Livestock Unit, Packet 2.2

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: How do animals acquire nutrients from their feed?

Anchoring Phenomenon: In this unit, we will be exploring how the digestive tracts of different kinds of livestock function in order to acquire nutrients from their feed. We will also consider the benefits and drawbacks of each digestive strategy and how this affects management decisions on farms and ranches.

Deeper Questions

1. How does digestion occur?
2. How do different digestive tracts differ in structure and function?
3. What are the advantages & drawbacks of each type of digestive tract?

Schedule

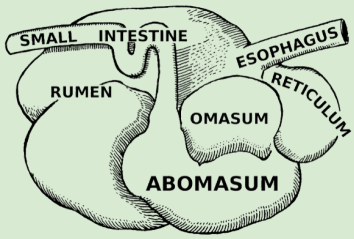
Part 1: Introduction
- Three Claims, Data Dive, Data Check

Part 2: Core Ideas
- Core Ideas, Driving Questions, & Lesson Check

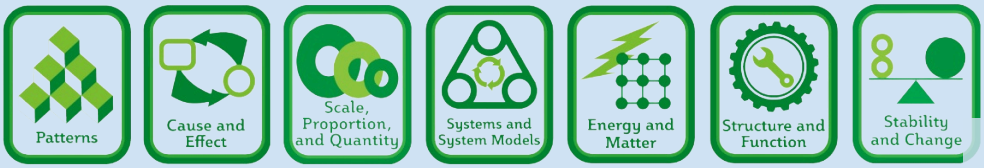
Part 3: Investigation
- Artificial Stomach Lab

Part 4: Review & Assessment
- Ranking Your Readiness
- Review, Formative Assessment, & Mastery Check

Part 5: Career Connections
- Extension Agent Scenarios



AFNR Standards: AS.01.02. Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts. AS.02.01. Demonstrate management techniques that ensure animal welfare. AS.03.01. Analyze the nutritional needs of animals. AS.03.02 Analyze feed rations and assess if they meet the nutritional needs of animals.AS.03.03 Utilize industry tools to make animal nutrition decisions.
NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS1-2. How bodily systems interact in multicellular organisms. HS-LS1-6. How carbon, hydrogen, and oxygen from sugar molecules form amino acids and/or other molecules. HS-LS1-7. How bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.



Semester Schedule

1. Crops Unit
1.1: How can we improve crop productivity?
1.2: How can we explain crop growth using atoms?
1.3: How do we design plant experiments?

2. Livestock Unit
2.1: How do animals convert feed into products?
2.2: How do animals acquire nutrients from their feed?
2.3: How can we use anatomy for management decisions?

3. Genetics Unit
3.1: How can we predict genetic inheritance?
3.2: How do genetic outcomes vary in more complex cases?
3.3: How do we design genetic experiments?

4. Biotech Unit
4.1: How can DNA be modified to enhance species?
4.2 How do we design biotech experiments?

5. Sustainability Unit
5.1: What determines if food production is sustainable?
5.2: What methods improve sustainability in agriculture?
5.3: How do we design sustainability experiments?

These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Core Ideas Reading; Practice Mastery Check;

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Part 1: Intro – Comparing Rations (2.2.1)

Overview: In this activity, you will begin by discussing your initial ideas about how animal growth relates to their diets and their cells. You will then analyze data and work in teams to develop initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence; Asking Questions & Defining Problems

1. Students are learning about livestock production in their agriculture courses. They wonder how the bodies of cattle use the feed they consume. **Do you agree or disagree with each student's claim**?
    a. Nina: All livestock species can be fed similarly (e.g., corn) to produce meat, milk, eggs, or wool.
    b. Daryll: Livestock diets vary widely because some need carbs while others need protein & fat.
    c. Oscar: Animals with more complicated digestive systems are better at digesting food.
2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas.

Data Dive - *Read the directions below.* *SEP: Analyzing & Interpreting Data. Data Source: PSU*

The data below show the components that make up a typical diet for four species of livestock. First look for patterns & trends in this data before answering questions. Sources: PSU; UMN; Amerah *et al.*, 2015; Schaafstra *et al.* 2017.

Example percentages of feed components in rations (note: rations vary depending on species, age, production stage, etc.).

Feed type	Cattle	Pigs	Poultry	Horses
Forage / roughage	69.10%	0.00%	0.00%	82.20%
Grain / starch feeds	9.10%	82.80%	54.20%	0.00%
Protein-rich feeds	7.10%	13.00%	24.20%	0.00%
Other energy feeds	12.30%	0.00%	2.80%	17.80%
Fats / oils	0.00%	0.00%	2.80%	0.00%
Minerals & vitamins	2.40%	4.20%	4.90%	0.01%
Total	100%	100%	100%	100%

1. **Begin by individually attempting to make sense of this data**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience that you have?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree?
3. **What are two conclusions that would be supported by this data?** How are these conclusions supported by this data? What specifically suggests that your claims are accurate?
4. **Do some species consume feed components that others don't?** Why? How might this change how these species are managed? How could it affect their feed conversion ratio (FCR)?
5. **Do these species have similar needs at the cellular level for macro- & micronutrients?** Explain
6. **Does this data support or refute any of the initial claims (see above)?** If so, explain.

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Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems.*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing explanations*

How do animals acquire nutrients from their feed? How do digestive strategies differ between different species of livestock? Write down an initial explanation in the space below. Don't worry if you aren't completely sure about this. You will come back and revise this explanation as you gain more information during this unit.

_____

_____

_____

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Part 2: Core Ideas - Livestock Digestive Strategies (2.2.2)

Overview: In this activity, you will use this reading to explore how differences in livestock anatomy affect what they can consume as well as how this determines what management decisions optimize their productivity. You will then complete a lesson check (you can use your written notes).

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*	
1. How is food mechanically and chemically broken down during digestion? 2. Why must food molecules be broken down into smaller units, and how are these molecules moved to cells? 3. How do cells use glucose, amino acids, and fatty acids to maintain the body and produce meat, milk, or eggs? 4. How does an animal's digestive anatomy affect the specific types of feed it can consume? 5. What unique anatomical feature allows ruminants (like cattle) to break down cellulose? How do monogastric animals (like pigs) differ from this? 6. How does fermentation differ in hindgut fermenters compared to ruminants?	7. How do chickens mechanically grind their food if they lack teeth? Explain 8. What are the advantages and disadvantages of each type of digestive anatomy? How can this affect management decisions? 9. Hypothesize why pigs and poultry tend to more efficiently convert feed to body weight compared to cattle. Discuss how this relates to the food they can consume based on their digestive anatomy. 10. Summarize two key management decisions made by farmers that are directly affected by the digestive anatomy of their livestock. 11. Under what circumstances might a farmer knowingly choose a ration that results in lower animal productivity? 12. What is sustainability and how might the choice of a ration impact this factor?

Use the space below to record notes:

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Part 3A: Artificial Stomach Lab (2.2.3)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are all ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Developing & Using Models

1. How is food mechanically and chemically broken down during digestion?
2. Why must food molecules be broken down into smaller units? How are these molecules moved to cells?
3. What are the advantages and disadvantages of each type of digestive anatomy? How can this affect management decisions?
4. How do feed particle size and fiber content directly affect nutrient absorption and digestive health?

This activity was completed _____ (*instructor signature*)

Overview: Differences in livestock digestive systems determine what rations will be most effective for production and efficiency. You will model a specific digestive anatomy in a laboratory setting to determine how digestive-system structures affect an animal's ability to obtain nutrients from feed.

Research Question & Hypothesis - *Discuss your ideas and record your predictions in the spaces below.*
SEP: Planning and Carrying Out Investigations

1. Develop a testable research question that you could investigate with a simulated digestive tract using one of the following options:
    a. How does particle size affect digestion?
    b. How does acidity affect digestion?
    c. How does fiber content affect digestion?
    d. How does enzyme availability affect digestion?
    e. Another option (requires instructor approval)

    Your question should have: *something you change + something you measure + a digestive process (e.g., how does particle size affect the extent to which corn can be fully digested?)*

    _____

    _____

2. Develop a hypothesis & rationale (*e.g., If I change ___, I predict that ___ will change ... because ...)*

    _____

    _____

    _____

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Planning - *Carefully read the directions below before beginning. Record info where prompted.*

1. An **independent variable** is what you change to test a hypothesis & answer your research question.

   What is your independent variable? _____

2. A **dependent variable** is what you measure to address your research question & hypothesis.

   What is your dependent variable(s)?_____

3. A **control** is a part of your experiment that does not receive any treatment. It provides a basis for comparison. This enables us to confirm if what we changed had any impact on the outcomes.

   In this experiment, what is your control? _____

   Sample size and **trials** affect the validity of your findings. **Sample size** refers to how many points of data will be collected. **Trials** refer to the number of times you will repeat the experiment under the same conditions. The larger the sample size and the more trials you perform, the more useful and reliable your findings are for answering your research question.

   *What is your sample size (how many points of data are being collected)?*_____

   *How many trials did you have?*_____ *How might your sample size and number of trials affect the reliability of your findings?*_____

   _____

4. **Constants** are the conditions that are kept the same between each replicate. If possible, an experiment should not be performed under changing conditions. This would make it impossible to determine whether our results were affected by our independent variable or by other changes. This would make our results less useful for answering our research question.

   *What is being kept constant in this experiment?*_____

   _____

5. ☐ You do not need to design an entirely new protocol. Instead, start with this existing example for a lab protocol (click this link). Change it to reflect both a) your RQ & hypothesis, and b) a specific type of livestock digestive system (monogastric, ruminant, hindgut fermenter, or gizzard). *Source: Beloit College*

6. ☐ On the next page, summarize how you will change this protocol to test your hypothesis.
   (Note: This lab model represents only some parts of digestion. It cannot reproduce all of the physical, chemical, & microbial processes that occur in an animal.)

7. What we will keep the same from the original protocol: _____

8. What we will change: _____

9. What we will measure: _____

10. Why we will measure this: _____

11. Summarize *all* the materials that you will need to complete this lab protocol:

12. To what extent are your proposed methods valid and reliable? How could it be improved?

Results & Data - *What do our data indicate?*
SEP: Analyzing and interpreting data. Using mathematics and computational thinking.

1. **Determine what data you will need to collect** What types of data do you need in order to confirm whether your data support or refute your hypothesis?

   _____

   _____

2. **How will you collect this data? Summarize the instruments and/or methods needed:**

   _____

   _____

3. **How will you record this data? How will you organize the data you collect? If you create a data table, how will it be organized? (e.g., what will be in each row and column?)**

   _____

   _____

4. **Create the table or organizational system you will use to collect and organize your data below:**

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1. **Now create a graph based on your collected data. First, label each axis on the graph below. The x-axis is horizontal (*back & forth*); the y-axis is vertical (*up & down*).**
    a. Usually the independent variable (*what was changed*) is on the horizontal x-axis and the dependent variable (*what was measured in response*) is on the vertical y-axis.
2. **Next, determine the type of graph you are making.**
    a. Bar graphs work well for comparing changes in quantities, while line graphs work well for comparing changes over time.
    b. Each component should be labeled with the type of treatment (e.g., *treated* and *control*).
3. **Third, determine the scale (*range of numbers*) you will use on the y-axis (vertical axis).**
    a. Determine your highest and lowest values for the data you will be graphing.
    b. Your scale should be large enough to encompass all of the values of data but should also be small enough to make it easy to compare the differences in data.
    c. Usually your scale starts at zero (but does not need to).
    d. Values on the y-axis usually increase by the same amount with each line.
4. **Fourth, complete this graph based on the data you collected.**
5. **Finally, create a caption that explains what kinds of trends and patterns are present in this graph. Then explain what these trends indicate for your research question and hypothesis.**
    a. Often a caption includes phrases like "In this graph you can see" and "This indicates that".

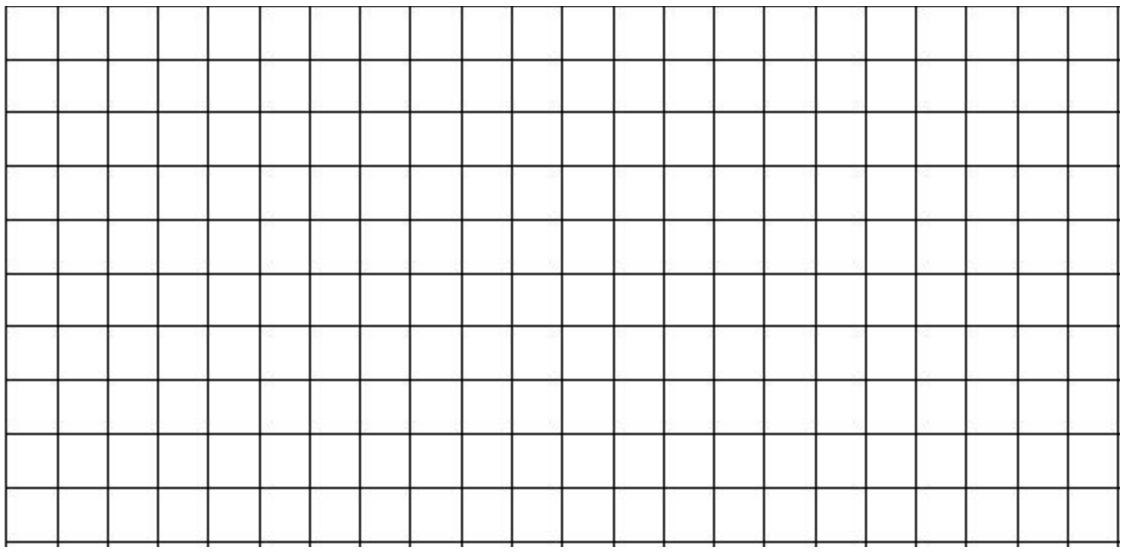


Figure 1: *This figure shows* _____

The key trend in this data is _____

This suggests that _____

_____

Discussion & Conclusion - *Is our hypothesis supported by our data? How does this relate to our research question? What conclusions can we reach based on this investigation?*
SEP: Constructing explanations & designing solutions. Making evidence-based arguments. Obtaining, evaluating, & communicating information.

1. Restate your research question and hypothesis. *We wondered:* _____

   _____

   We predicted: _____

   _____

2. Was your hypothesis supported by your data? Yes / No / Not sure (*circle one*).

   Explain: _____

   _____

   _____

3. Why do you think this outcome occurred? What was occurring at the cellular and molecular levels that would cause the results you observed in this experiment?

   _____

   _____

   _____

4. What could we change to make our experiments have more valid and reliable findings?

   _____

   _____

   _____

Part 4: Review & Assessment (2.2.4)

Step 1: Review each Driving Question. Circle any questions that are still unclear to you.
Step 2: Identify and discuss any remaining confusion with your instructor.
Step 3: Complete the Formative Assessment (last page). Compare responses as a class.
Step 4: Individually complete a Mastery Check. If needed, your instructor will provide further support.

Part 5: Extension Agent Scenarios (2.2.5)

Background: University extension agents use research and science to help farmers solve real-world problems. They may advise farmers about animal health, nutrition, production, costs, and sustainable management.

In this activity, you are the extension agent. Farmers have brought you problems involving livestock feed and digestion. Use what you know about each animal's digestive system, feed characteristics, and production needs to recommend a solution.

Support each of your recommendations with a claim (direct response to a question), evidence (the data or observations that support your claim), and reasoning (explanation of how your evidence supports your claim and why this evidence matters).

Scenario 1: A poultry farm receives a shipment of feed that was mistakenly ground much more coarsely than usual. The feed mill offers the farmer a small discount if they agree to keep the shipment. The farmer asks whether the savings are worth accepting the larger particle size. Should the farmer use the discounted feed or reject the shipment? *Image Source*

Claim: _____

Evidence & Reasoning: _____

_____

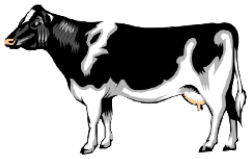
Scenario 2: A new pig farm wants to avoid a 'feedlot operation' and intends to adopt 'all natural pasture-raised swine'. Their goal is to raise their pigs completely on hay and grasses, instead of the corn and soybean ingredients normally found in pig rations. Their intent is to reduce their costs and impact on the environment. Will this be effective? *Image Source*

Claim: _____

Evidence & Reasoning: _____

_____

Scenario 3: A dairy farmer is concerned because their herd's average milk production has measurably decreased. However, the dairy cattle are eating the same amount of feed with nearly identical ingredients as before. The only aspect that has changed is the impact of their new machinery on feed particle size. How might you explain this outcome? *Image Source*



Claim: _____

Evidence & Reasoning: _____

_____

Scenario 4: A horse farm has recently replaced much of its normal hay with a much larger amount of grain. Several horses subsequently experience digestive problems. What should the owner investigate? *Image Source*

Claim: _____

Evidence & Reasoning: _____

_____

Scenario 5: A sheep flock has developed a digestive problem that damages the lining of the small intestine, causing it to swell. The farmer notices changes in manure and a decrease in average daily gain. How could damage to the intestine affect animal growth? *Hint: swelling can decrease surface area of the finger-like projections of the intestinal lining.* *Image Source*

Claim: _____

Evidence & Reasoning: _____

_____

Scenario 6: A beef producer is considering switching to grassfed beef. Under their current operation, animals used for meat are moved from pasture to feedlots as they age. These animals consume large amounts of grain in the final stages of their lives to optimize their ADG and growth rates. This farmer is considering switching to a grassfed operation where they stay on pastures their entire lives. How might switching from a grain-based finishing system to an entirely forage-based system affect feed use, growth rate, and production efficiency? What additional information would you need before recommending the change? *Image Source*

Claim: _____

Evidence & Reasoning: _____

_____

Packet 2.2 Formative Assessment (2.2.4)

Name: _____Hour____Date:_____Score:_____

Directions: Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist. If you are stuck, refer to your work in this packet and the resources linked on pg. 1.

Background: This data compares the amount of forage/roughage fed to four species of livestock as a percent of the mass of their total diet. Use this data to answer the following questions.

1. Briefly summarize the similarities in how food is digested in all types of livestock. In particular, address each of the following: a) mechanical and enzymatic breakdown; b) how food molecules reach the cells; c) how cells use macronutrients found in their food.

Feed type	Cattle	Pigs	Poultry	Horses
Forage / roughage	69.10%	0.00%	0.00%	82.20%

2. The data above show the amount of roughage (hay, grasses, etc.) as a percent of a typical diet in different kinds of livestock. Summarize the key trend in this data. Then explain why some livestock can consume more roughage than others based on their digestive anatomy. *Hint: what types of structures are found in livestock that consume large amounts of roughage and how does this enable them to eat this?*

3. Both horses and cattle can utilize large amounts of roughage in their diet, but they digest this feed content in different ways. Summarize how their digestive tracts are both similar and different.

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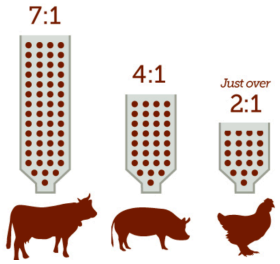
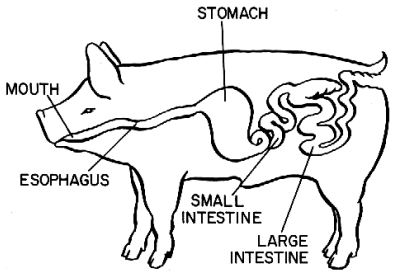
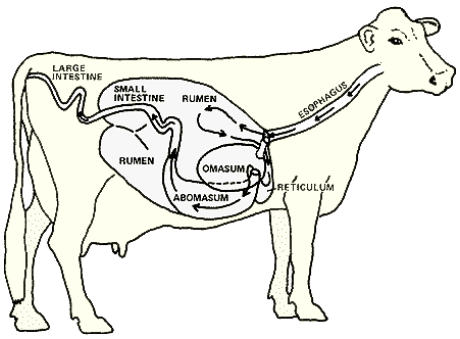
4. How can chickens break down their feed into smaller particles without teeth? Why is this necessary if their stomachs also produce digestive enzymes similarly to other livestock?

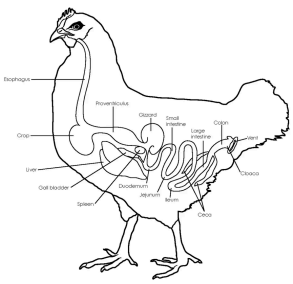
5. Based on this data, cattle often have a feed conversion ratio (FCR) of 7:1 (meaning it requires about 7 lbs. of food per pound of body weight gained). Pigs can have a FCR of 4:1 and poultry have a FCR of 2:1. How does this relate to their digestive anatomy & the types of feed they are able to consume? *Image Source*



6. As a result of differences in their anatomy, explain how management decisions differ between cattle and non-ruminants like pigs and poultry. Give at least two examples.







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