations and Designing Solutions	**Classroom connection:** Students will test then describe their findings to explain the differences between different crops and their uses; students will create an infographic to show relative difference between crops and macromolecules.

Disciplinary core ideas

MS-LS1.C Organization of Matter and Energy Flow in Organisms	**Classroom connection:** Students will determine that different crops have different amounts of macromolecules.

Cross-cutting concepts

Energy & Matter	**Classroom connection:** Students will discover the relative amounts of energy (nutrients) of different types within each organism and how that impacts their use.

Background

Nutrients occur in varying amounts within the seeds of all plants. Dent corn grown as a commodity crop has a much larger complex carbohydrate (starch) content than soybeans. Soybeans have a larger amount of protein and lipids. Sweet corn will have a larger amount of monosaccharides. Because of these differences, soybean and corn are used to produce different fuels and other products.

Soybeans have fats or lipids that result in vegetable oil when extracted from the crushed bean. That oil is used to produce biodiesel with a by-product of glycerin.

Dent corn has a high amount of complex carbohydrate (starch) that can be broken down by yeast in the presence of enzymes to produce ethanol, a biofuel with coproducts of corn oil, carbon dioxide and distillers grain that contain the remaining protein, fat, minerals and vitamins. Once the distillers grains are dried, they make a valuable feed for livestock.

Materials

Provide the following materials to each student group.

- Corn flour
- Soybean flour
- Corn seeds
- Soybean seeds
- Whole-grain flour
- Old-fashioned oats
- Wheat seeds
- Benedict's solution
- Sudan III
- Iodine
- Protein strips or Biuret solution
- Coffee grinder
- Balance
- Distilled water
- Mortar and pestle
- Filter paper
- Funnel
- Small beaker
- Test tube
- Test tube holder
- Hot plate
- Cell well plate
- Beaker with water for water bath
- Vortex (optional)

Procedure

Students should work together in groups of 2–4 to complete the nutrient analysis tests.

Note: A Bradford Assay using Coomassie dye may be used to determine the change in protein content, a more sensitive test that can be used with the solution alone, or as an assay using a spectrophotometer to compare to a standard curve.

Ask students to make a data table to compare the different products in terms of starch, glucose and protein.

Differentiation

Other ways to connect with students with various needs:

- **Local community:** Students may investigate the use of corn and soy in pet/animal feed in their local area. Students may choose to interview a farmer, local farmer cooperative, or animal supply store. Students can communicate with their findings with their classmates and their local community.
- **Students with special needs (auditory/visual/language/reading):** Protocol can be enlarged for visually impaired; a video of the protocol may be recorded with a voice over or close captioning for others.

- **Extra Support:**
  - Provide feed labels to show that many of these crops are used in animal feed.
  - U.S. Soybean Farmers Continue to Feed the World and Meet Clean Fuels Demand `unitedsoybean.org/hopper/u-s-soybean-farmers-continue-to-feed-the-world-and-meet-clean-fuels-demand`
  - 10 Products You Didn't Know Were Made with Corn `nebraskacorn.gov/cornstalk/corn101/ten-products-you-didnt-know-were-made-with-corn`
  - Wheat: `glnc.org.au/resource/wheat`
  - Oats as cattle feed: `iowabeefcenter.org/bch/OatsCattleFeed.pdf`
- **Extensions:** Students may compare the different uses/products of these crops. Students may investigate how each plant differs genetically to produce the different levels of macromolecules within each seed.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Students create an explanation for the uses we put each of the crops tested.	Student created an explanation of why one or two crops are best suited for one or two uses.	Student created an explanation of why each crop is best suited for a specific use with data from testing.	Student created an explanation of why each crop is best suited for multiple uses with data from testing.
Develop an "infographic" to show the differences between relative amounts of sugar, starch, lipid and protein in different crops.	Student has collected data about relative amounts of sugar, starch, lipid and protein.	Student has collected data about relative amounts of sugar, starch, lipid and protein; and has compared relative amounts in a visual way.	Student has collected data about relative amounts of sugar, starch, lipid and protein; and has compared relative amounts in a visual way; displayed in a creative, graphic visual.

Rubric for self-assessment

Skill	Yes	No	Unsure
I generated data to compare nutrient content differences between corn and soybeans.			
I can explain why corn is used for ethanol production, why soybeans are used for biodiesel, and the main uses of wheat and oats.			