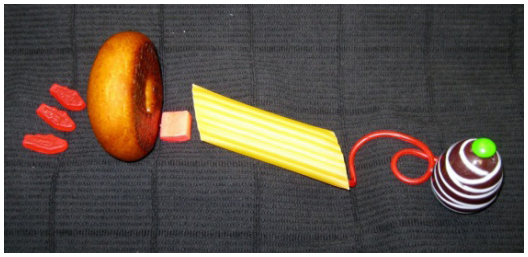
Constructing Reproduction*



Overview:

The *Constructing Reproduction* lesson is designed to add a visual and hands-on component to a topic that can be challenging to teach. Participants will work in teams to create models of a cow reproductive tract, then learn about and use their models to demonstrate the process of fertilization in cattle.

SKILL LEVEL:
- Intermediate to advanced

LIFE SKILLS:
- Communication, critical thinking and decision-making

SETTING:
- An outdoor or indoor space with a supply station and tables or other flat work surfaces; seating is optional

TIME:
- 20–25 minutes

MATERIALS:
- ❒ Markers
- ❒ Flipchart or other large paper
- ❒ Easel or display space
- ❒ Masking tape
- ❒ "Unlabeled Reproductive Tract of the Cow" handout (one per participant, optional)
- ❒ "Labeled Reproductive Tract of the Cow" handout (one per participant, optional)
- ❒ Clock or stopwatch
- ❒ Pens or pencils (one per participant)
- ❒ One or more trash bags
- ❒ "Constructing Reproduction Kit" materials (1 kit per team, plus one demonstration kit; quantities are based on what is needed to create kits for 10 three-person teams, and may need to be adjusted)
  - 7.3-ounce bag of hard-shelled, bite-sized candies (such as Skittles, M&Ms or Reese's Pieces)
  - 10 plastic eggs or large gumballs
  - One 8-ounce bag of small, fish-shaped candy (such as Swedish fish or gummies)
  - One 14-ounce bag of licorice (pull-apart style, if available)
  - 10 mini bagels or doughnuts
  - One 2.07-ounce roll of Starburst or similarly sized and shaped candies
  - 10 manicotti noodles
  - Quart-sized resealable plastic bags (one per team, plus one for demonstration)
  - A flat, portable workstation such as strips of aluminum foil or plastic wrap or flat baking sheets (one per team, optional – needed only if tables aren't available in workspace)

(**Note:** If you would prefer to create reusable kits, you could replace the edible pieces with objects that roughly match their shapes. It's not practical to match the sizes of the actual cow parts, but if possible, find objects that are roughly in the same proportions to each other as the edible parts. Potential matches include Legos, Lincoln Logs, Tinker Toys, table tennis balls, pickup sticks, nuts and bolts, small-diameter pipe insulation and wire. You could ask families for contributions from their children's unused toys or find these items at resale stores, charity shops and garage sales.)

Note To Volunteers:

Animal reproduction is an important aspect of many 4-H animal science projects, but lessons on the subject have the potential to embarrass youth participants and concern their parents or guardians, who may fear that more information is being introduced than is developmentally appropriate for the participant. For this reason it's important to notify parents or guardians well ahead of time that you plan to use this lesson with your 4-H club or group.

Even with parental permission, the lesson may be most appropriate for use with mature groups that have built up a degree of trust with each other.

*Some concepts in this lesson were adapted with permission from the "Fertilization and Pregnancy" lesson created by the *California Department of Education, CTEOnline (www.cteonline.org) website.*

Objectives:

After completing this activity, participants will be able to:

- Describe the process of reproduction, including fertilization, in cattle.
- Use their models to demonstrate how fertilization takes place in cattle.
- Discuss the advantages and disadvantages of the two major farm animal fertilization options: natural breeding and artificial insemination (AI).
- Give a basic explanation of how embryo transfer (ET) is done in farm animals.

PROCEDURE:

Before the meeting:

1. Review the lesson and gather any supplies you will need.
2. Print as large a copy of the "Unlabeled Reproductive Tract of the Cow" handout as you can. (**Note:** If you don't have access to a copier that can enlarge the images, you could use a computer or overhead projector to increase the image size so you can trace it onto flipchart paper. You may want to laminate at least one enlargement so you can use it repeatedly.) Hang one enlarged handout where the whole group will be able to see it, but keep it covered until the appropriate point in the lesson. You may also want to make one photocopy of the "Labeled Reproductive Tract of the Cow" handout on 8.5-inch by 11-inch paper for each participant.
3. Assemble one "Constructing Reproduction Kit" for each team. Place one plastic egg, three (or a small bag of) hard-shelled candies, three fish-shaped candies, one strand of licorice, one mini bagel or doughnut, one Starburst candy and one large manicotti noodle in each quart-sized bag. Set the kits on the supply station.
4. Recreate the following list of supplies and what part of the cow's reproductive tract each represents on flipchart paper and display it where everyone can see it, but keep it covered until the appropriate point in the lesson.

A model of a cow's reproductive tract

Model part	Reproductive organ it represents
Plastic egg or large gumball	Ovary
Hard-shelled candy	Ovum (egg)
Small, fish-shaped candy (such as Swedish fish or fish-shaped gummies)	Sperm
Licorice (pull-apart style)	Oviduct (Fallopian tube)
Mini bagel or doughnut	Cervix
Candy such as Starburst	Uterine body
Manicotti noodle	Uterine horn

5. Recruit one or more teen or adult volunteers to help with the activity.

During the meeting:

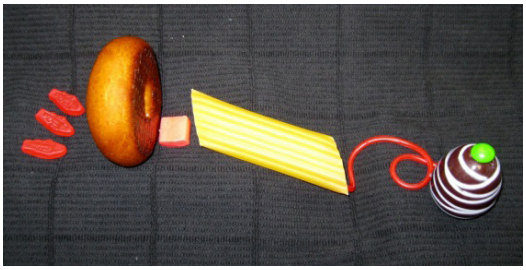
1. Introduce the activity by reading aloud or paraphrasing the following:

   Today we're going to discuss some of the basics of farm animal reproduction. The first step will be to review the basic parts that make up the reproductive system of a female farm animal. We'll be looking specifically at cows because knowledge of their

reproductive systems is extremely important to both beef and dairy producers. Additionally, their reproductive systems are similar to those of many other farm species.

2. Ask the group the following questions. (You may want to record their answers on flipchart paper and display the paper where everyone can see it.)
   - Why is it important for farm animals to mate and raise healthy offspring? *(For the animals themselves, to continue the species. For the humans who arrange the mating: To continue the supply of food, clothing and other products and materials that come from the animals; to improve the breed; to provide 4-H and other show animals.)*
   - Starting with the mating of mature animals, what are the basic steps in the process of mammal reproduction? *(Mating, fertilization, gestation or pregnancy, birth or parturition.)*
3. Uncover the diagram of the reproductive tract of a cow. Explain that while this diagram is of a cow's reproductive system, the females of most species of mammals have similar parts. Ask for volunteers to take turns naming one part of the female reproductive tract shown on the diagram. As participants name each part, label the part on the diagram. Continue until all of the parts have been labeled. (Refer to the "Labeled Reproductive Tract of a Cow" handout to ensure that the diagram is labeled correctly.)
4. Next, divide the group into teams of three or four people, depending on the size of the group and how many kits you made. Have the teams spread out around the work space, and ask one person from each team to collect a "Constructing Reproduction Kit" (and, if necessary, a baking sheet) from the supply station.
5. Read aloud or paraphrase the following:

   As I mentioned earlier, this lesson is about animal reproduction. When I give the signal, your team will have 5 minutes to think up and build something related to animal reproduction using the building materials in your kit. You can alter the supplies however you want to as you're building, and I encourage you to find a use for as many of the supplies in your kits as you can.
6. Walk around the room as the teams work, answering any questions they may have. At the 3-minute point warn the teams that if they're still planning, it's time to switch to building.
7. After 5 minutes, or when the teams seem to have finished their creations, call time and tell the teams to stop working. When the participants have returned their attention to the whole group, ask for one volunteer from each team to explain the team's creation, what it has to do with animal reproduction and what each piece of it represents. Continue the sharing until all of the teams have had a turn. If time and space allow, have the teams walk around the work space to look closely at the models created by the other teams.



8. Next, uncover the supplies sheet and explain what part of the cow's reproductive tract each item in the kit represents.

9. Discuss the supplies and give the teams a few minutes to adjust or rebuild their earlier creations to correct their model. If your group is young or inexperienced, or is otherwise having trouble with the model, you may need to walk them through the building process, using the following instructions and referring to the photo of the model as needed.

   Place the ovary (plastic egg) on the top right corner of your work surface. Connect the oviduct (licorice) to the ovary, then to the uterine horn (manicotti noodle). Place the uterine body (Starburst) next to the uterine horn, followed by the cervix (mini bagel). Put the ovum (hard-shelled candy) into, on or next to the egg, because the ova are held in the ovaries until they're released (usually one at a time) and begin moving toward the uterine body and uterine horn. Place the sperm (fish-shaped candy) outside of the cervix, because that's where they're deposited during natural breeding.

10. Next, read aloud or paraphrase the following:

    Congratulations – you've just built a model of a cow's reproductive tract, minus the vagina and vulva. A real cow reproductive tract is Y-shaped from the uterus on, with an ovary, oviduct and uterine horn on each side of the "Y." Note that your models only have the right side of the Y. The uterine horns are relatively large and visible, so they're represented by the manicotti noodles. The uterine body in cattle is very small (at least when there's no embryo growing in it), so it's represented by a smaller object, the Starburst candy.

    The oviduct, sperm and ovum in your models aren't the correct sizes. A real oviduct is very thin and winding; it isn't even as big around as a single strand of pull-apart licorice. One end of the oviduct is covered by a funnel-shaped membrane called the* infundibulum *that helps direct a newly released ovum from the ovary into the oviduct.

    Ova are the largest single cells in the cow's body – large enough to be seen without a microscope. By contrast, sperm are the smallest cells in a bull's body, and can't be seen without a microscope.

11. Answer any questions the group may have, then ask the teams to pick up and move the ova in their models from the ovary down the oviduct. Explain that an ovum is released once in each 21-day estrous cycle (the period from one "estrus" or "heat" to the next). Next, have the teams pick up and move the sperm from outside the cervix up the reproductive tract to the oviduct.

12. Explain that when an ovum and sperm meet in the cow's reproductive tract – whether the sperm gets there by natural breeding or artificial insemination – they can combine to form a zygote. The zygote moves to the uterine horn and attaches itself to the wall, where it will develop into an embryo, then a fetus and eventually into a calf.

13. Encourage each team member to practice the process of fertilization using the team's model. When everyone who wishes to has had a turn, have a volunteer take a trash bag around the room and collect the model pieces from each team. Save the supplies that are reusable, such as the plastic eggs.

14. Draw the group's attention back to the labeled diagram of the reproductive tract of a cow. Ask them the following questions:

- Name the two main methods of impregnating a farm animal. *(Natural breeding and artificial insemination or AI.)*
- Where is the sperm deposited when an animal is bred naturally? *(In the female's vagina.)*
- Where is the sperm deposited when an animal is bred via AI? *(In the female's uterine body or uterine horn, depending on whether the goal is to have the sperm in both horns or just one.)*
- Why does the location of the sperm deposit make a difference? *(Where the sperm is deposited is very important in AI because there aren't nearly as many sperm in a single "straw" of semen as there are in a single ejaculation. [A straw is the container that holds one "dose" of semen.] In natural breeding, the bull deposits 4 to 5 cc with 1 to 1.5 billion sperm per cc. In AI, the semen from one ejaculation is divided into several 0.5 cc straws, each containing 30 million to 40 million sperm. Each straw also contains an extender to help it survive the freezing and thawing process. Conception rates are improved when sperm is deposited forward of the cervix.*

15. Read aloud or paraphrase the following:

Embryo transfer (ET) is becoming better known in the livestock industry. In the ET process, the donor female is usually bred through artificial insemination, which may result in several fertilized eggs. Before the fertilized eggs attach to the uterine wall, they're either collected and transferred to the uterus of surrogate females that will carry the fetuses to term, or the eggs are frozen to be used later. ET is generally done so that a female that has proven she will or that is expected to pass along desirable genetic and phenotypic (physical appearance) characteristics to her offspring can produce more offspring over her lifetime than she could if she carried one embryo at a time to term.

TALKING IT OVER:

Ask the group the following questions.

- What are some of the advantages of having fertilization take place naturally in farm animals? Disadvantages?
- What are some of the advantages of using technology like AI in farm animals? Disadvantages?
- Why is it important for farmers, 4-H'ers and others to understand how fertilization takes place in farm animals?
- What role is technology currently playing in breeding farm animals?
- What role might technology have in breeding farm animals in the future?
- What was the most challenging part of this activity?

16. If you made copies of the "Labeled Reproductive Tract of the Cow" handout for each participant, pass them out now. Summarize the lesson by reading aloud or paraphrasing the following:

Today we've focused on the reproductive tract of cows. They, along with the females of most other mammalian farm animal species (including sheep, horses, cats, dogs and rabbits), are* bicornuate*, which means their reproductive tracts have two uterine horns. While many species of farm animals have similar reproductive tracts, they're not identical. Rabbits, for example, have two cervixes.

No matter the details of how a female animal's reproductive tract is shaped, successful fertilization depends on breeding taking place when the right hormones are present at the right levels when the female is at the right stage of the estrous cycle. And even when all of those conditions are met, many other factors affect whether fertilization takes place and the female gives birth to live and healthy offspring.

ADAPTATIONS & EXTENSIONS:

- **For older or more experienced participants:**
  - Contact a local processing facility and arrange to collect female reproductive tracts from various farm animal species. Have the participants dissect the tracts, looking closely at the organs and other structures. You'll need to recruit volunteers to help supervise the activity and make sure that safety precautions (such as wearing surgical gloves and eye protection) are strictly followed.
  - Pass out copies of the "Unlabeled Reproductive Tract of a Cow" handout and have participants work independently to label the parts.
  - Challenge participants to research the hormones and hormone levels that are involved in the process of reproduction in various female farm animals. Suggest that they research the following information:
    - The typical level of each hormone.
    - How the hormone levels change throughout the estrous cycle, fertilization and pregnancy.
    - The function of each hormone.
    - Why each hormone is required for a safe and healthy pregnancy.
- **For younger or less experienced participants:** Work as a large group to build one model of a cow reproductive tract.
- Add a new portion to the lesson to better explain gestation (pregnancy), how the fetus is carried by the mother during pregnancy and the size of the fetus at different stages of development.

ALIGNMENT TO SCIENCE & ENGINEERING PRACTICES:

How 4-H Increases Science Literacy

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry-based. The lessons in the *4-H Animal Science Anywhere* series can be used to enhance classroom science education in Michigan and elsewhere. The lesson activities are aligned with the eight Scientific and Engineering Practices (SEP) from *A Framework for K–12 Science Education* (National Research Council, 2012, p. 42).

The Michigan State Board of Education adopted a set of new state science standards in late 2015 that are based on the SEP. The activities in the *4-H Animal Science Anywhere: Constructing Reproduction* lesson were evaluated for their alignment with the SEP by MSU Extension Educator Tracy D'Augustino in 2016.

Table 2. How This Lesson Aligns With the Science and Engineering Practices (National Research Council, 2012, p. 42)

Science & Engineering Practice	Action	Activity Step
1. Asking questions and defining problems	▸ Participants discuss why it's important for animals to mate and raise healthy offspring. ▸ Participants brainstorm the basic steps in mammal reproduction.	2
2. Developing and using models	▸ Participants build models of a cow reproductive tract. ▸ Participants explain how the parts of their models represent cow reproductive parts.	4–6 7
3. Planning and carrying out investigations		
4. Analyzing and interpreting data	Participants learn about mammal reproduction using their models.	4–7
5. Using mathematics and computational thinking	Participants explore how hormones are involved in mammal reproduction and how the levels change.	Adaptations & Extensions
6. Constructing explanations questions and designing solutions	▸ Participants build and describe their models of the cow reproductive tract. ▸ Participants explain the process of fertilization in a cow.	4–7 13
7. Engaging in argument from evidence	▸ Participants discuss the advantages and disadvantages of natural and artificial fertilization. ▸ Participants discuss why it's important to know how fertilization takes place.	Talking It Over
8. Obtaining, evaluating, and communicating information	Participants learn about the mammal reproductive tract and fertilization, and communicate the information with others.	Whole lesson

REFERENCES & RESOURCES:

Mosman, C. T. (1991). Breeding and reproduction [Unit G]. Ag 530 – *Zoology animal science for Idaho secondary agriculture instructors.* Moscow: University of Idaho, Department of Agricultural and Extension Education. Retrieved from http://www.uidaho.edu/cals/ae4hyd/secondaryagcurriculum/ag530-zoologyanimalscience

Parish, J. A., & Larson, J. E. (2010). *Artificial insemination programs for cattle* [2628]. Mississippi State: Mississippi State University, MSU Extension Service. Retrieved from msucares.com/pubs/publications/p2628.pdf

Senger, P. L. (2003). *Pathways to pregnancy and parturition (2nd ed.).* Washington, DC: Current Conception. This illustrated book may help you answer participants' questions about animal reproduction.

Whittier, J. C. (1993). *Reproductive anatomy and physiology of the cow* [G2015]. Columbia: University of Missouri, U of M Extension, Department of Animal Science. Retrieved from http://extension.missouri.edu/publications/DisplayPrinterFriendlyPub.aspx?P=G2015

ACKNOWLEDGMENTS:

Author: Julie Thelen, 4-H Livestock and Veterinary Science Educator, Michigan State University Extension

This bulletin was produced by ANR Creative (*anrcom.msu.edu*) for MSU Extension (*msue.anr.msu.edu*).

MICHIGAN STATE UNIVERSITY | Extension

*Unlabeled Reproductive Tract of the Cow**

Side View

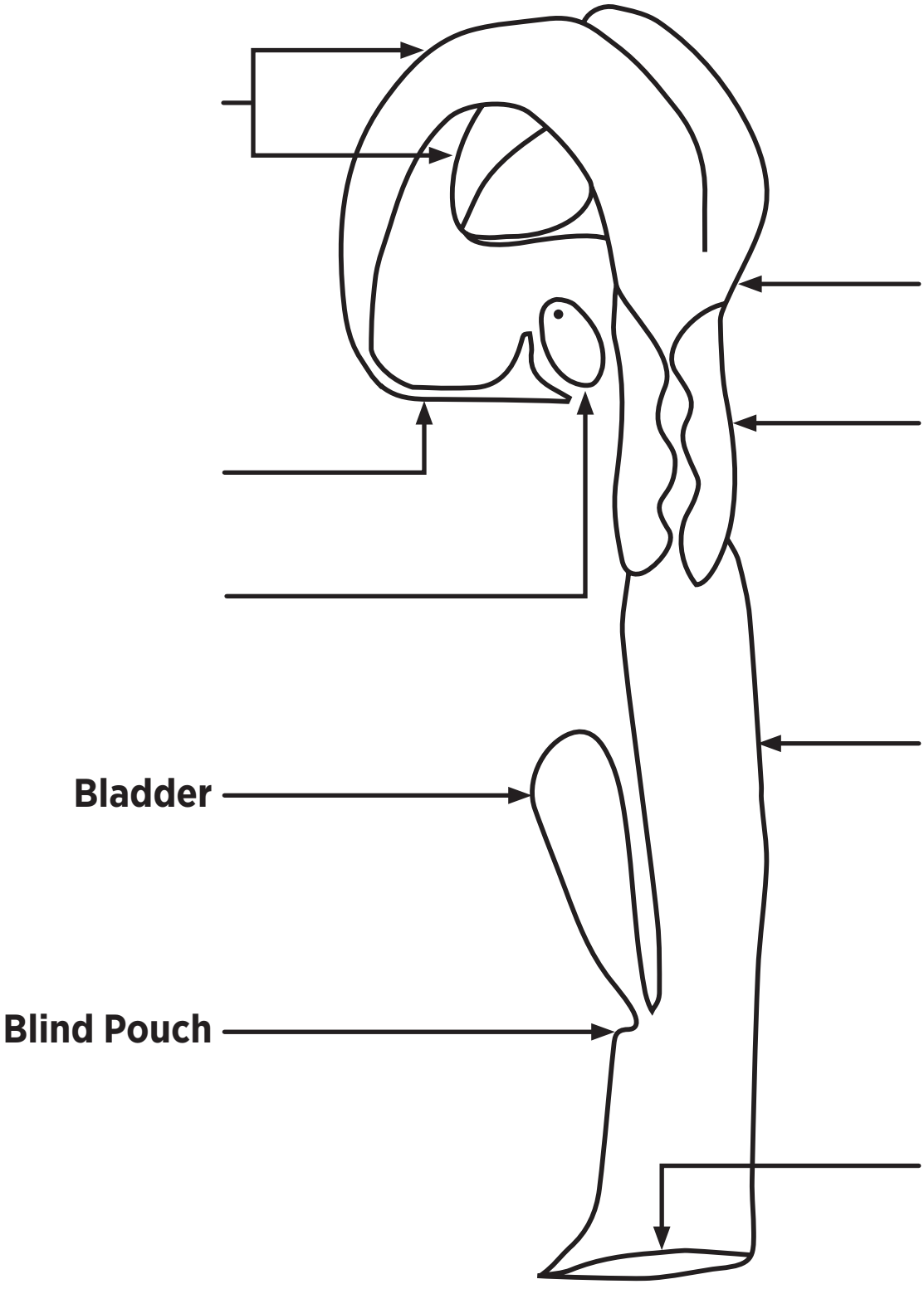


*Image adapted from University of Missouri Extension.

*Unlabeled Reproductive Tract of the Cow**

Dorsal View

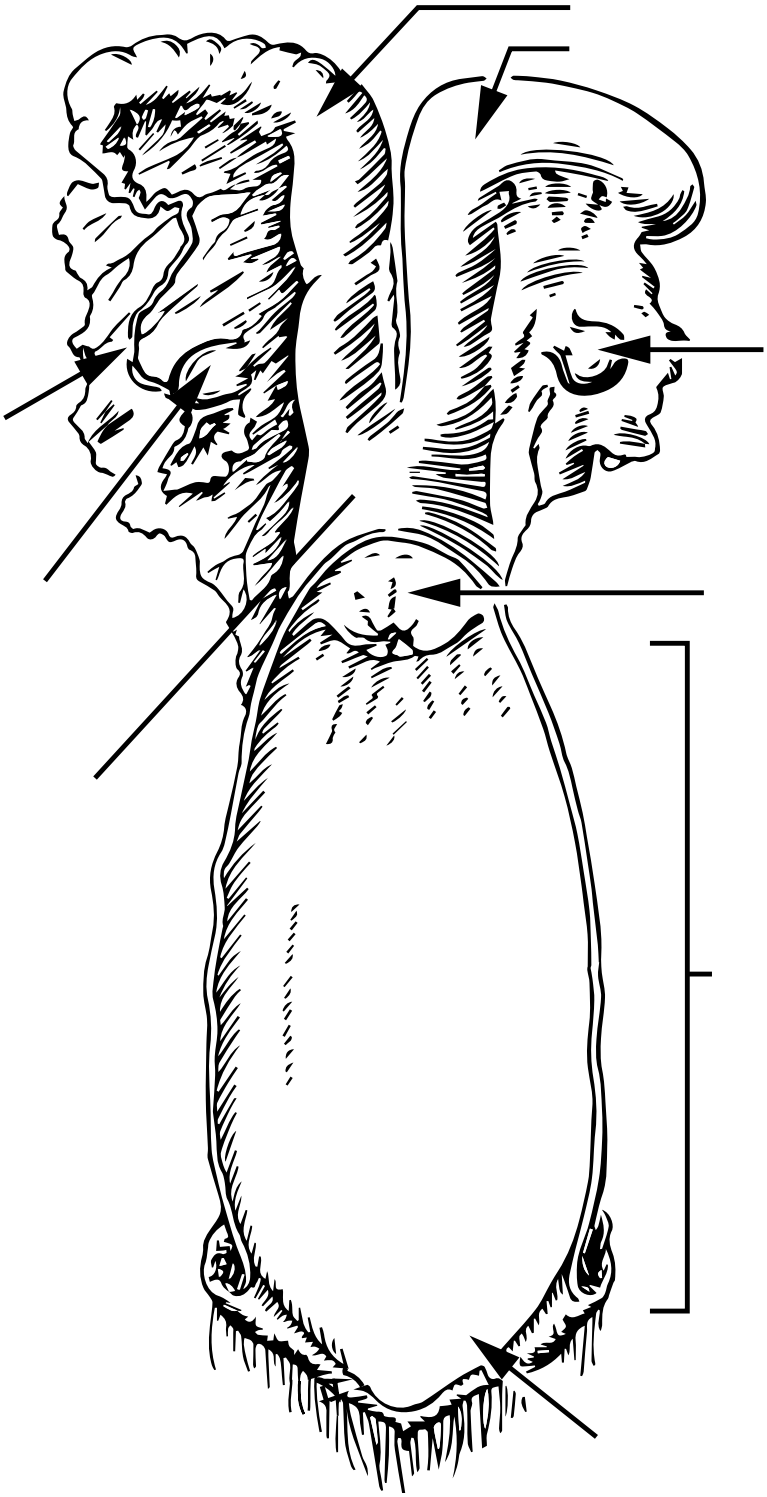


*Image adapted from Mosman, C. T. (1991).

*Labeled Reproductive Tract of the Cow**

Side View

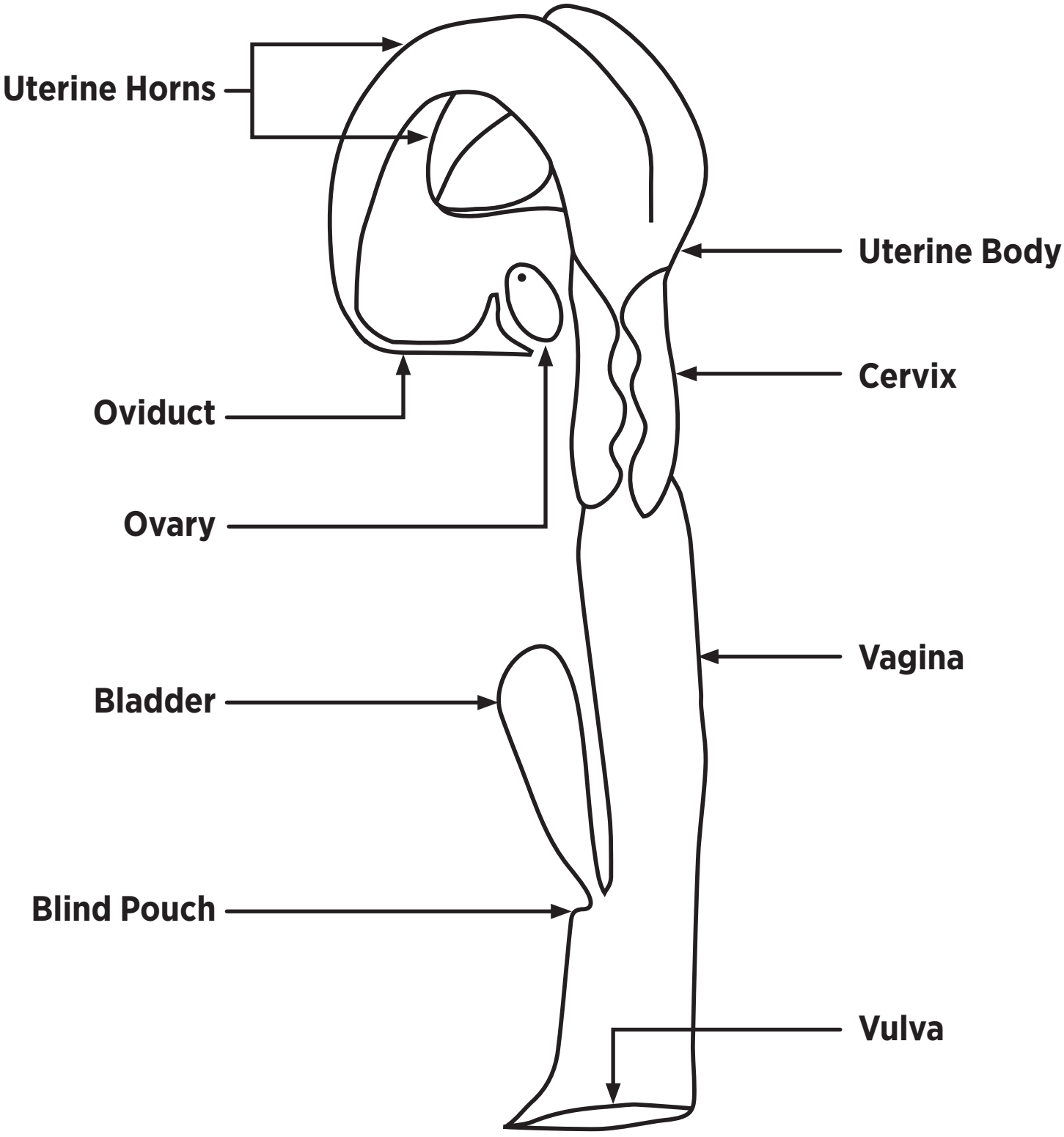


*Image adapted with permission from University of Missouri Extension.

*Labeled Reproductive Tract of the Cow**

Dorsal View

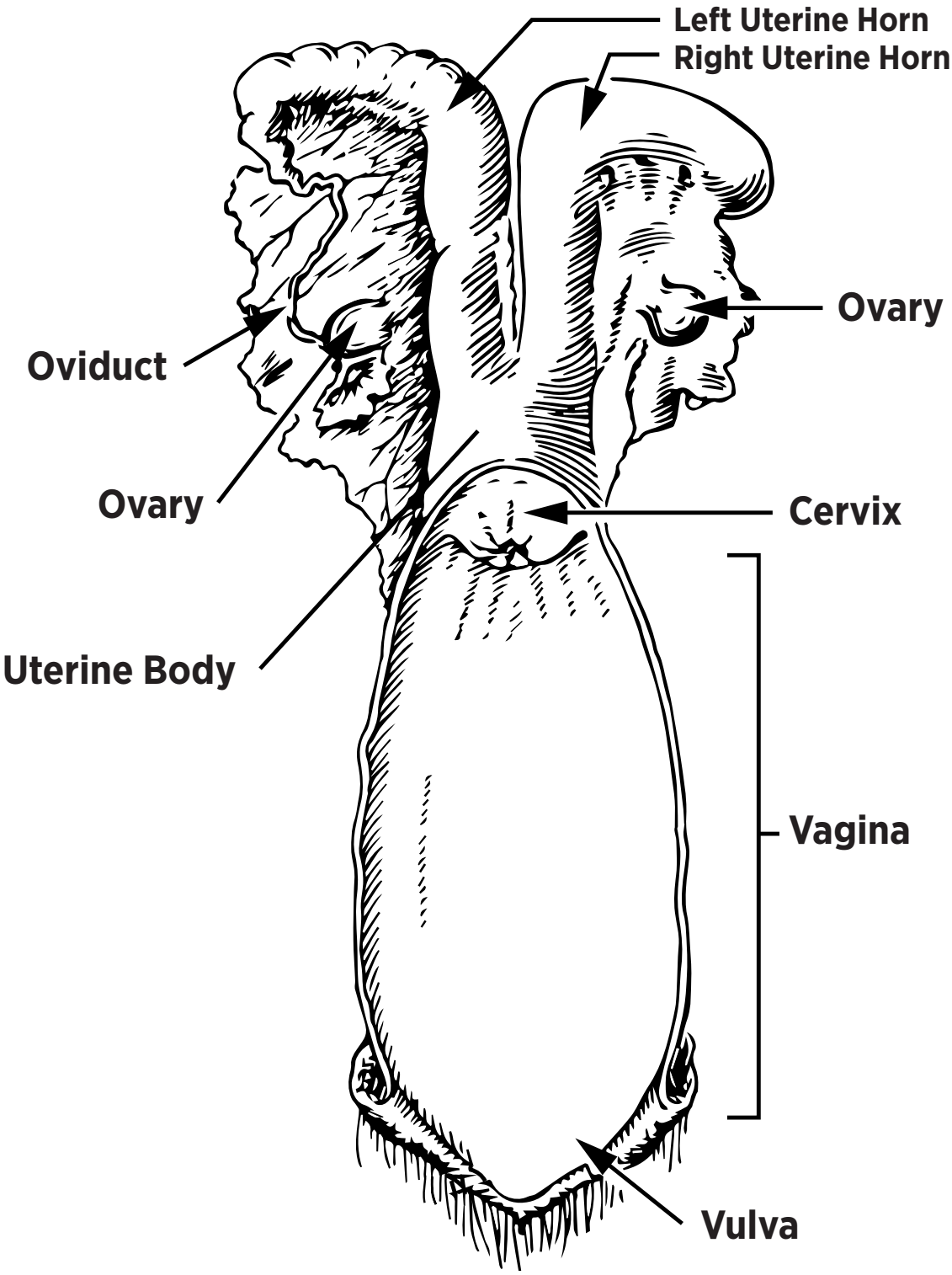


*Image adapted from Mosman, C. T. (1991).