NEBRASKA AGRICULTURE IN THE CLASSROOM
NEBRASKA FARM BUREAU FOUNDATION

Lesson Three: Digesting DNA

Level: High School

PURPOSE

Students develop a model to explain how enzymes affect the digestive system of a pig as they grow through the weaning stage.

NEBRASKA STATE EDUCATION CONTENT STANDARDS CONNECTION

SC.HS.6.1.a Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out these essential functions of life through systems of specialized cells.

SC.HS.6.1.b Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

AFNR.HS.2.3.a Analyze nutritional needs of animals.

AFNR.HS.2.3.c Utilize industry tools to make animal nutrition decisions.

AFNR.HS.2.2.a Demonstrate management techniques that ensure animal welfare.

ESTIMATED TIME

50 minutes

MATERIALS NEEDED

» Puzzle Pieces, approximately 10 pieces per group of 3-4 students
  - Puzzle pieces should be shuffled and then divided so each group has 10 pieces, but they are mixed an must collaborate to have the correct pieces.
  - If puzzles are not available, print and cut apart the included handout to create puzzles.

» Weaning Nutrition Summary Worksheet

» Building Materials: LEGO ® blocks, blocks, or colored popsicle sticks and glue.
  - 1 set per 3 students
  - One set includes:
    * 20 Blue
    * 10 White
    * 6 Yellow
    * 6 Orange
    * 3 Green

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VOCABULARY

Enzyme: A substance produced by a living organism that acts as a catalyst to bring about a specific biochemical reaction. Digestive enzymes are secreted by various parts of the digestive system to break down food nutrients such as protein, carbohydrates and fat.

Lactase: An enzyme that breaks down lactose.

Lactose: A carbohydrate from milk; i.e. "milk sugar".

Maltase and Amylase: Enzymes that break down grain carbohydrates.

Nursery: Climate-controlled barn where newly weaned piglets are kept and raised from approximately 13 – 50 pounds.

Phase-Feeding: Feeding piglets multiple diets allowing them to transition successfully and healthily from a liquid, milk-based diet to a solid, grain-based diet.

Wean: When a piglet is removed from its mother's milk and given solid food to eat and water to drink.

BACKGROUND INFORMATION

Read or summarize the following information for students prior to the lesson:

When piglets are about 3-4 weeks old, they are weaned. Weaning is when the piglets are removed from their mother's milk and moved to another barn, called a nursery where they are housed with other similar-size piglets. At this time, sows are moved back into a gestation barn, where they are eventually bred again. Depending on the specific pig operation, the nursery building may be at the same site as the farrowing barn or located miles away on another pig farm who specializes in raising weaned pigs. Piglets are moved into the new barn or onto a truck using "rattle paddles," which are gently shaken to encourage pigs to move yet remain as calm as possible. In this process, smaller pigs are sorted off and kept in a separate pig to ensure the large pigs don't trample or "pick on" these pigs.

The nursery, just like the farrowing barn, is climate controlled to keep the pigs comfortable. In the nursery, pigs are slowly transitioned from an all-milk diet to solid food, using a system called phase feeding. In phase feeding, pigs are gradually fed 3-4 different diets to allow their digestive systems to slowly adjust to the solid food diet they will primarily eat for the remainder of their growth and life: corn and soybean meal. The first diets contain feeds high in specialized protein and dried milk products and gradually introduces corn and soybean meal until that is primarily what the pigs are eating. Pigs always have access to waterers, which enables them to drink as often and as much as they like. Weaned pigs are kept in the nursery from approximately 13-55 pounds. At that time, they are moved to a finishing barn.

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Part One: Learning Activity

INTEREST APPROACH

1. Write the word "change" on the board. Ask students to consider a time in their life when something big changed. Perhaps they switched schools, started playing a different sport, moved houses, or a sibling moved out of the house. Ask, "How did they react to that change? Was it a positive or negative change?" Allow a few students to share stories.
2. Discuss that for newborn piglets, weaning, the time when they are removed from their mother's milk and moved from the farrowing barn into the nursery, is a time of enormous change. Not only are they being removed from their favorite beverage and given a new diet, but they are suddenly in a new building, potentially surrounded by new piglets. This change is hard and pig farmer must do all they can do keep piglets comfortable, avoid sickness, and help them transition from a milk diet to a dry, grain-based diet.

CONDUCT ACTIVITY

Part One

1. Divide students into groups of 3-4. Give each group a mixed-up puzzle. Explain that the challenge is for each group to put together their puzzle as quickly as possible.
2. When students become stumped, encourage them to use their resources. Prompt them until they collaborate with other groups to get the correct pieces put together.
3. Discuss:
   - » Was it possible to complete the puzzle in your individual groups? Why or why not?
     - No. The pieces were incorrect and did not fit together.
   - » What did you have to do to complete your puzzle?
     - Collaborate with other groups. Find the correct pieces.
4. Explain that similar to the puzzle activity, when pigs are weaned and enter nurseries, they do not possess the right "pieces" or the right digestive enzymes to break down solid foods. Over time, they must slowly build up the correct enzymes.
5. Pass out the *Weaning Nutrition Summary Page* to each student. Have students capture the following information:
   - » Enzyme: a substance produced by a living organism that acts as a catalyst to bring about a specific biochemical reaction. Digestive enzymes are secreted by various parts of the digestive system to break down food nutrients such as protein, carbohydrates and fats.
   - » Milk carbohydrates are called lactose. Their corresponding enzyme is lactase.

» Grain carbohydrates can be starches, fibers, etc. They have several corresponding enzymes, including maltase and amylase.

6. Explain that to aid piglets in developing new digestive enzymes, pig farmers use phase feeding, where pigs are fed 3-4 different diets. These 3-4 diets start with many ingredients that mimic the composition of milk and move to have fewer, but more complex ingredients.
7. With students in the same groups of 3-4, distribute 1 blank piece of paper/group.
8. Explain that to represent each of the 4 diets, students will become "builders" of pig diets, using different colored building materials to serve as various feed ingredients. Each phase of building will use fewer pieces to represent that pig diets start out complex and get simpler and simpler with fewer ingredients.

PART TWO

Challenge Guidelines

- The challenge for each group is to build a free-standing bridge in **each** phase with **only** the allowed number of pieces. The bridge must replicate a true bridge containing supports on both sides and be 'hollow' underneath. Each bridge must be free-standing and able to hold a can of food on top of it.
- Before groups can move on to the next phase, they must show the teacher that their bridge is successfully holding their can of food and get a teacher stamp or signature on their summary worksheets.
- Every student in each group must participate in the building. For each new phase, students can completely rebuild their bridge or simply modify their original bridge. The goal is to be the first group to complete all 4 phases successfully.

1. Distribute building materials to each group, but don't allow them to begin building yet. (Sets can be pre-counted, or students can be directed to select the appropriate number of each material. Suggested building materials: LEGO® blocks, blocks, colored popsicle sticks and glue)

   Contents of each set*:

   - 20 blue
   - 10 white
   - 6 Yellow
   - 6 Orange
   - 3 Green

   *Depending on building materials available, if the challenge seems too easy or too hard, make adjustments of allowed materials for each phase.
2. Instruct groups to take out their blank piece of paper. Allow students 2 minutes to analyze their building

materials and plan their 4 phases by diagramming their plan (s). Students must get the instructor "okay" to begin building, even if it takes them longer than 2 minutes.

3. As students build, travel around the room checking on progress and marking student challenge worksheets as they complete each phase. The first group to complete each phase 'wins.'

FOLLOW UP QUESTIONS

Discuss as a class using the following guiding questions:

1. Why was the planning phase required for all groups prior to beginning to build? How does this relate to what pig farmers at nurseries do?
   - Pig farmers carefully plan and calculate what they will feed their pigs in all phases of production. In nurseries specifically, they want to ensure pigs are able to successfully and healthily transition from their mother's milk to a dry, grain-based diet, just like you wanted your bridge to be sturdy. Any missing parts in the diet could result in sickness or slow-growth.
2. What were some of the challenges experienced as you built?
   - Answers will vary.
3. What are some challenges pig farmers might experience when putting together pig diets?
   - High-cost of ingredients, uncertainty of what to feed pigs initially, sickness
4. What is "phase feeding" in pig nurseries? Why is it necessary?
   - Phase feeding is feeding piglets multiple diets (3-4). It is necessary to allow pigs to transition successfully and healthily from a liquid, milk-based diet to a solid, grain-based diet.
5. How did the blocks represent the various phases of pig feeding?
   - In each phase there were different combinations of colored building materials, just like in pig diets there are different combinations of pig feeds. Additionally, in each phase you had fewer blocks, just like pig diets get simpler as pigs grow older and larger, usually containing only 2 major ingredients (corn and soybean meal) with trace amounts of vitamins, minerals, and amino acids.
6. Why were there fewer building materials in each phase?
   - This represents that a pig's diet eventually moves from being extremely complex to simple.
7. Look at the list of specific ingredients in phases 1-2. What is the significance of products such as dried whey?
   - They mimic milk compositionally, but allow the pig's stomach to acclimate to dry feeds.
8. Overall, how does the digestive system of the pig change throughout the phase feeding process?
   - It builds up enzymes that are able to break down new ingredients.

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Part 2 (Optional): Attend a Virtual Field Trip

Biosecurity is a procedure to protect animals against disease. Farmers limit travel to their pig barns by practicing biosecurity. This ensures they can raise their pigs in a safe and healthy environment.

Virtual Field Trips allow farmers to open their barn doors to show students what happens inside. The farmer uses a tablet to connect with classrooms to be a part of a live, video-chat allowing students to have their questions answered in real time.

Visit the Nebraska Farm Bureau Foundation website, *www.nefbfoundation.org/educators/get-involved/virtual-field-trips*, to see a list of upcoming Virtual Field Trips and to sign up for a time to attend. If you have questions, please contact Nebraska Farm Bureau Foundation at *foundationforag@nefb.org* or (402) – 421 – 4747.

SOURCES UTILIZED

National Hog Farmer
www.nationalhogfarmer.com/mag/farming_feeding_strategies_weaned

Penn State Extension
extension.psu.edu/courses/swine/nutrition/nursery-pig-nutrition/weaning-at-three-to-four-weeks-of-age

Purina Animal Nutrition
www.purinamills.com/swine-feed/education/detail/phase-feeding-pigs https://www.purinamills.com/swine-feed/education/detail/immunity-and-gastrointestinal-function-of-weaning-pigs

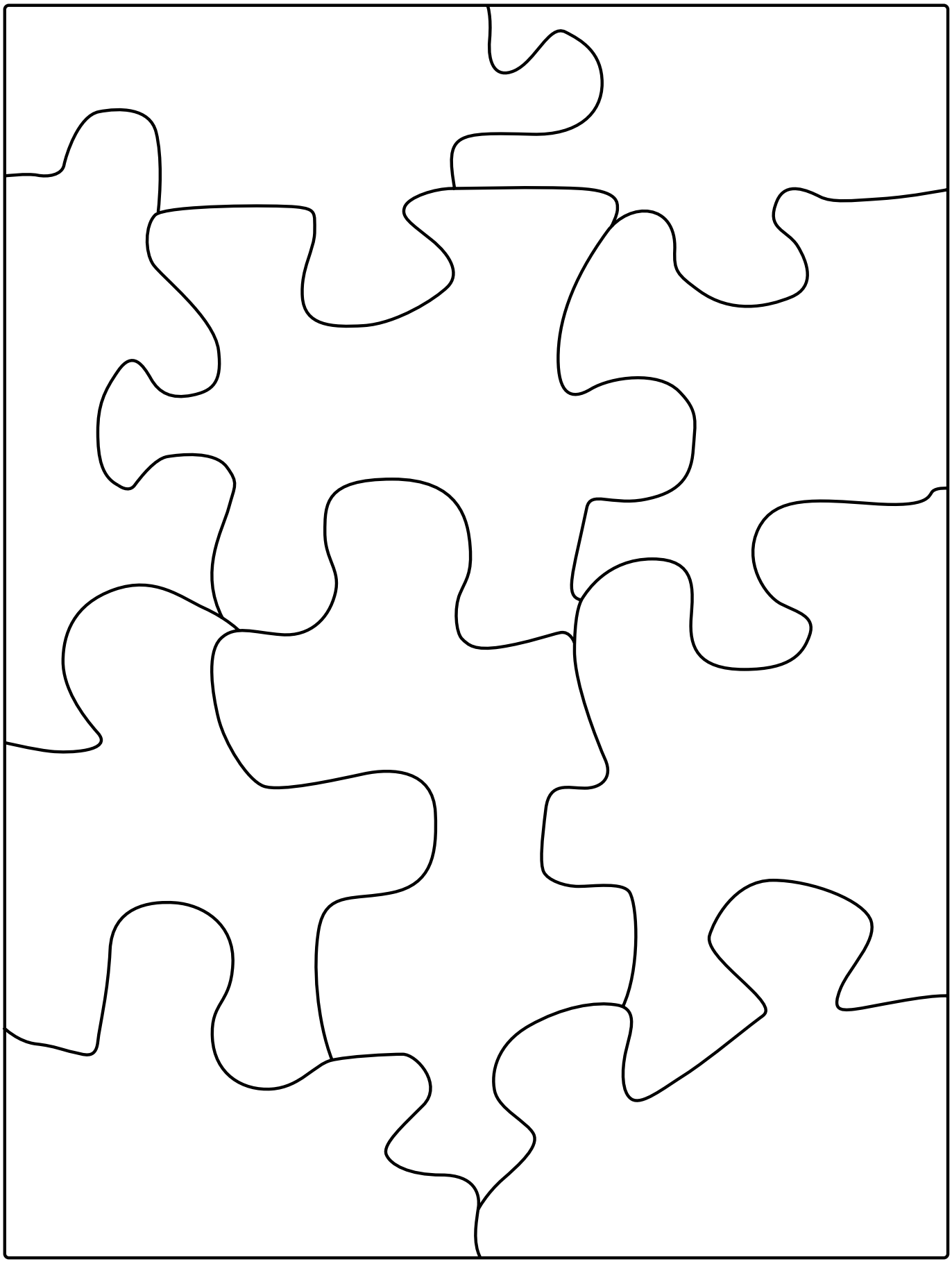
U.S. Pork Center of Excellence
porkgateway.org/resource/nursery-swine-nutrient-recommendations-and-feeding-management

NATIONAL AGRICULTURAL LITERACY OUTCOMES

Science, Technology, Engineering & Mathematics

> T4.9-12.e Identify current and emerging scientific discoveries and technologies and their possible use in agriculture.

Teacher Instructions: Print and cut apart enough puzzles for students to be in groups of 2-3. Mix around the pieces so groups do not have the appropriate puzzle pieces, but must collaborate to complete their puzzle.



10 pieces

Name: _____ Period: _____ Date: _____ Due: _____

Weaning Nutrition Summary Worksheet

PART ONE: DIGESTIVE ENZYMES

Instructions: Fill in the blanks as you learn the various components of weaning nutrition.

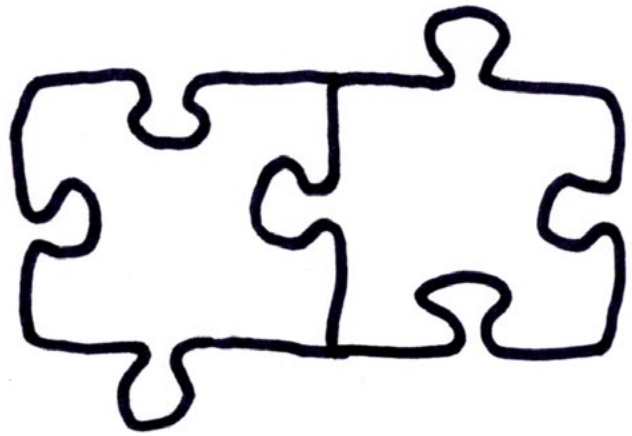
Enzyme: *a substance produced by a living organism that acts as a catalyst to bring about a specific biochemical reaction.*

Digestive enzymes are secreted by various parts of the digestive system to break down food nutrients such as protein, carbohydrates and fats.

MILK CARBOHYDRATE DIGESTION

Milk carbohydrate: Lactose

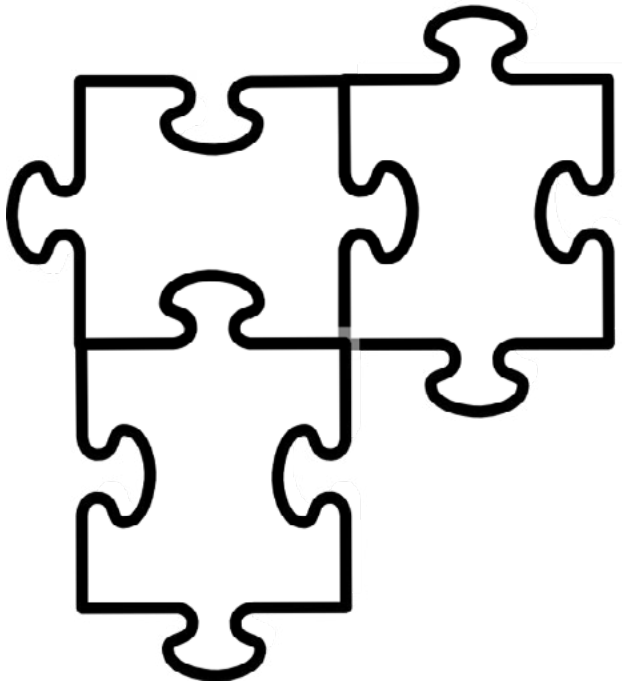
Enzyme: Lactase



GRAIN CARBOHYDRATE DIGESTION

Grain carbohydrate: Starch, fiber

Enzyme: Amylase



Enzyme: Maltase

PART TWO: PHASE FEEDING

Instructions: In each phase, use only the allowed number and color of building materials. After each phase is completed, gain instructor approval before moving on to the next phase.

Building Materials Key	***BLUE:** specialty protein ingredients*	***WHITE:** milk based ingredients*
***YELLOW:** corn*	***ORANGE:** soybean meal*	***GREEN:** added amino acids*

Phase	**Sample ingredients**	**Ingredient purpose**	**Building materials**	**Teacher check**
Phase 1: (13-17 pounds) Transition pig from a 100% milk diet to dry feed. Diet must be easy to eat and digest.	*specialty proteins: fish meal, dried blood meal, dried whey, poultry meal, soybean meal, lactose or deproteinized whey*	*Easy to digest; helps the pig by using the enzymes already in the pig's stomach.*	*20 blue pieces* *10 white pieces*	
Phase 2: (17-25 pounds) Maintaining a complex diet is important, but contains fewer specialty ingredients than phase 1.	*specialty proteins: fish meal, dried blood meal, dried whey, poultry meal, soybean meal, lactose or deproteinized whey (fewer amounts than phase 1)*	*Easy to digest; helps the pig by using the enzymes already in the pig's stomach.*	*15 blue pieces* *5 white pieces*	
Phase 3: (25-40 pounds) Pig is ready to transition closer to a corn-soybean diet. During this phase, pigs are growing rapidly and need higher energy diets.	*Corn and soybean meal.* *Small amounts of milk-based products and specialty proteins.* *Added amino acids (lysine)*	*Corn is high in energy and soybean meal is high in protein.* *Amino acids are added in powder form to ensure pigs get enough protein.*	*6 Yellow* *6 Orange* *3 White* *1 Blue* *3 Green*	
Phase 4: (40-55 pounds) Pigs are starting to enter the "finishing" stage where they will gain weight up to 250 pounds before they go to market.	*Corn and soybean meal.* *Small amounts of milk-based products and specialty proteins.* *Added amino acids (lysine)*	*Corn is high in energy and soybean meal is high in protein.* *Amino acids are added in powder form to ensure pigs get enough protein.*	*5 Yellow* *5 Orange* *1 Green*	

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Weaning Nutrition Summary Worksheet

PART ONE: DIGESTIVE ENZYMES

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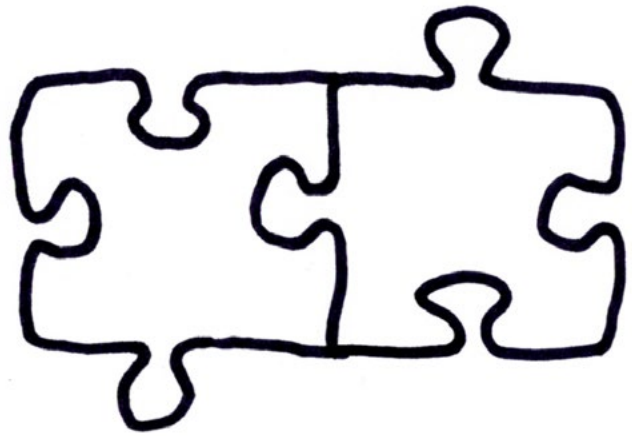
Enzyme: _____

_____

_____

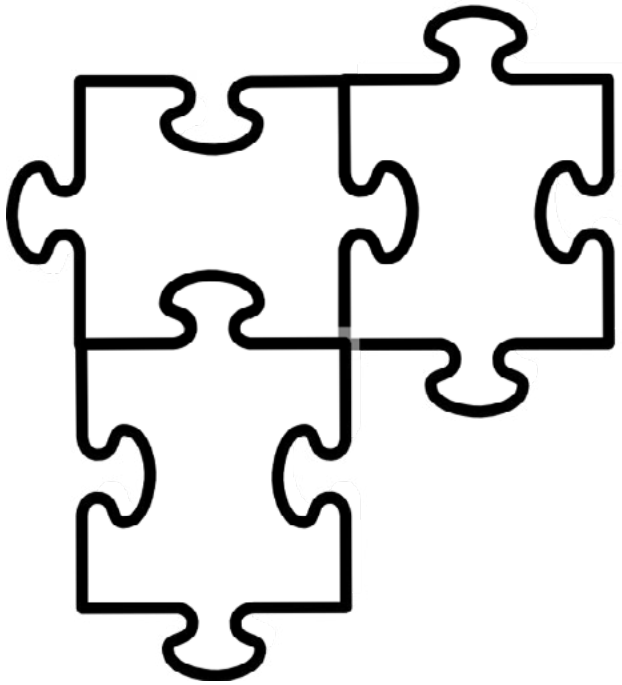
MILK CARBOHYDRATE DIGESTION

Milk carbohydrate _____ Enzyme _____



GRAIN CARBOHYDRATE DIGESTION

Grain carbohydrate _____ Enzyme _____



Enzyme

_____

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