ANIMAL SCIENCE (HS)

Macromolecules in animal feed

Focus questions	What are the differences in the macromolecules content of different animal foods? How do the amounts differ for different animals?
Learning target	Students will compare the relative amounts of protein, sugar and starch and lipids in different animal foods.
Vocabulary	Monosaccharide, starch, protein, lipid

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

Performance expectation HS-LS1-7	**Classroom connection:** Students discover the differences between different animal foods in order to model cellular respiration, a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

Science and engineering practices

Developing and Using Models	**Classroom connection:** Students will describe and apply their findings to the specific animal the food was developed for in order to model the relative amounts of each macromolecule and how it is used by the animal.

Disciplinary core ideas

HS-LS1.C Organization of Matter and Energy Flow in Organisms	**Classroom connection:** Students will determine that animal foods have varying amounts of nutrients specific to the metabolic needs of the animal.

Cross-cutting concepts

Energy & Matter	**Classroom connection:** Students will discover the relative amounts of energy (nutrients) of different types within each food type and how those nutrients are broken down for use by the animals.

Background

Animal foods are developed by animal nutritionists to meet the requirements of specific animals. Most animals, just like humans, need carbohydrates, lipids and protein. However, the stage of life and the activity of the animals will determine how much of each is required. Animal feed companies spend more than $1 billion each year to advertise over 2,000 separate brands. As consumers, we see mainly dog and cat food commercials, but there are many different kinds of pet foods. Livestock feed is also a large market.

Chickens, pork, cattle, dairy, fish and goats all require feed to grow and produce eggs, milk and meat. Corn is the largest ingredient of animal feed, while other coarse grains, soy and wheat, also contribute significant amounts to animal feed.

In this lesson, students will choose one type of animal food to investigate, then create a model to apply the nutrient information to the animal and life stage for which the food is developed.

Materials

Provide the following materials to each student group.

- Various animal foods (i.e., fish, turtle, cat, dog, rabbit, cattle, chicken, pig/hog, goat, etc.)
- Benedict's solution (or glucose strips)
- 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)

Prior knowledge

Students should have basic knowledge of macromolecules and calories gained from each. Students should have studied cellular respiration and have a basic understanding of how macromolecules are broken down during digestion and changed into energy through respiration.

Suggested timing

- 1 class period for testing
- 1–2 class periods for research and model building

Teacher preparation

1. Copy student handout.
2. Gather different pet food types. Students may want to bring in their own pet food samples. If so, ask them to bring the name of the brand and take a photo of the label including ingredients.

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 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.

1. Ask students to record their findings for the amounts of carbohydrates, lipds and proteins.
2. Have students research information about the metabolism of the animal for which the food was developed.
3. Ask students to develop a model (could be a physical model using blocks, a flow diagram or animation/video) to show how one of the nutrients is broken down through cellular respiration to create energy for the animal.
4. Gather materials for each group to use.

Differentiation

Other ways to connect with students with various needs:

- **Local community:** 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 food and feed labels for students who do not have pets or cannot bring in pet food.
- **Extensions:** Students may want to compare animal foods that are canned to dry foods. Students might survey classmates to determine which food brands or types are most popular. Students might compare labels and prices of foods to determine which nutrients are most expensive.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Complete tests for macromolecules in a chosen animal food.	Student tested for one–two macromolecules.	Student tested for all macromolecules and recorded data.	Student tested for all macromolecules and recorded data and compared relative amounts to the ingredient label.
Develop a model to show how sugars, starches, lipids and proteins are broken down by animal digestion then energy is gained through the process of cellular respiration.	Student has a partial model showing how molecules are broken down through digestion by their chosen animal.	Student has a model showing how molecules are broken down through digestion by their chosen animal and how the animal gains energy through cellular respiration.	Student has a model showing how molecules are broken down through digestion by their chosen animal, how the animal gains energy through cellular respiration and is able to explain the process.

Rubric for self-assessment

Skill	Yes	No	Unsure
I completed tests for macromolecules in an animal food.			
I developed a model to show how sugars, starches, lipids or proteins are broken down by animal digestion.			
I can explain how energy is gained by an animal through the process of cellular respiration.			