



DAIRY CALF GUT CLOSURE AND COLOSTRUM ANTIBODY ABSORPTION

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LIFE SKILLS:

Critical thinking, evidence-based decision making, responsible animal caretaking, application of science to life.

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INTRODUCTION

Have you ever wondered why colostrum is the most important meal of a calf's life and why timing matters? Get ready to moo-ve with this activity exploring the components in colostrum that travel through your calf's gastrointestinal tract.

OVERVIEW

This lesson blends calf physiology, development, and nutrition into a hands-on activity intended for use with either a 4-H dairy club, SPIN Club topic, or as a study review for a 4-H dairy quiz bowl team.

OBJECTIVES

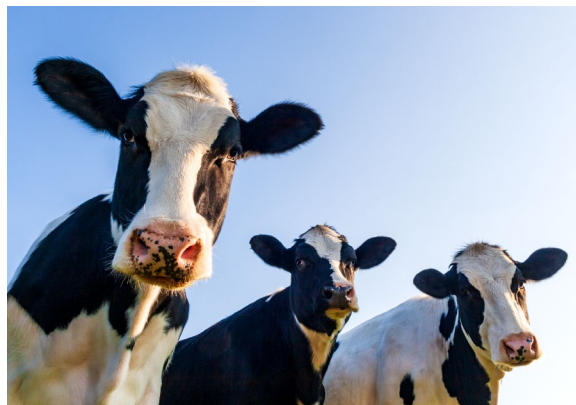
1. Identify the various types of immunoglobulins and the role that they play in calf health.
2. Explain why colostrum is important for the neonatal calf immune response.
3. Describe the gastrointestinal physiological changes that occur in the first 24 hours of life and the impact colostrum may have on the animal.
4. Understand how calf physiology and immunity influence management decisions on the farm.

TIME NEEDED

30 - 60 minutes or one club meeting (depending on group size).

GROUP SIZE

May accommodate a variety of group sizes.





DAIRY CALF GUT CLOSURE AND COLOSTRUM ANTIBODY ABSORPTION – Page 2

TERMS AND DEFINITIONS

Antibodies: proteins that are produced by the body's immune system to help protect against foreign invaders and are specialized so that the defense is specific to the bacteria or virus (etc.). These proteins are produced by B cells or lymphocytes specifically, a unique cell in the immune system. Also known as immunoglobulins.

Passive Transfer (of Immunity): temporary protection given to someone else after receiving a donation of antibodies. Passive means that your body does not need to generate antibodies, just receive them. *Example:* a calf drinking colostrum has transfer of passive immunity because it is drinking a liquid with antibodies.

Brix (°): traditionally, Brix is a measurement of how much sugar is present in liquid, but dairy scientists have developed a mathematical relationship to use Brix to estimate how much immunoglobulin G (IgG; see immunoglobulin) is present in colostrum or serum. This is measured with a refractometer, a machine that measures how much light bends as it passes through the liquid.

Colostrum: first milk produced by mom after giving birth.

Gastrointestinal: the digestive track that helps break down food and makes sure nutrients are absorbed. This tract travels from mouth to rectum and contains the stomach and intestines.

Gut Permeability: how easily molecules or organisms can pass through the gastrointestinal wall (see gastrointestinal). In a healthy organism, the gut wall helps filter what passes to the bloodstream (good things) and what does not (bad things). In a sick organism, the filter does not catch as much before substances pass through, which means that substances that do not normally pass, can slip through.

Immunity: describes the immune system (a physiological process that helps make sure an individual is healthy; see physiology). The ability of a body to keep healthy by acting as a shield (resisting) or fighting off foreign invaders like bacteria or viruses (and others).

Immunoglobulins: these are proteins that are produced by the body's immune system to help protect against foreign invaders and are specialized so that the defense is specific to the bacteria or virus (etc.). These proteins are produced by B cells or lymphocytes specifically, a unique cell in the immune system. Also known as antibodies.

Isotypes: different versions of the same element. Think of siblings in a family, different yet related. *Example:* there are five isotypes of immunoglobulins (A, D, E, G, M).

Neonatal: the first 28 days of life.

Pinocytosis: process that occurs when a cell creates a transport vehicle to hold fluid from outside the cell and all the molecules it contains.

Physiology: the study of how living organisms exist (growth, function, etc.). This field of study helps explain the "why" of living beings.





DAIRY CALF GUT CLOSURE AND COLOSTRUM ANTIBODY ABSORPTION – Page 3

MATERIALS

- Lesson PowerPoint (PPT) or printed handouts of the slides, if not using the internet
- Technology for PPT (laptop, projector)
- Stopwatch (phone or laptop)
- Internet if using laptop as stopwatch on projector
- Four containers of assorted sizes: one extra-small (16-ounce cup), one small (mixing bowl), one medium (five-gallon bucket), one large (storage tote)
- Three standard cereal bowls or other vessels to scope
- Prepared antibodies to represent five isotypes (packing peanuts super glued together, pipe cleaners, paper cutouts, etc.) Three-dimensional objects work best for this activity.
- Optional: music for background, game buzzers

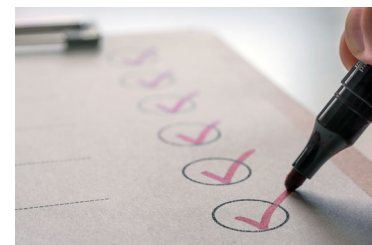
REFLECTION QUESTIONS

See closing activity-based discussion below; step 7.

PROCEDURE

Before: This lesson plan requires individual learning and space for movement. An optional component of quiz bowl would require teamwork. As a facilitator:

- Review the PPT slides and speaker notes. The PPT speaker notes will contain scripts that include what should be emphasized.
- Optional – will there be a practice quiz bowl session before or after the activity?
Refresh participants on the official rules and remind them of the rules prior to the session of play.
- Gather materials for the session and prepare the antibodies required for activity.
- Set up tables and chairs respectively for the lesson plan in which participants will be engaged: Individual learning set-up for the lesson only or group set-up if engaging in the optional quiz bowl practice.
- Prepare a space in the room where participants can move and walk quickly. The tables should be at least six feet from the storage containers that will be used.
- Warm up the technology (laptop and projector, optional buzzers for quiz bowl), pull up the PPT slides and internet stopwatch. If not using technology, make copies of the slides for participants.





DAIRY CALF GUT CLOSURE AND COLOSTRUM ANTIBODY ABSORPTION - Page 4

PROCEDURE CONTINUED

Optional first and last 10 minutes: use the practice quiz bowl questions at the end of the slide deck to gauge where participants are with their learning, prior to using the lesson.

First 15 minutes: Go through the lesson PowerPoint; the script is in the speaker notes of the presentation.

Second 15-30 minutes: Remind participants that this activity is meant to represent the antibody transfer in a young dairy calf in the first 24 hours of life and reinforce the importance of colostrum. Participants will complete the activity individually but compete with one another with the number of “successfully” transferred antibodies after each of their turns. There will be three rounds per student; each round will represent different qualities of colostrum.

1. Prepare the antibody isotypes prior to the session and store them in the large storage tote. See the example image of how to make IgM (5 arms), IgA (2 arms), and the remaining isotypes (IgG; IgE; single).



Figure 1: Examples of different antibody isotypes that are necessary for the game. The example shown here is made from packing peanuts hot-glued together.

- a. For each round of antibody transfer, there will be a different quality colostrum provided. Remove antibodies from tote to correspond to each round.
 - i. For excellent quality (Brix > 22° for field application), the tote should have the maximum amount of antibody; use the whole supply.
 - ii. For good quality colostrum (Brix = 22°), remove $\frac{1}{4}$ - $\frac{1}{2}$ of antibodies from tote.
 - iii. For the poor-quality colostrum (Brix < 22°), only have $\frac{1}{4}$ of the supply available in the tote.
2. Place the colostrum tote at least 12 feet from the containers that participants will transfer antibodies into.
3. Gut permeability is reduced by over half by hour 6 of life. Set the timer for 12 seconds for each of the three segments in round one (6 hours * 2 = enough time for participants to do at least one transfer).
 - a. Segment 1 = **0 – 6 hours of life**
 - b. Segment 2 = **6 – 12 hours of life**
 - c. Segment 3 = **12 – 24 hours of life**
 - d. For practical application, traditionally we suggest colostrum is fed within 2 hours of birth and then a second colostrum meal within 12 hours of that meal (if feasible for the farm).



DAIRY CALF GUT CLOSURE AND COLOSTRUM ANTIBODY ABSORPTION - Page 5

PROCEDURE CONTINUED

4. Participants will use a 16-ounce cup to scoop from the colostrum supply and transfer to separate containers according to activity segment. The size of the container will decrease with each segment to represent the ability of antibodies to pass through the gut as the calf gets older.
 - a. Segment 1 = 0 – 6 hours of life = **largest container**; example is 5-gallon bucket
 - b. Segment 2 = 6 – 12 hours of life = **medium container**; example is standard mixing bowl
 - c. Segment 3 = 12 – 24 hours of life = **extra-small container**; example is cereal bowl
5. Use the 12-second timer for participants to race and transfer as many antibodies as possible from the colostrum tote to the corresponding segment container. At the end of the participant's turn (3 segments), count the antibodies successfully transferred (made it in a container, not on the floor). The student with the largest number of antibodies transferred wins.
 - a. If time allows, count number of antibodies transferred to each segment container to represent the decrease over "time."
6. Repeat for each colostrum quality type. Refer to page 4, item 1a, if needed.

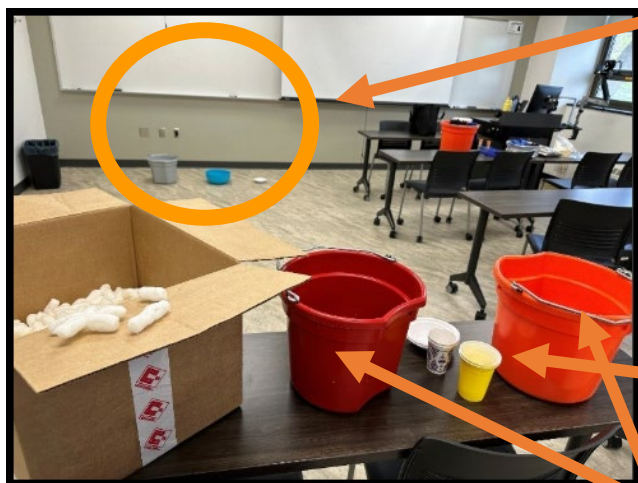


Figure 2: Image contains an example of different storage containers for colostrum quality examples (box and two red feeding containers on the table). In addition, it also shows an example of a transfer vessel (yellow cup on table) and the varied sizes of segment containers on the floor in the background.

7. **Suggested reflection** – Lead participants in discussion about the differences between colostrum quality (Brix °) and timing of delivery. Facilitator may also walk participants through scenarios that exist on a farm such as colostrum shortages and the alternatives, or how best to get antibodies to the calf, despite poor quality colostrum.
8. **Career exploration** – Have a discussion or let youth research jobs and careers related to this lesson. Possibilities include researcher, veterinarian, lab technician, dairy producer, milker, calf manager, agribusiness manager, and agricultural equipment salesperson.