ANIMAL SCIENCE (HS)

Comparing human and cow diets

Focus question	Why do humans' and animals' dietary needs change throughout their lifetimes?
Learning target	Students will compare a human diet to a total mixed ration of a lactating dairy cow.
Vocabulary	Total mixed ration, forage, energy concentrate, lactating

HS LS2 Ecosystems: Interactions, Energy, and Dynamics

Performance expectation HS-LS1-4	**Classroom connection:** Students will create a model to represent the similarities in daily intake at the macromolecular level between animal feed and human food.

Science and engineering practices

Using Mathematical or Computational Representations of Phenomenon	**Classroom connection:** Students use a TMR to create a scaled version using human foods. Examples of mathematical comparisons could include graphs, charts, or histograms.
Developing and Using Models	**Classroom connection:** Use a model based on evidence to illustrate the relationship between the monogastric digestive system of a human to the ruminant digestive system of a cow.

Disciplinary core ideas

LS1.B Growth and Development of Organisms	**Classroom connection:** Cellular differentiation produces and maintains complex organisms, with different digestive systems that are adapted to specific food types.

Cross-cutting concepts

Scale, Proportion, and Quantity	**Classroom connection:** Students will use math to create a scaled version of a TMR using human foods or of the percentages necessary for an active human.
Systems and System Models	**Classroom connection:** Students will compare the differences in human and animal feed by creating a total mixed ration to scale from human snacks.

Background

Human diets are made up of the three major nutrients, carbohydrates, fats/lipids and proteins. Water, vitamins and minerals complement the major nutrients to give humans the energy they need for daily living. Athletes need nutrients in different proportions to provide quick energy, muscle repair and growth, sustained energy, hydration and muscle function, oxygen transport, bone health and strength, antioxidants for recovery and inflammation. At different stages of life, energy reuirements change (i.e. adolescence, pregnancy, aging).

In order to maintain a high level of production, **lactating** dairy cows, those actively producing milk, need a complete and balanced diet that meets their nutrient requirements for body maintenance, lactation, growth, and pregnancy. The most common way dairy farmers/nutritionists achieve this is through a **total mixed ration (TMR).** A TMR is a mixture of **forages** (e.g., hay and corn silage), concentrated feeds of protein (e.g., soybean meal and distillers grains), and additional supplements (e.g., vitamins and minerals), which is balanced to meet the specific needs of each unique dairy herd. The goal of a total mixed ration is to provide a complete and consistent diet in each bite. When done correctly, these balanced bites support the rumen environment, allowing rumen microbes to turn “trash” (feed ingredients not fit for human consumption) into “treasure” (milk and other dairy products).

On the farm, dairy herds are often split into different pens/groups based on the animal’s age, stage of lactation, level of milk production, and/or stage of pregnancy. To fully optimize a TMR, nutritionists account for the differences in nutritional requirements for each of these groups. For example, a lactating cow requires increased levels of energy (carbohydrates and fats), in the form of an **energy concentrate,** and protein in order to sustain their body weight, level of milk production, and pregnancy/calf development. Non-lactating dairy cows, also known as dry cows, are not being milked daily because they are in the “rest” period of their lactation cycle, to help prepare for the birth of their calf and the start of their next lactation cycle. The diet of non-lactating cows needs to support daily activities or the last few weeks of pregnancy. The ration will maintain their body weight. They require fewer carbohydrates for energy and less protein as compared to lactating cows. Lactating dairy cows also need to eat more than dry cows, consuming 3.5–4.5% of their body weight daily, while dry cows will consume only 2–3% of their body weight. Understanding what life stage each section of the herd is in is crucial to constructing a diet that meets their requirements, allowing a herd to stay productive, healthy, and sustainable!

- Lactating dairy cows will consume 3–4% of their body weight every day. For a 1500-lb Holstein cow, that’s 45–60 lbs of feed!
- A dairy cow will spend roughly 6 to 7 hours a day eating, providing the energy and nutrients to produce 6–10 gallons of milk per day. A single cow can produce nearly 200,000 glasses of milk over the course of her life.

Prior knowledge

In order to successfully complete this activity, students should:

- know about the different macromolecules found in food: protein, fats/lipids, and carbohydrates.
- be able to do basic algebra by finding percentage equivalents.
- understand the differences between monogastric and ruminant digestive systems.

Materials

Check for allergies among students before using the materials below.

- Bags of pretzels *
- Bags of corn chips (not tortilla chips) *
- Bags of skittles *
- Bags of cashews *
- Bags of sunflower seeds *
- Balances that measure in ounces
- Weigh boats
- Bowls (for holding ration after measuring)

** Amounts will vary based on class and group size.*

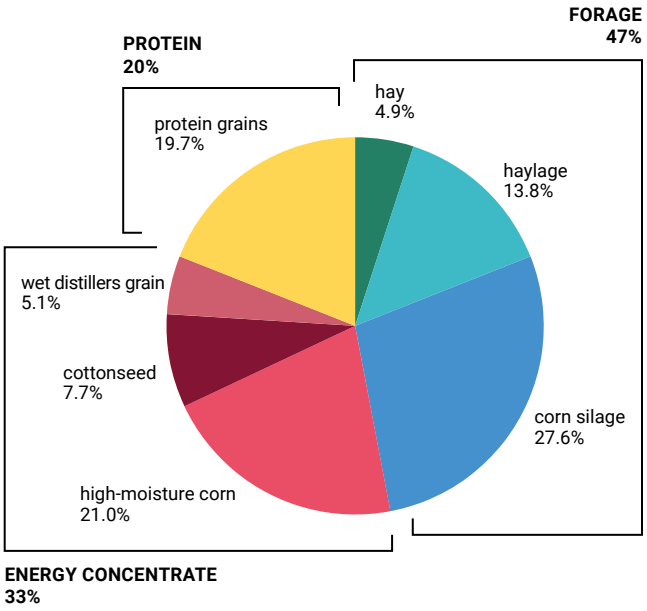
Teacher preparation

1. Copy student sheet.
2. Review differences between the human and ruminant digestive system (i.e. ruminants have a four-chambered stomach; the microbes in their stomach are adapted to digesting cellulosic (grass and fiber) materials that humans cannot digest; ruminants eat throughout the day, continuously regurgitating and re-chweing food; the macromolecules that are contained in the food for humans and animals are the same.
3. Prepare areas where students can measure out material and use balances. A plastic tablecloth to cover the desktop and gloves for students are recommended, since they will be measuring from a common bag and perhaps adding materials back into the bag if they get too much.
4. Students may need access to calculators in order to complete the mathematical conversions.

Procedure

1. Introduce the activity by asking students what they ate for breakfast this morning. If they did not eat breakfast, ask what they ate for their last meal before class. Have them share with their seat neighbor.
2. Ask them how their food choices would be different if they were planning to hike up a mountain or play in an athletic event after school. Have the table groups work together to create a list of foods they would recommend for an athlete before an event.
3. Lead a discussion about what macromolecules are in their food: carbohydrates, fats, and proteins. You may want to have some labels of common foods they might eat available for them to see the amounts of those nutrients in their food (pop tarts, breakfast cereal, oatmeal, eggs) with a list of nutrition facts.
4. Discuss which foods give energy over a prolonged period of time vs quick energy. When might an animal need to have energy in high concentration over a prolonged period of time?
5. Students choose whether they will make a snack mix for an athlete based on their own research of nutrient needs or use the chart below to match a TMR for a lactating cow.
6. Students determine how many different foods and in what ratio to make an 8-oz snack that will meet the nutrtional requirements.

- **For a 2-year old, high-producing cow, the total ration is 50 lbs/day**
- Forage: 47%
  - Hay: 2.5 lbs or 5%
  - Haylage: 7 lbs or 14%
  - Corn silage: 14 lbs or 28%
- Energy concentrate: 33%
  - High moisture corn: 10.64 lbs or 20%
  - Cottonseed: 3.92 lbs or 8%
  - Wet distillers grains: 2.6 lbs or 5%
- Protein: 20%
  - Protein mix (canola, soy, etc.): 10 lbs or 20%



Differentiation

Other ways to connect with students with various needs:

- **Local community:** Students may visit a local dairy farm. If there are no farms in your local area, reach out to your local extension office to see if an agent or a farmer would virtually visit your classroom.
- **Students with special needs (language/reading/auditory/visual):** Students should be able to use calculators or have support to determine the ounces that will match the percentages needed of each of the categories or could be paired with another student as partners to create the TMR. Students who may be color-blind will need to have the colors of the charts labeled for each category.
- **Extra support:** Support for students with math challenges should be provided.
- **Extensions:** Students may complete the ration formulation using a Pearson square (`pir.sa.gov.au/__data/assets/pdf_file/0009/272871/Ration_formulation_using_the_Pearson_Square.pdf`) to figure out the value of the crude protein from two different grains.

Student handout

Reflection

1. Why did you formulate your ration the way you did? Provide reasons for why you think this would be effective for an athlete's performance or the production of the dairy cow and profitability of the farm.

Answers will vary. Students may ask about production of milk from a high-performing herd to determine if the higher costs of certain mixes will result in higher milk production.

2. How much would your ration cost to feed per pound? To determine this, take the percentage of each ingredient and multiply it by its cost per pound. Fill in the table above.

Answers will vary depending on the percentages of each ingredient used.

3. How does your cost compare to the other groups? List costs of other groups below.

Answers will vary.

4. Do you think the cheapest group's ration is also the most profitable ration? Explain.

Answers will vary. More information is needed to make a reasoned answer.
Discuss what other information may be needed to decide.

5. Do you think your ration is the best ration? Explain.

Answers will vary. More information is needed to make a reasoned answer.
Discuss what other information may be needed to decide.

6. If you chose to follow the TMR for a cow, explain the connection between the quality of feed in the TMR and milk production.

TMRs are a considerable factor in milk production. Lactating cows need high amounts of energy and protein to produce milk. Changes in the ingredients within the TMR will result in changes in the output and quality of milk the cow produces. Visit: **floridamilk.com/on-the-farm/farm-practices/cow-care.stml** for more information.

7. What is the difference between the types of foods that a human eats and the types of foods that cows eat? Could humans live on a cow's diet? Why or why not?

The types of foods cows eat are made from cellulosic fibers (grass, hay, silage which comes from corn stalks, cobs and corn kernels that has been fermented). However, the macromolecules are the same. Humans cannot digest the cellulose in grass or corn stalks. There is a lot of fiber in corn kernels. The digestive system in cows allows the breakdown of these materials, while the human digestive system does not have the same digestive system nor the same microbes.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Determine a TMR that results in the desired energy needs for an athlete or the production of milk per cow, scaling the ration to create an 8 oz ration using human foods.	Student created a TMR that was not properly scaled or did not follow the maximum of 3 oz rule.	Student created a TMR that was properly scaled with a variety of different ingredients.	Student created a TMR that was properly scaled with a variety of different ingredients, and was able to explain how the TMR impacts the performance of an athlete or the quality/volume of milk produced by a lactating cow.
Use a chart to show the total amount of each portion of the TMR.	Student created the TMR with amounts but did not create a pie chart.	Student created the TMR with amounts and created a chart to show the percentages.	Student created the TMR with amounts and created an appropriate graph (pie chart) to show the percentages of each and which category they were in.
Compare diet of a human to diet of a cow and connect to the differences in digestive systems.	Student compared diet percentages for an athlete to a lactating cow, but did not connect to the difference in digestive systems.	Student compared diet percentages for an athlete to a lactating cow and described the difference in digestive systems, but did not connect to the different types of food that humans and cows eat.	Student completed the TMR, explained how it maximizes the yield of milk, and made another suggestion(s) for how milk production might be increased.

Rubric for self-assessment

Skill	Yes	No	Unsure
I used math to determine the TMR using proper percentages.			
I used math to create a graph to show TMR components.			
I understand the relationship of different dietary needs based on different energy needs of an individual person or animal.			