
Welcome to the Mississippi Master Cattle Producer Program Self-Study Program Beef Cattle Reproduction training module. This program is administered by the Mississippi State University Extension Service. For answers to questions about this training program, contact Dr. Jane Parish, MSU-ES Extension Beef Cattle Specialist.

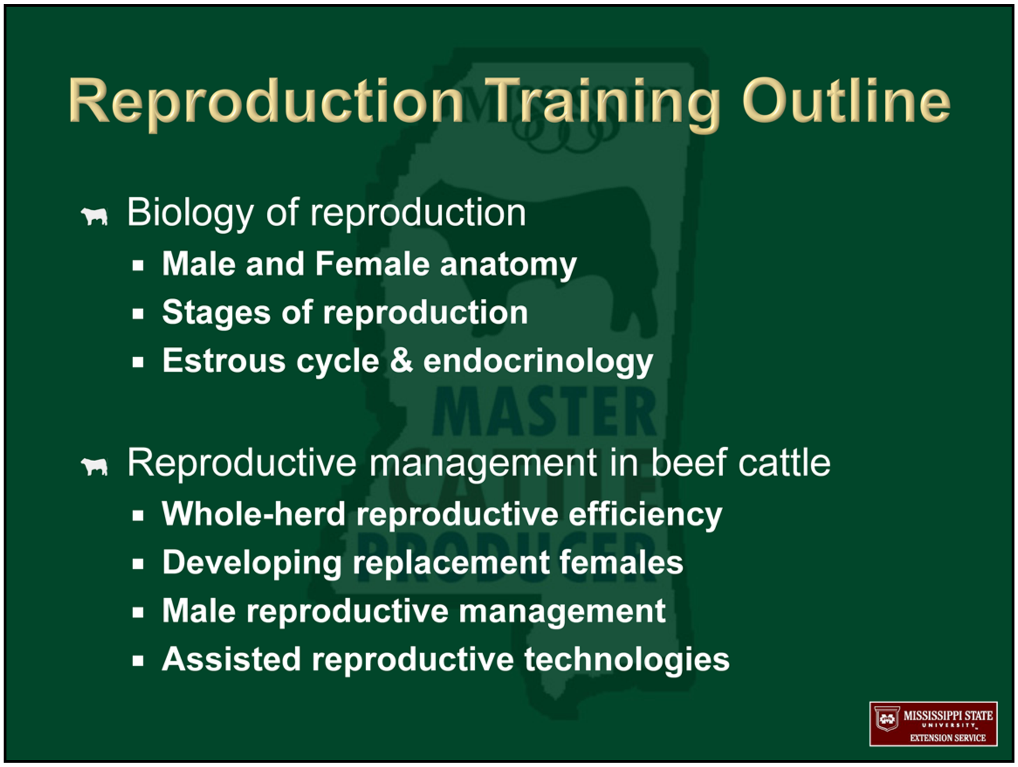
Jane Parish

662.325.7466 office, 662.325.8873 fax, jparish@ads.msstate.edu

Mississippi Master Cattle Producer Program

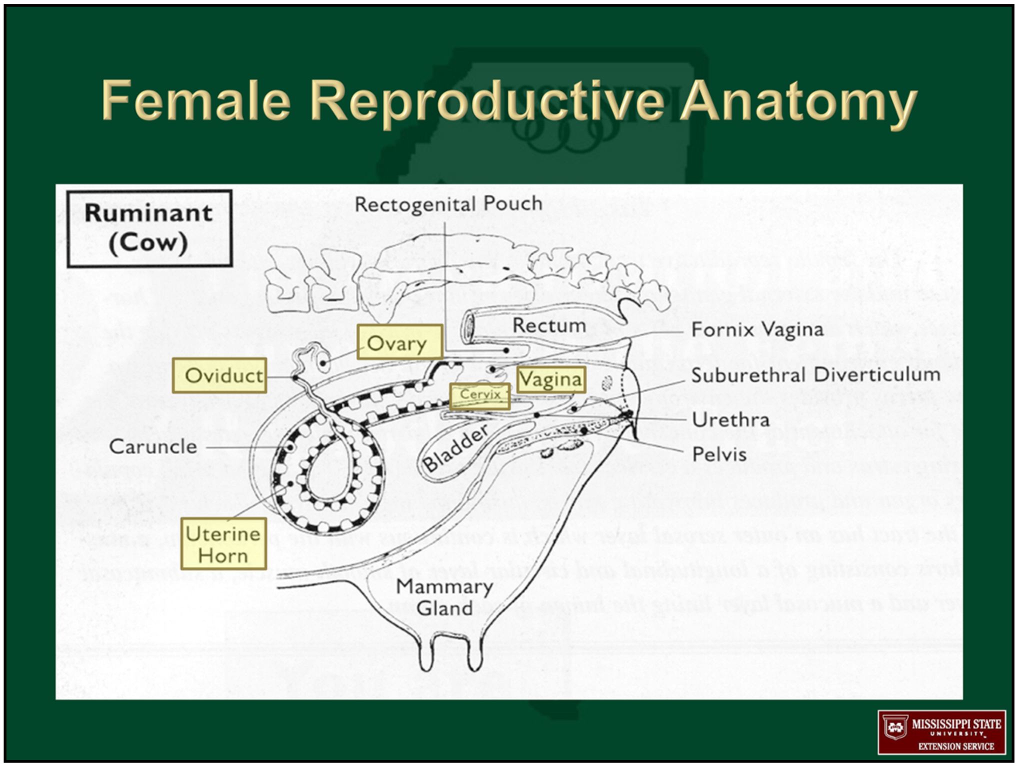
Box 9815

Mississippi State, MS 39762




This training first introduces reproductive biology to gain a basic understanding of how cattle reproduce. It is important to understand the biology and reproductive anatomy of cattle so that, when a problem is encountered, a solution can be quickly formulated. At very least, the right questions can be asked.

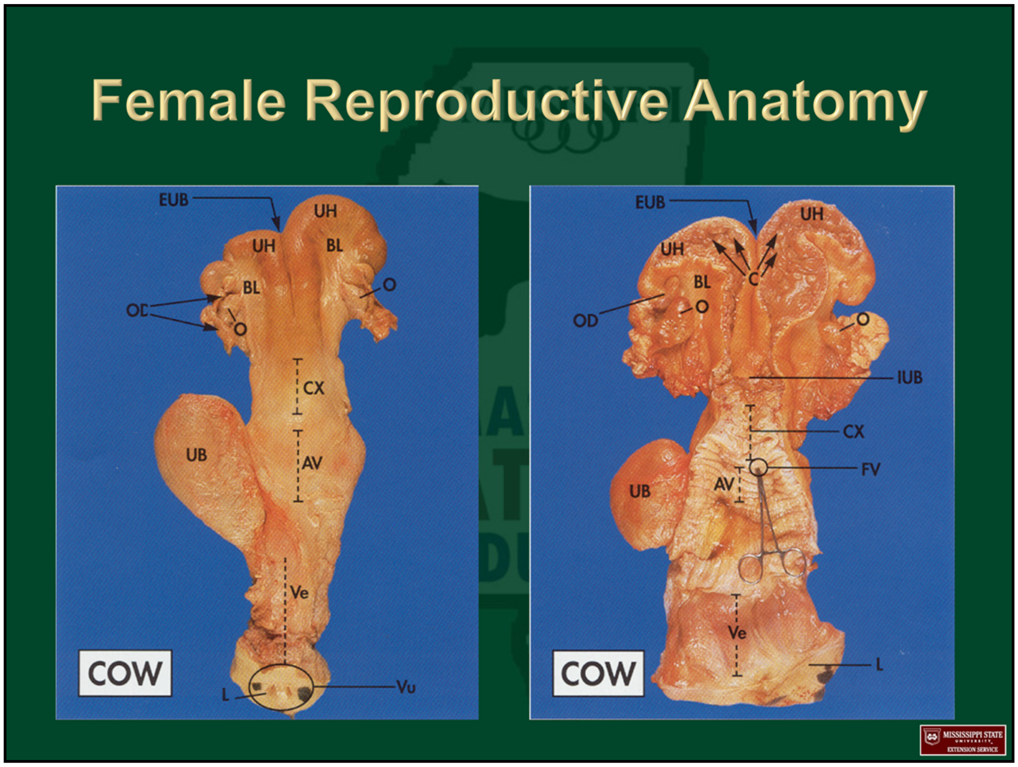
The last half of this training builds on the basics of cattle reproduction to show the importance of proper reproductive management. Finally, more advanced techniques and practices are introduced that can, in some cases, be used to further improve profitability and sustainability.




This drawing represents the cross-section of a cow whose head would be pointed toward the left of the slide and tail to the right. Notice the positioning of the major reproductive organs: vagina, cervix, uterine horn oviduct and ovary.

The most basic description of reproduction in cattle is as follows: Semen is deposited in the vagina when the female is sexually receptive. Sperm cells in that semen are moved to the oviduct. In the meantime, an egg is released from the ovary and also moves to the oviduct. When the sperm and egg meet, fertilization occurs and produces an embryo. The embryo moves from the oviduct into the uterus where it develops into a fetus and is gestated for the remainder of the pregnancy. After the fetus reaches full term, it is expelled (parturition or calving).

While this is a very basic description of reproduction, there are many things that must happen at the appropriate timing for success. Subsequent slides describe the specific functions of each of these anatomical features.

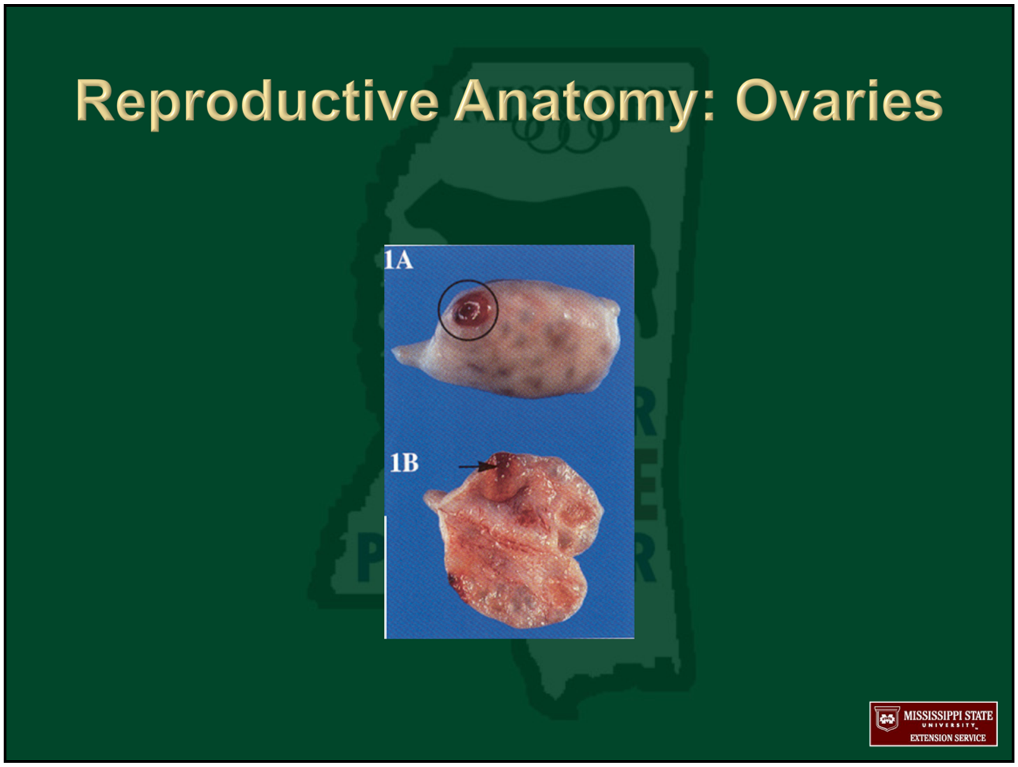



These pictures are of the reproductive tract that was dissected out of a cow. The picture on the left shows the external features of the tract. The picture on the right is the same uterus opened to reveal the internal layer(s). Think of the entire female reproductive tract as a tube with different textures, sizes, and features. The inside hollow portion of that tube is called the lumen.

Beginning at the bottom, the external genitalia is referred to as the vulva (Vu). The dotted line, extending from the circle around the vulva, shows the length of the vestibule vagina (Ve). This is the portion of the vagina behind where the urinary bladder (UB) empties in through the urethra. From there is the anterior vagina (AV). The two sections of the vagina are different in their environment and function.

After the anterior vagina comes the cervix (CX). The cervix is one of the most prominent features of the female reproductive tract and is often referred to as the “landmark” because it is relatively easy to identify from the other tissues when rectally palpating cows.

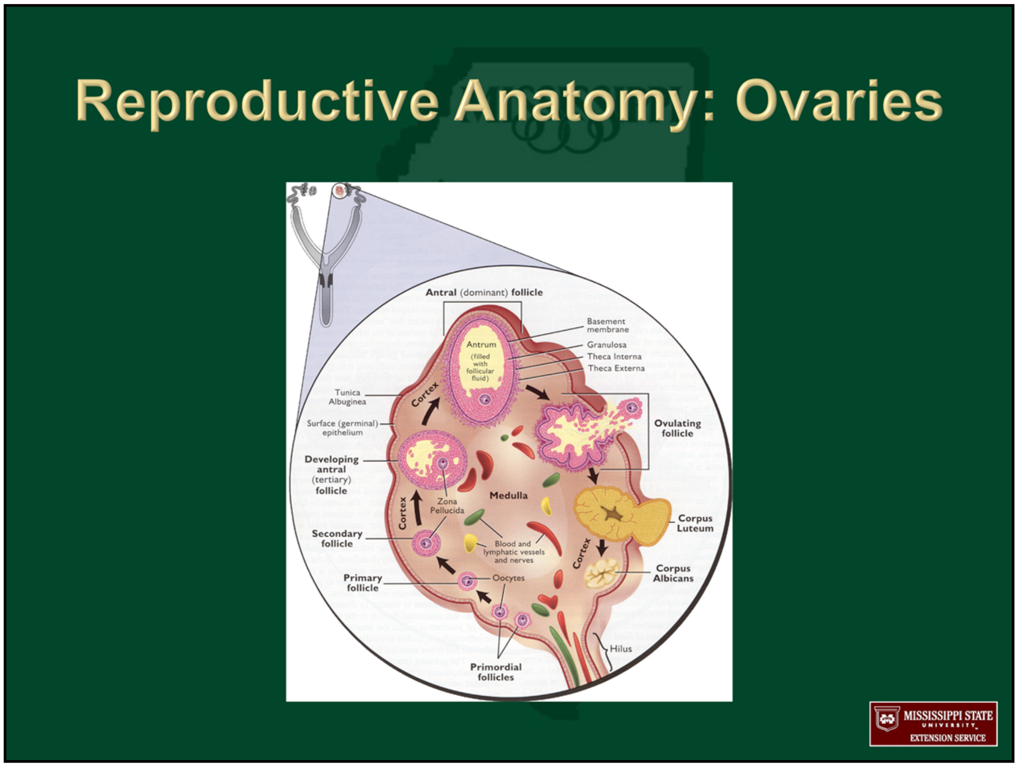
Beyond the cervix is the uterus. After a portion the uterus splits (internal or external uterine bifurcation; IUB or EUB, respectively). From that split, the uterus takes the shape of two ram’s horns, where it gets the name uterine horn (UH). The horn narrows at the end and becomes a small tube called the oviduct (OD). The ovary (O) is located at the end of the oviduct.




The ovary houses the ovum (eggs) that will eventually be released into the oviduct to be fertilized. This picture shows an ovary dissected away from all its surrounding tissue. The bottom image is the same ovary split down the middle to show its inner core.

The structures on the ovary and the hormones they produce will be discussed in more detail later. The egg must be released from the ovary, into the oviduct, to be fertilized. The timing of this is extremely important.

The ovary has all the eggs it will ever have when the heifer is born. They do not replicate and the ovary is never replenished. That means that, when a calf is born to a 13-year-old cow, the egg it developed from sat dormant in that cow and remained viable since before the cow was born. The importance of realizing this is to know that those eggs can, in severe cases, become damaged and fertility can be permanently affected.




This cartoon illustrates structures that grow and regress on the ovary. As a structure grows, it does not move around the surface of the ovary but remains in the spot where it began to develop. It is pictured as moving here solely for illustrative purposes.

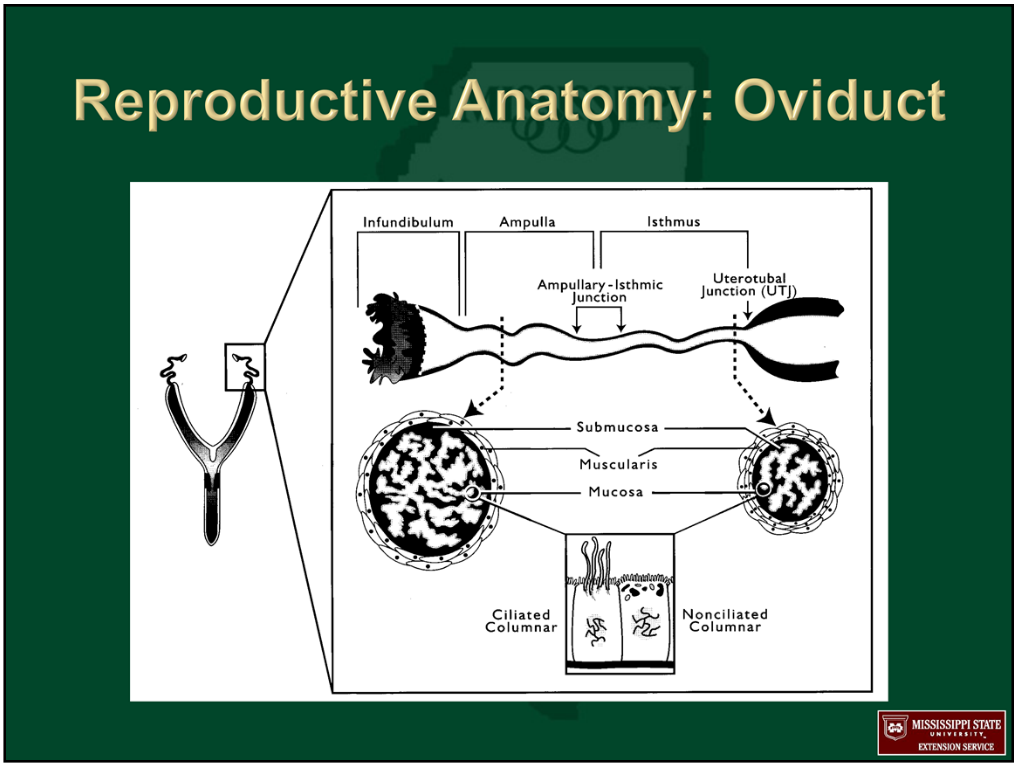
The follicle begins as a small group of cells organized around the egg. When it receives the right hormone signals, the cells multiply and the follicle begins to grow. Eventually, those cells produce fluids that fill the inside of the follicle, and it appears as a blister on the surface of the ovary.

After the cow comes in heat (estrus), the follicle ruptures and expels the egg. When this happens, the remaining tissue turns into another structure called the corpus luteum (CL). The CL eventually regresses and lets anther follicle develop and ovulate. Some of these events occur simultaneously and on both ovaries. This will be explained in more detail in following slides on the estrous cycle.

Each structure produces different hormones:

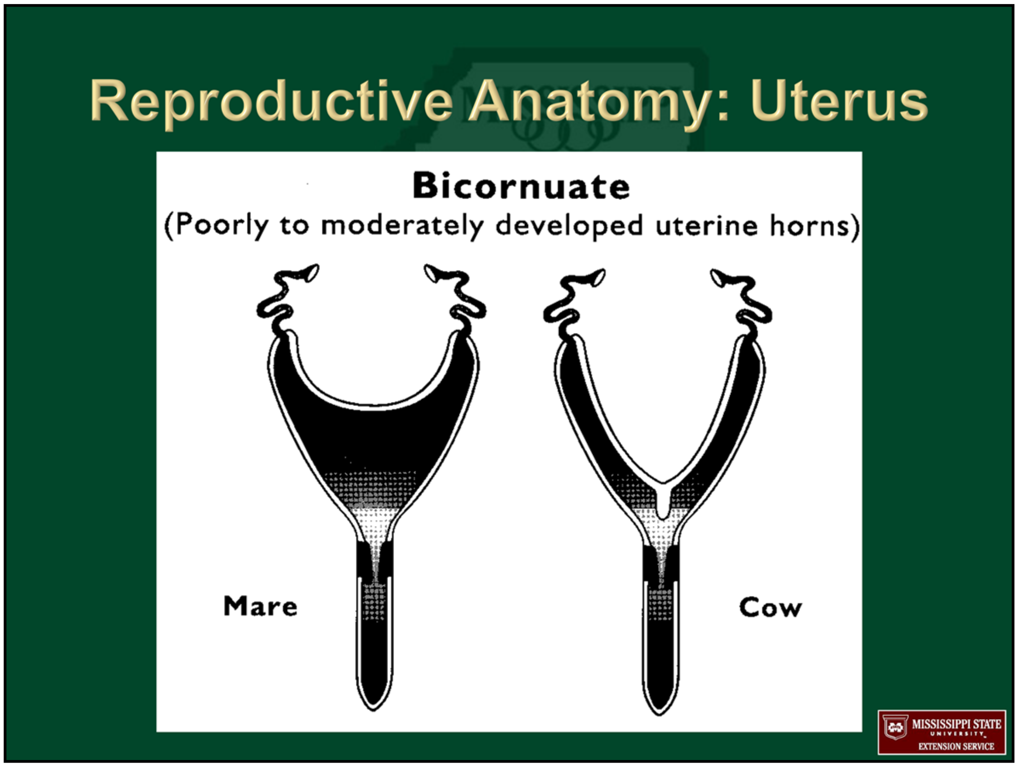
–The follicle produces **estrogen**

–The CL produces **progesterone**

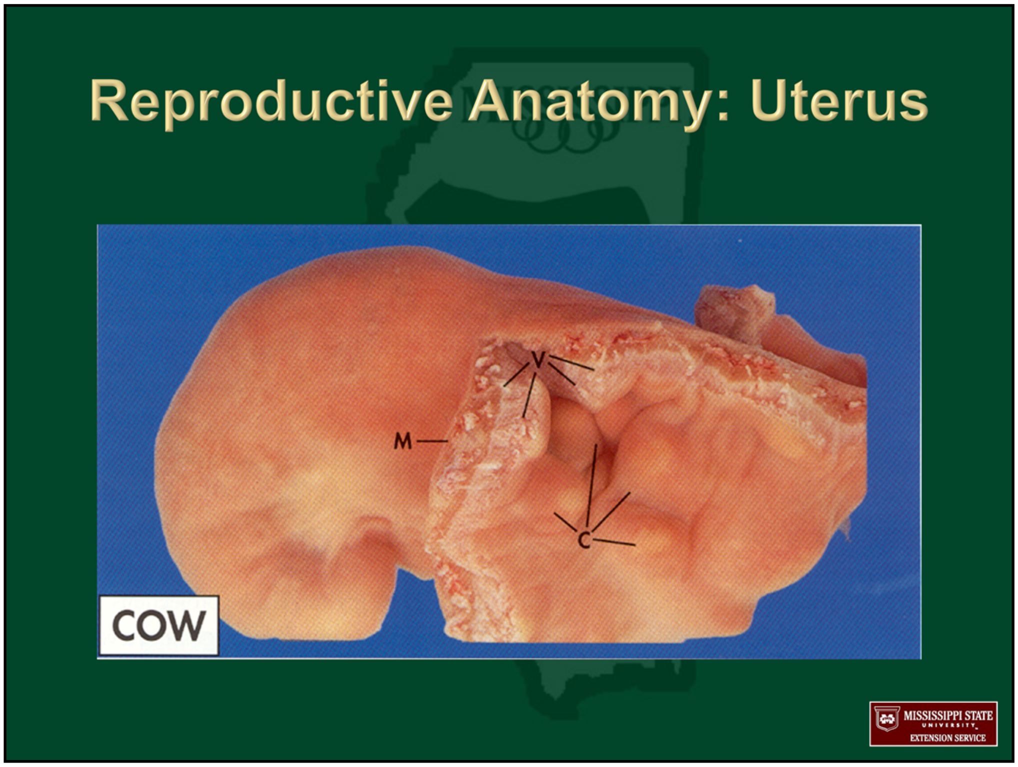



This diagram shows the position of the oviduct in relation to the rest of the female reproductive tract, and the enlarged section gives more detail. The dotted lines indicate where the corresponding cross-section views would be taken.

The oviduct is made up of three distinct sections the: infundibulum, ampulla, and isthmus. The infundibulum acts as a funnel the wraps around the ovary to catch the egg when it is released. It moves the egg down into the ampulla where small projections sweep it toward the center of the oviduct. The isthmus joins at the center to create the ampullary-isthmus junction. Fertilization always occurs at this junction because, if sperm cells were deposited at the right time, they will be waiting there after having been swept up from the uterus.

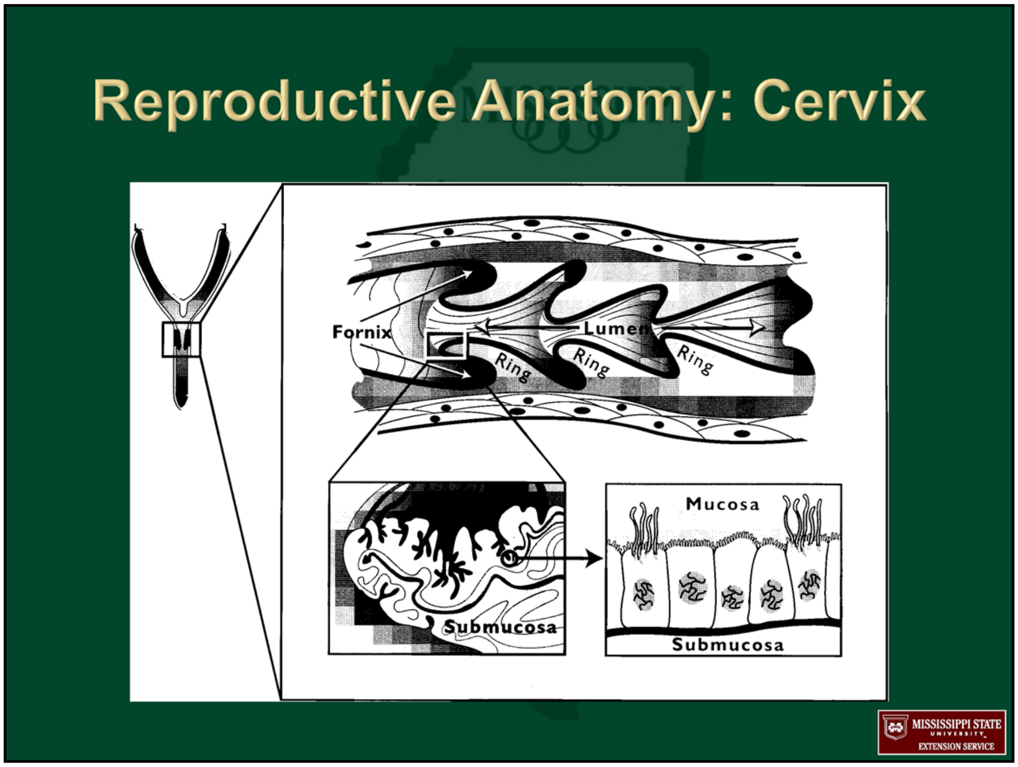



This is a drawing of the general relative shape of the mare and cow uterus. Notice the oviducts toward the top of the drawing and the cervix depicted as a thickening just after the bifurcation.




This is a picture of one uterine horn that has been split to reveal the layers and inside wall. The layers are made of smooth muscle that is important for expelling the fetus at the end of pregnancy.

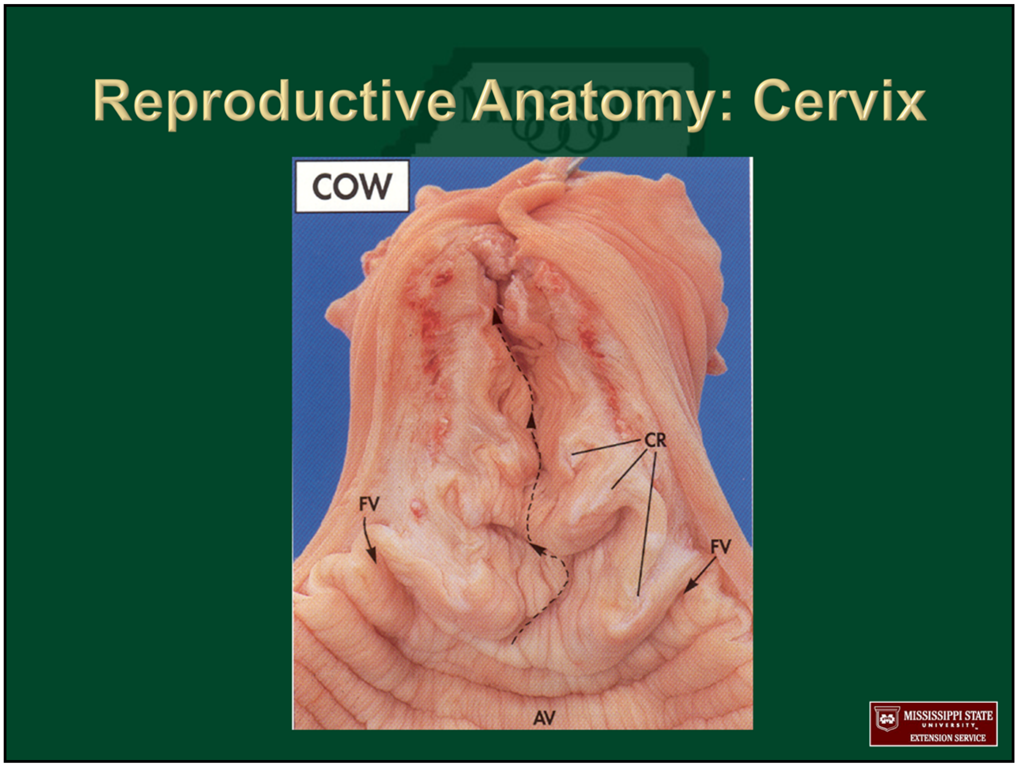
The bumps on the inside wall are called caruncles (C). These are the actual points where the placenta will attach to the uterus for transfer of nutrients from the dam's blood to the fetus and waste from the fetus to the dam's blood.



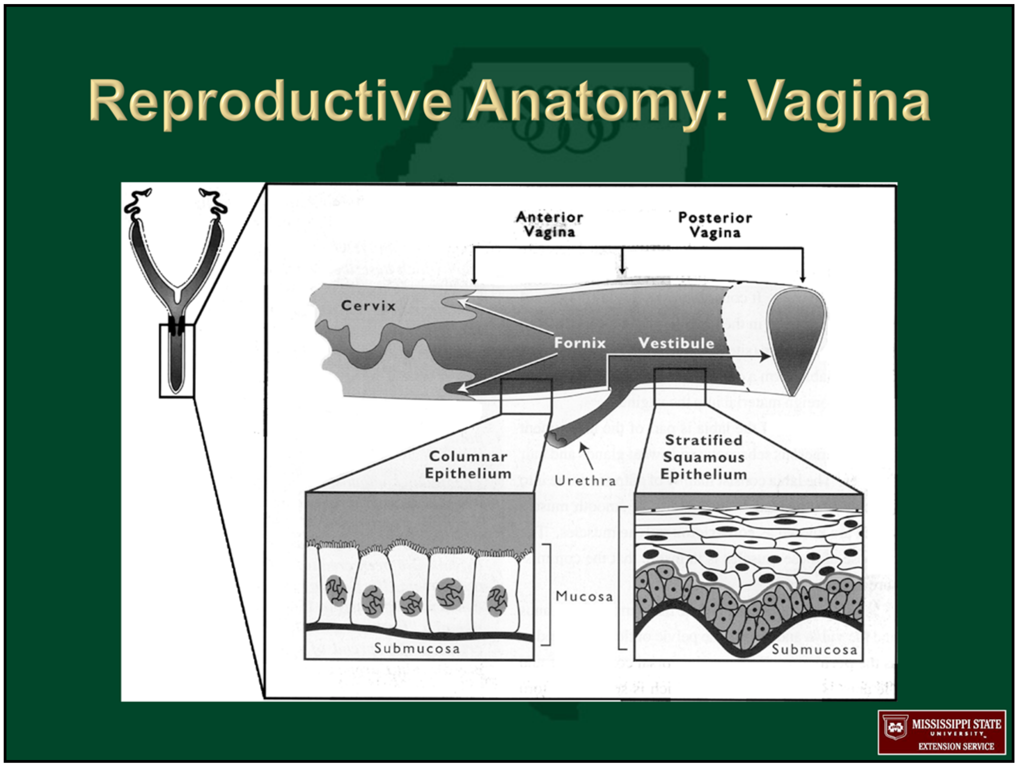

The next major feature moving down the reproductive tract is the cervix. This drawing depicts its position in the tract and the structure of the tissue. The major role of the cervix is to create a physical barrier between the uterus and the outside environment that will protect the developing fetus.

The tissue that makes up the cervix is very dynamic and can change from a dense and rigid structure to a loose and flaccid structure that expands to allow a full-term fetus to pass through. For most of a cow's life, the cervix is rigid and has interlocking folds (often referred to as "rings") with thick mucus in the lumen. When the cow becomes sexually receptive (estrus or heat), the cervical tissue relaxes and the mucus becomes thinner. This allows semen and sperm cells to move through to the uterus on its way to the oviduct.

In artificial insemination (AI), the semen has been extended and must be deposited in the uterus rather than in the vagina where it would be deposited during natural mating. To do this, it is loaded in a long slender "gun" that is manually passed through the cervix.

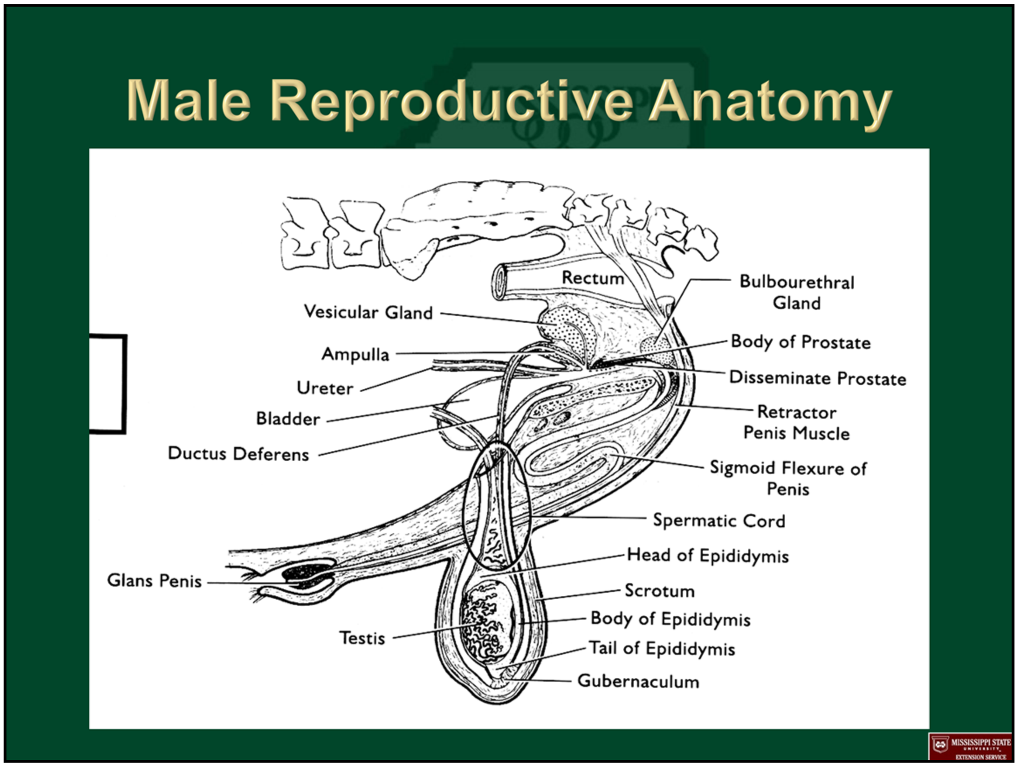



This is a picture of a dissected cervix that has been split to reveal the structure of the cervical rings (CR). Another structure to note is the fornix vagina (FV). This is essentially a blind fold that frustrates many beginner AI technicians. It creates the false sensation that an AI rod is inside the cervix when it is actually in this blind pocket.




The vagina spans from the cervix to vulva and is comprised of two distinct sections. The sections are differentiated by where the urethra (drains the urinary bladder) enters. The environment of the posterior vagina is not hospitable to sperm cells so, in natural mating, semen is usually deposited in the anterior vagina.

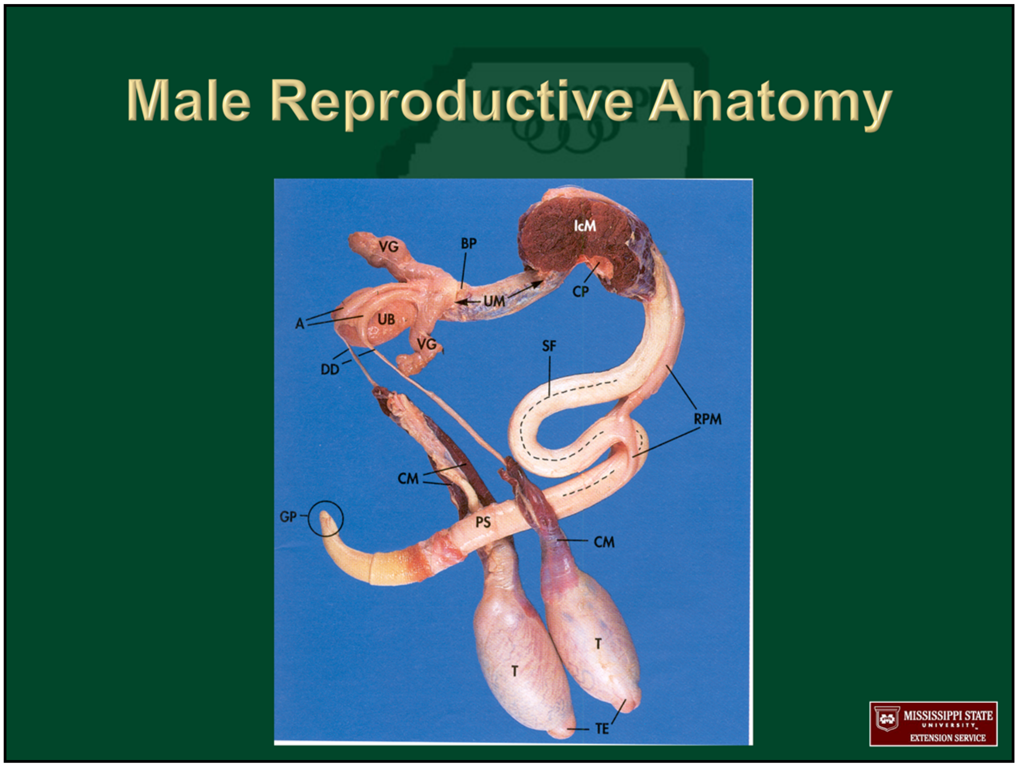
Note again the fornix, a blind pocket at the end of the cervix. The urethra is another important consideration that relates to AI. When entering the vagina, an AI rod should be angled upward to avoid inserting it into the urethra.



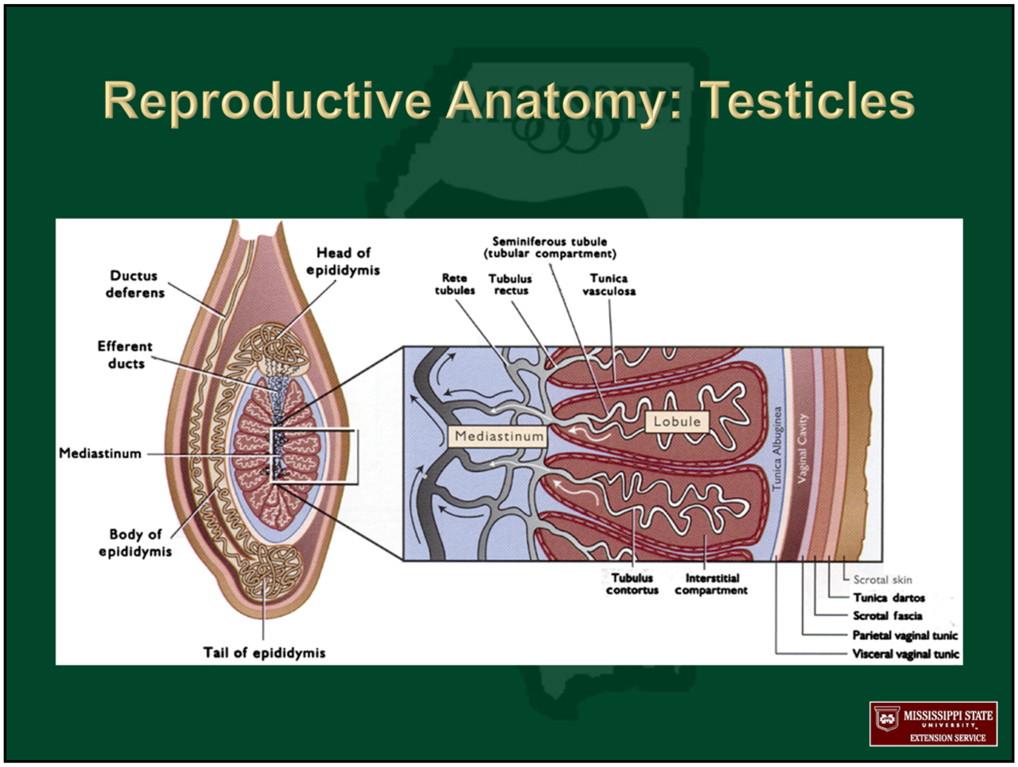

Male reproductive anatomy is often overlooked because there are fewer reproductive management techniques dealing with it. It is as important to understand as female reproductive anatomy and, in natural mating systems, has more impact per animal on percent calf crop.

This drawing depicts a cross section of the bull. Like the female, the male reproductive tract is made of a series of tubes. The main function is to deliver sperm cells to the reproductive tract of a sexually receptive female.

Sperm cells are produced in the testis. As they move through the male tract, the accessory sex glands (listed in the drawing) add fluids (semen) and factors that are important for sperm function. Finally, when the bull intermits (services) a receptive female, the penis extends and delivers the semen and sperm cells to the anterior vagina.



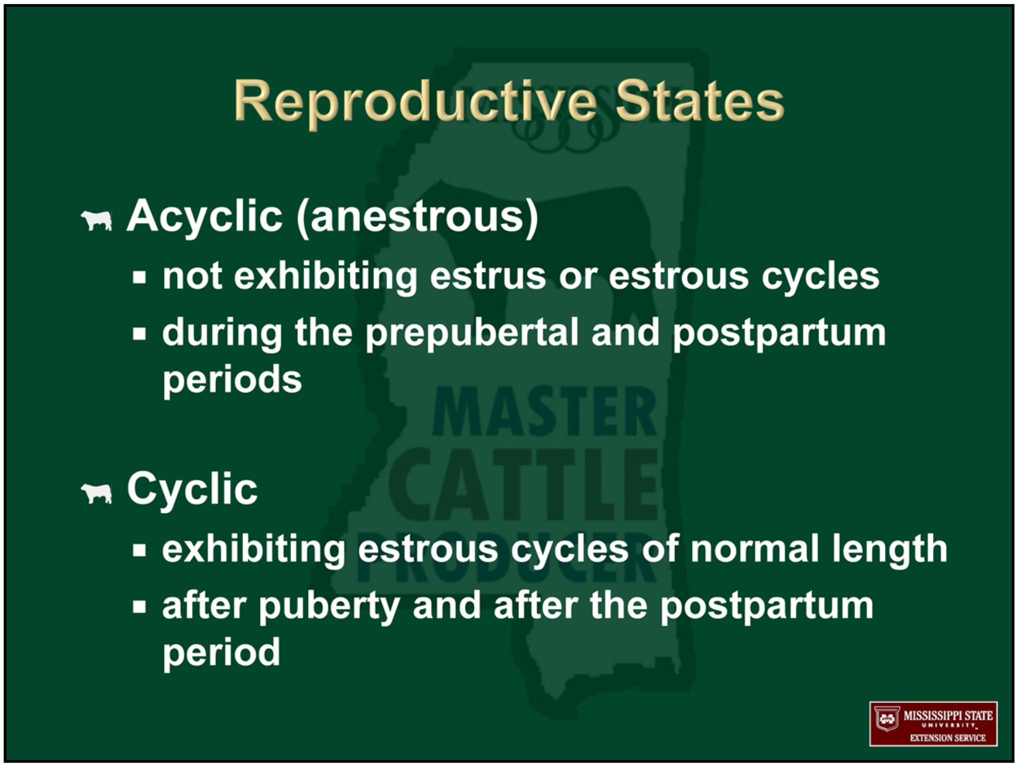

This is a picture of a dissected male reproductive tract showing the same structures from the previous drawing. One major difference between species is the way the penis is extended. The tissue of the bull's penis does not become erect but is always turgid. When the bull becomes sexually excited, the Retractor Penis Muscle (RTP) relaxes and allows the penis to extend from its sheath.




This illustration represents a cross section of a bull's testis. The enlarged section shows microscopic tubes in the core of the testis where sperm cells are produced. As the sperm cells develop, they move through the cell walls of these tubes and eventually are released into the tube and carried out through the epididymis.

The testis is housed in the scrotum that closely regulates temperature by moving it closer to or farther away from the body. Sperm cell production requires a lower temperature than the core body temperature.

One of the most important things to understand about male reproduction is that sperm production takes roughly 60 days from start to finish. If that development is interrupted by illness or injury, then sperm production can be compromised for the following 60 days. That is why a breeding soundness exam (BSE) is so important. In a BSE, a veterinarian will take a semen sample and evaluate sperm cells under a microscope. If he/she finds that the sperm are low quality, they will suggest a follow-up exam or culling the bull.




The reproductive function of a cow or heifer is characterized by whether it displays normal estrous cycles.

Periods when a cow or heifer does not display estrous cycles are referred to as “anestrous” or “acyclic.” These periods are most common before puberty in heifers and after calving for cows. The duration of these periods can be shortened by maintaining good nutrition and proper health management.

When a cow or heifer exhibits estrous cycles of normal length and interval, it is referred to as “cyclic.” This should be the case after a heifer goes through puberty and after the postpartum period for a cow.

## Stages of Female Reproduction

| Stage | Description |
|---|---|
| Prepubertal | Growing heifers (not cycling). |
| Puberty | First estrus (begins normal cycles). |
| Estrous Cycles | Continued cycles w/ even intervals. |
| Gestation | Pregnancy (not cycling). |
| Parturition | Birth (calving). |
| Postpartum | Recovery after calving (not cycling). |



Prepubertal = before the first estrous cycle for a heifer.

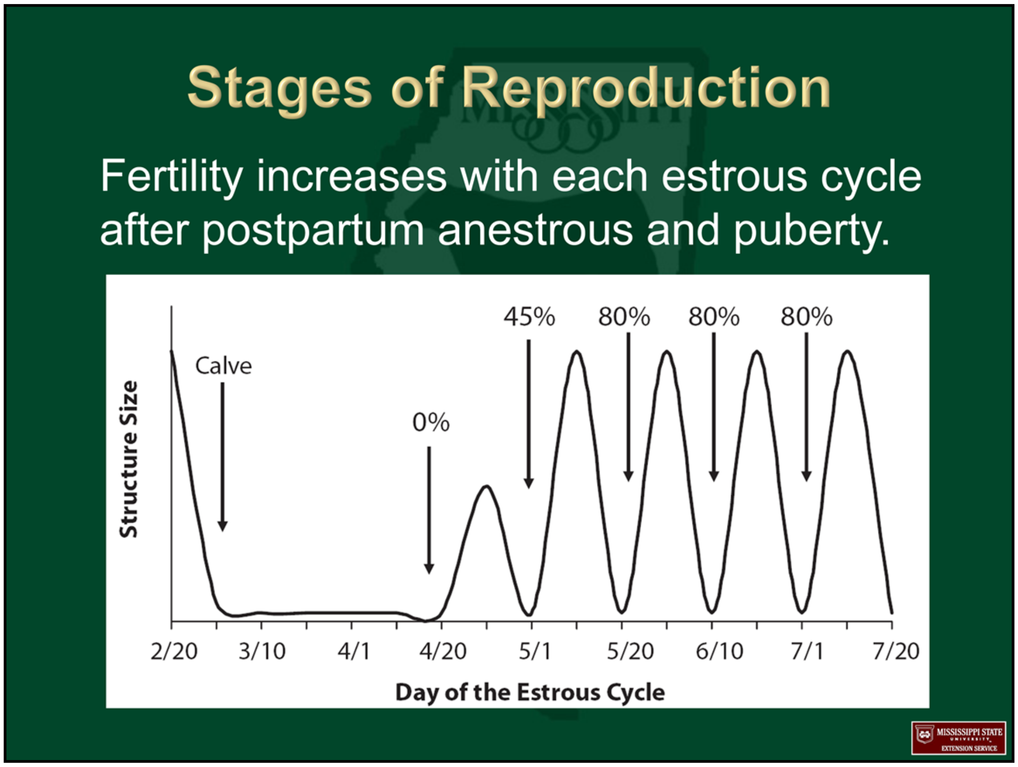
Puberty = first estrus for a heifer.

Estrous Cycle = the period between two heats (estrus), normally 18 to 21 days for cattle.

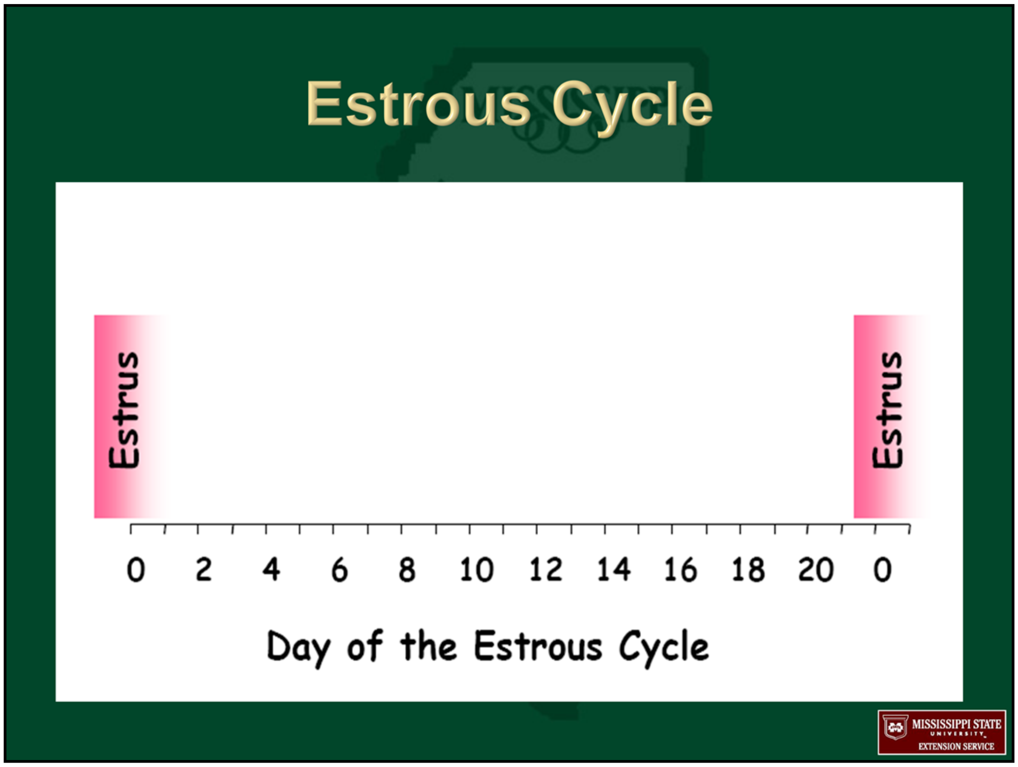
Gestation = the period between fertilization and parturition.

Parturition = birth or calving.

Postpartum = the period of recovery after a cow calves.

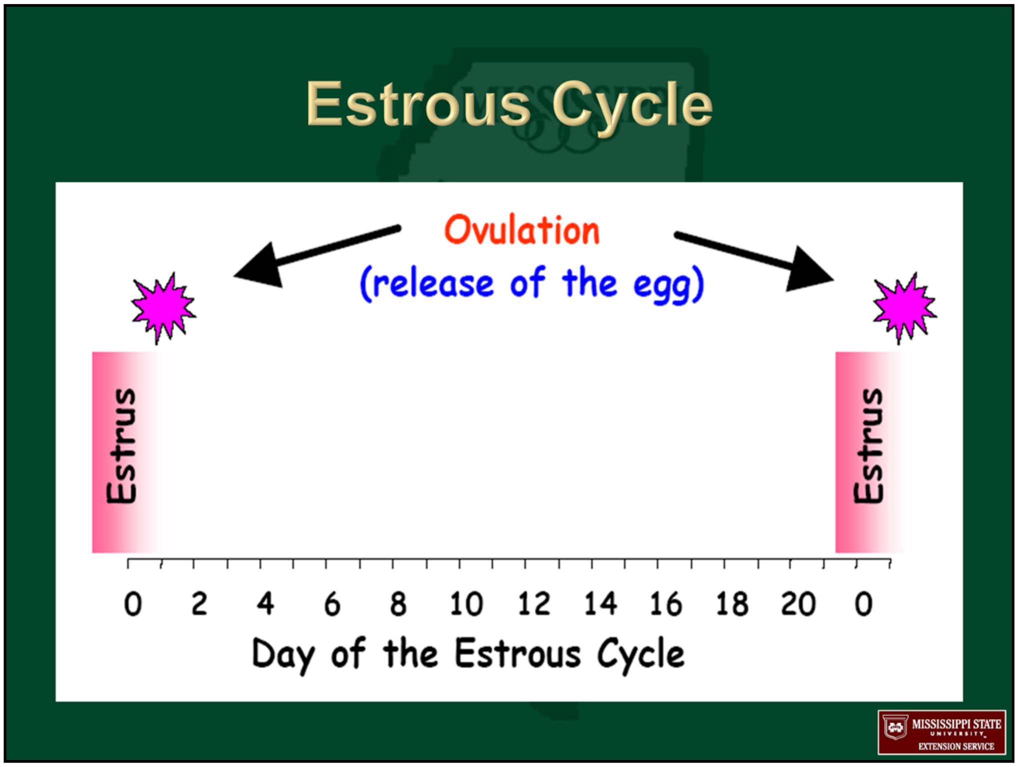



As a cow or heifer comes out of a period of anestrous, either prepubertal or postartum, the first estrus (heat) will be “silent.” That means it will ovulate but will not stand to be mounted or be sexually active. Fertility is essentially zero for that estrus, and the cycle will be short (14 to 16 days).

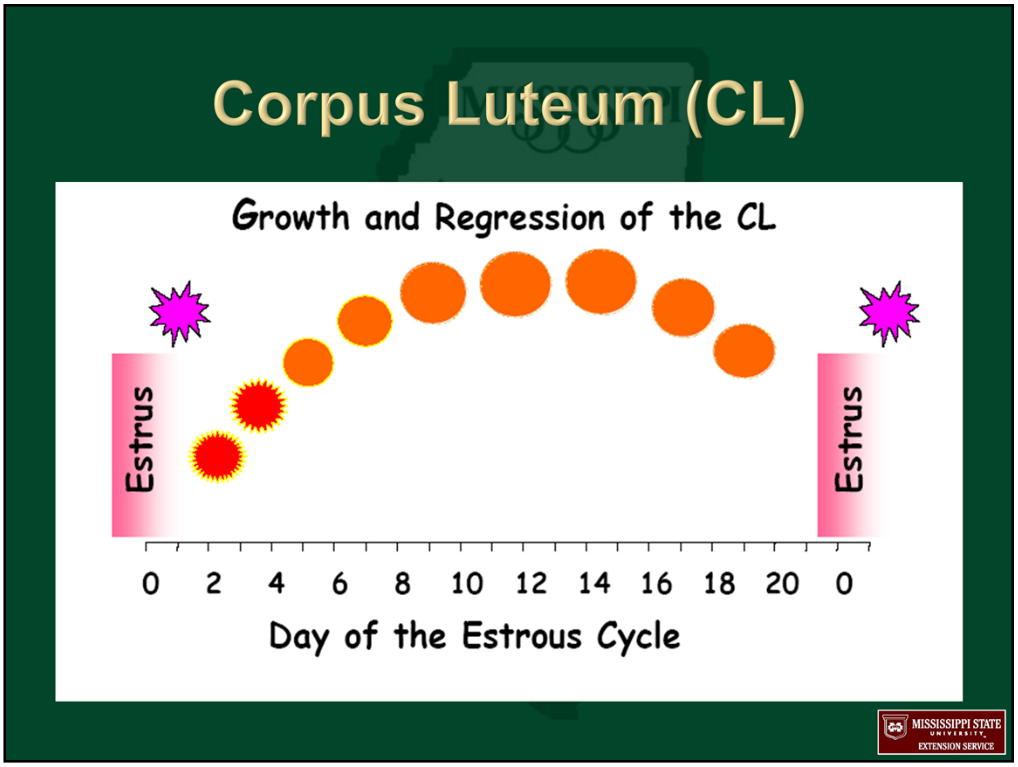



The estrous cycle is defined as the period between two periods of sexual receptivity (estrus or heat). For the heifer and cow, this period averages 18 to 21 days in length.

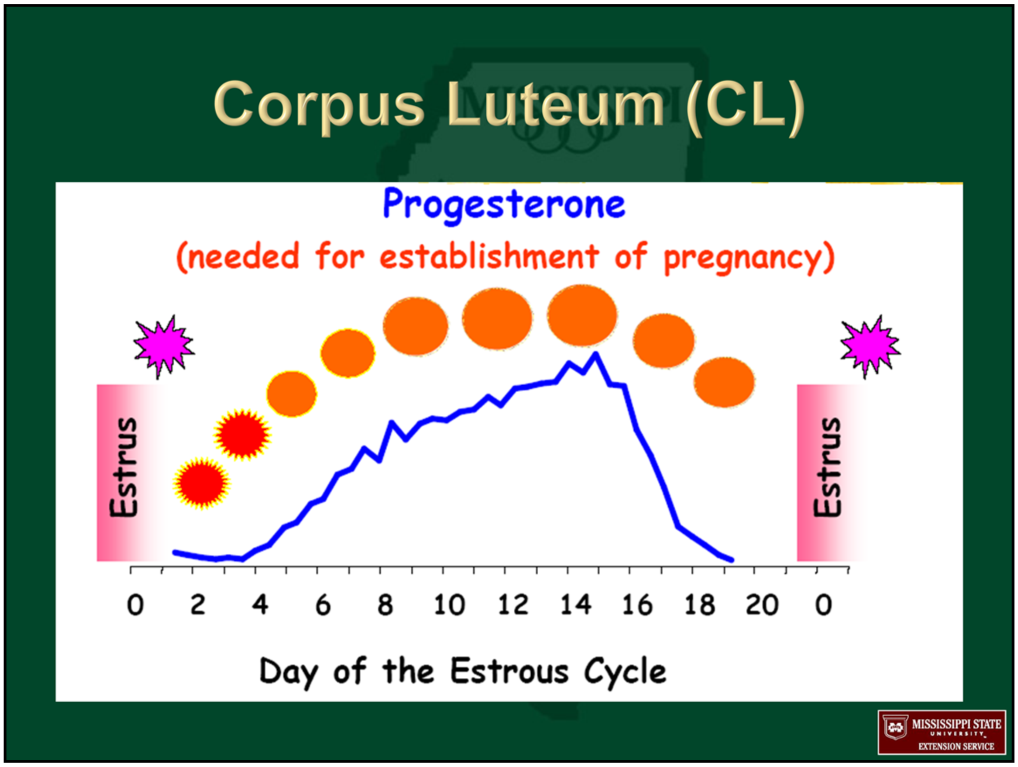
This graph will be used in the following slides to illustrate what happens on the ovary and in the blood during the estrous cycle. The X-axis represents days of the cycle, and the Y-axis represents relative concentrations of hormones in the blood or relative size of structures on the ovary.



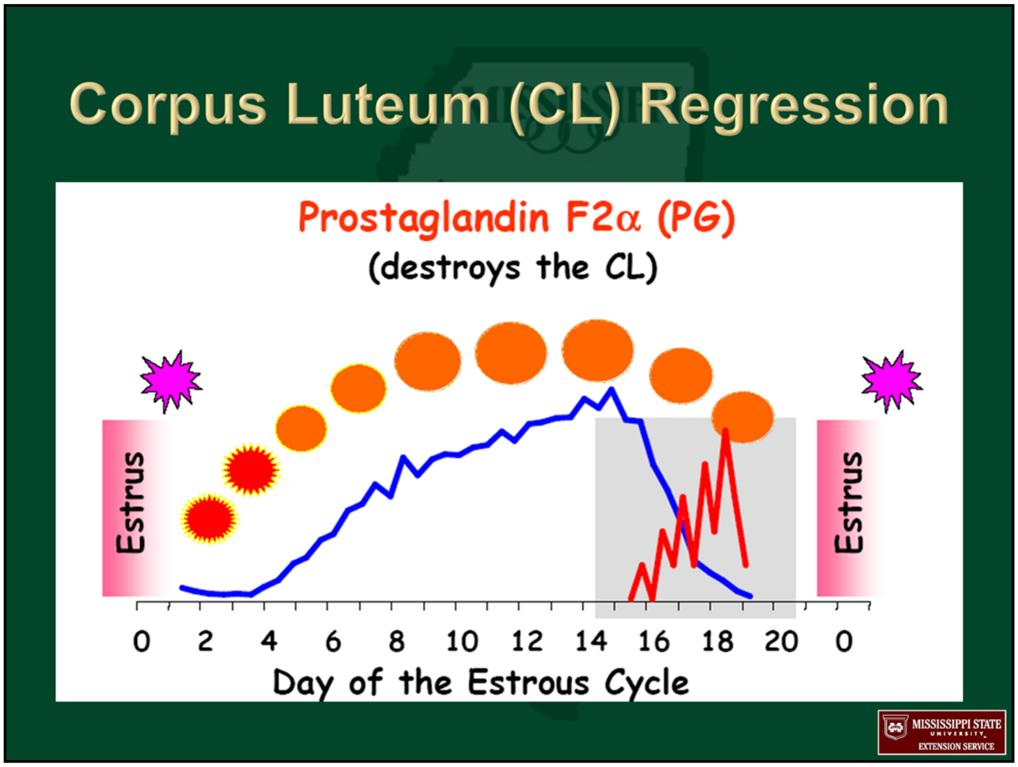

Ovulation is defined as rupture of the follicle that releases the ovum (egg). The timing of behavioral estrus (heat) and ovulation is controlled by the same hormones. This is important because the bull (or AI technician) must know the best time to deposit semen for good fertility.



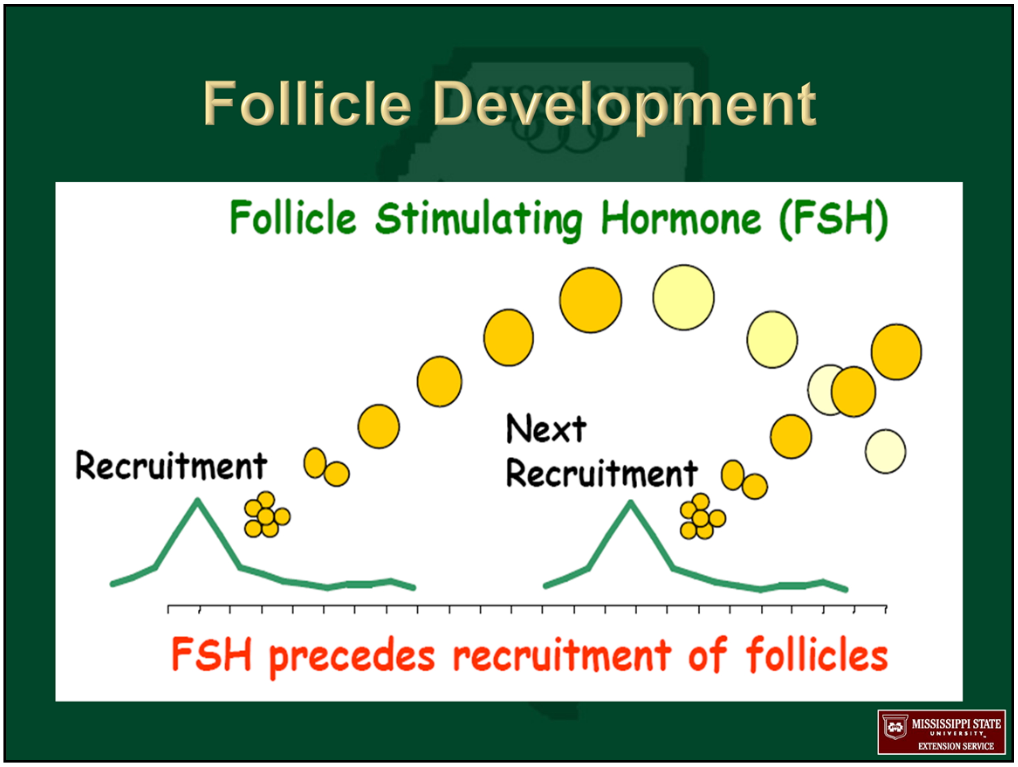

The tissue of the newly ruptured follicle does not just go away, it continues to have an important function as it turns into the corpus luteum (CL).




The newly formed CL begins to produce progesterone (blue line), a steroid hormone that must be in the blood to establish and maintain pregnancy.

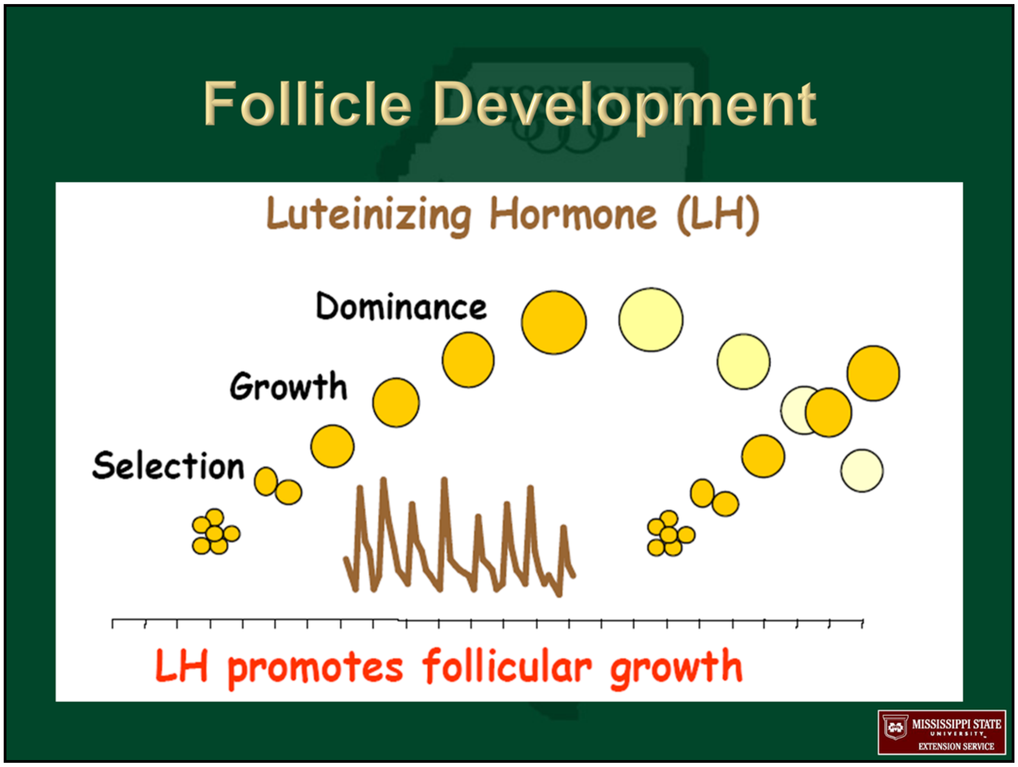



An inherent timing mechanism is in place to get rid of (lyse) the CL if a pregnancy does not result from the previous ovulation. This timing mechanism is housed in the uterus which produces another hormone, prostaglandin $F_2\alpha$ (PG; red line), that lyses (kills) the CL. This is important because the progesterone from the CL would block the next ovulation and prevent the next estrus.

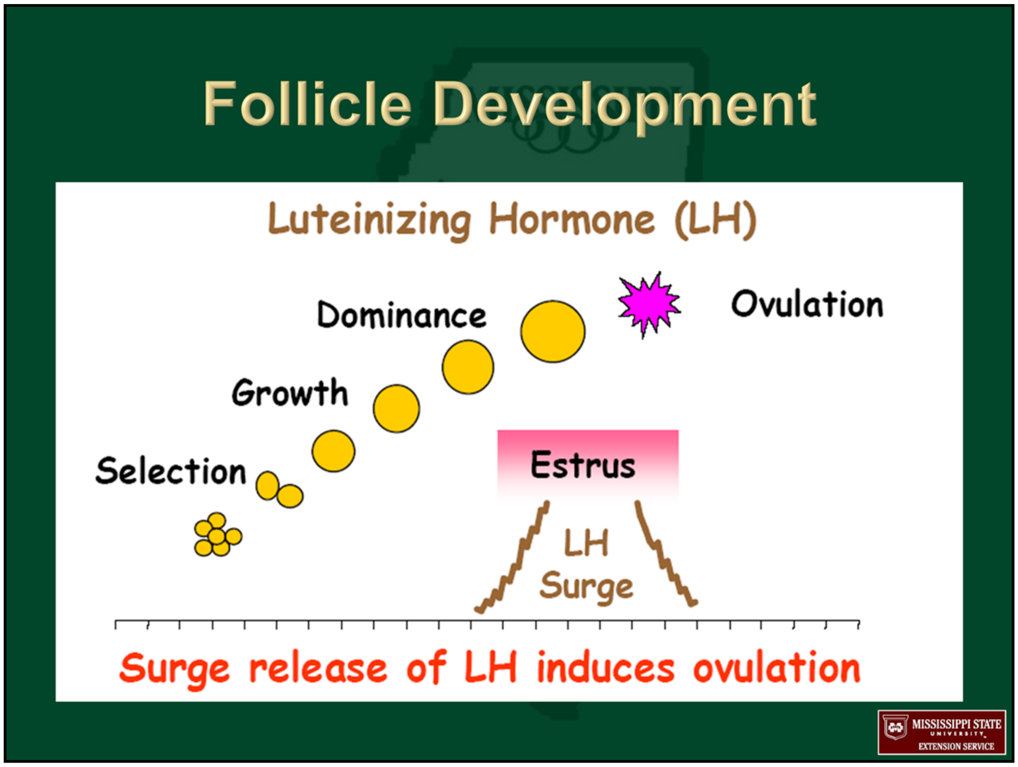



Another important issue is the growth of follicles before they ovulate. This involves more hormones that are produced by a gland located under the brain. These hormones travel through the blood to the ovary to direct follicle growth. They are follicle stimulating hormone (FSH; green line) and luteinizing hormone (LH).

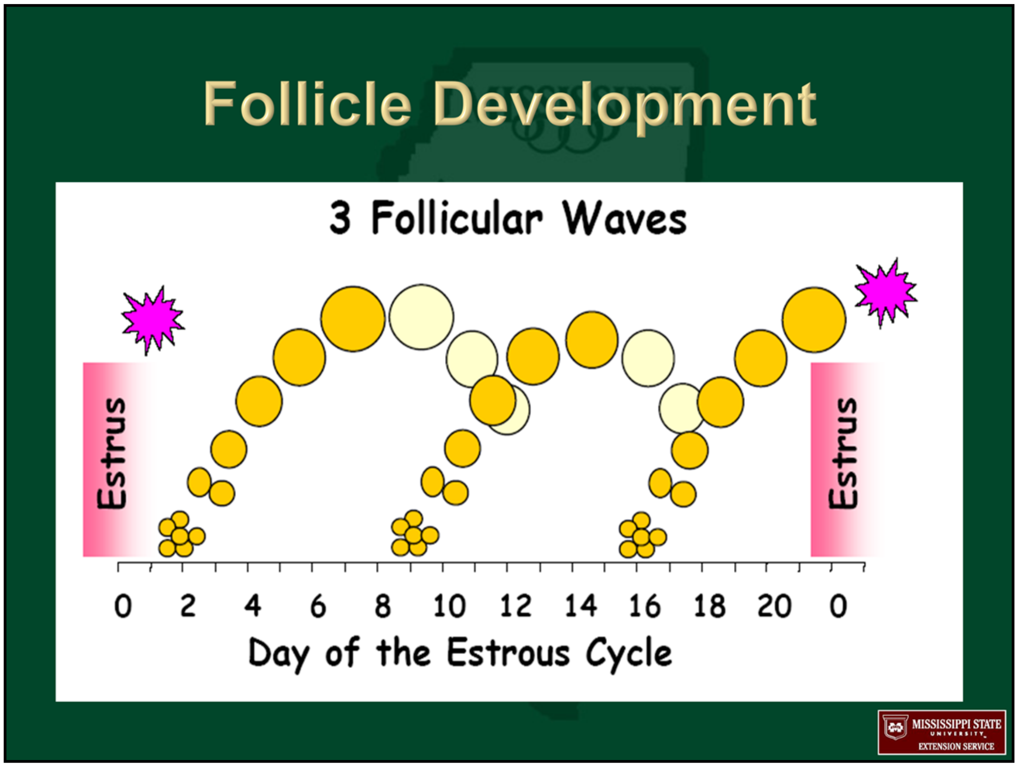
When FSH is released, it stimulates a group of follicles to begin to grow (recruitment). These follicles continue to grow until only one remains and matures enough to ovulate. However, if the other hormones not at the correct concentration, the follicle fails to ovulate and regresses. When this happens, a new group is recruited, and the process starts again.



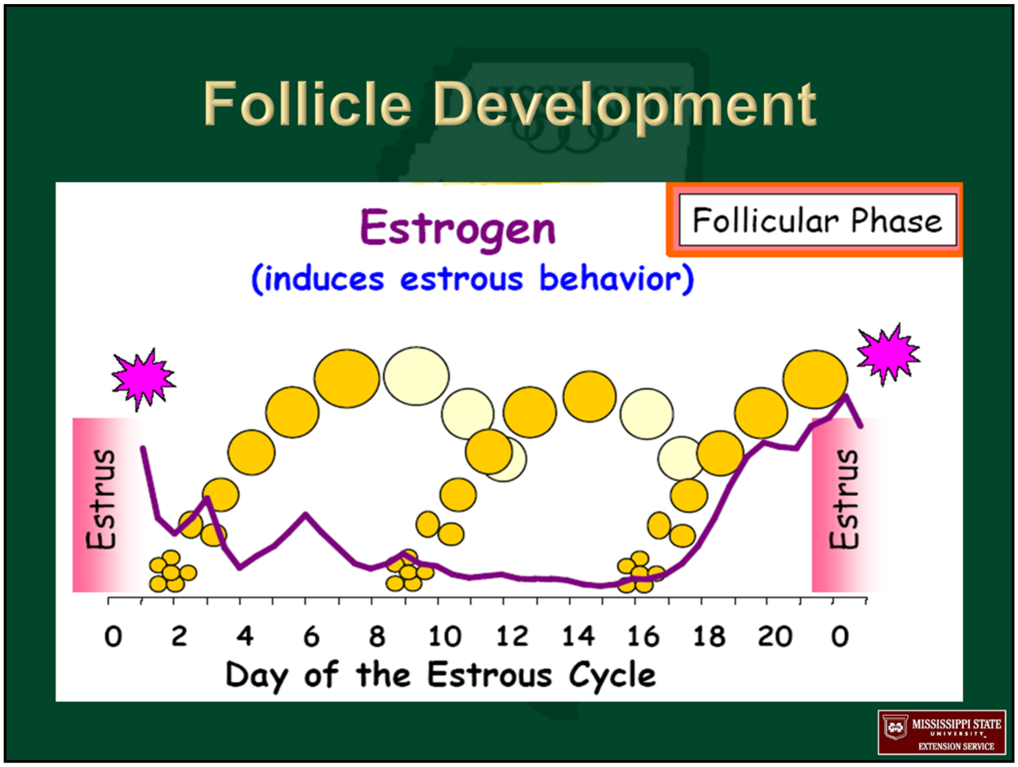

After recruitment of a group of follicles, LH is responsible for keeping them growing. As previously mentioned, many of the follicles die off until only one is left to mature. If progesterone is not gone from the blood when that one follicle is ready to ovulate, then it will also regress and let a new group of follicles be recruited.



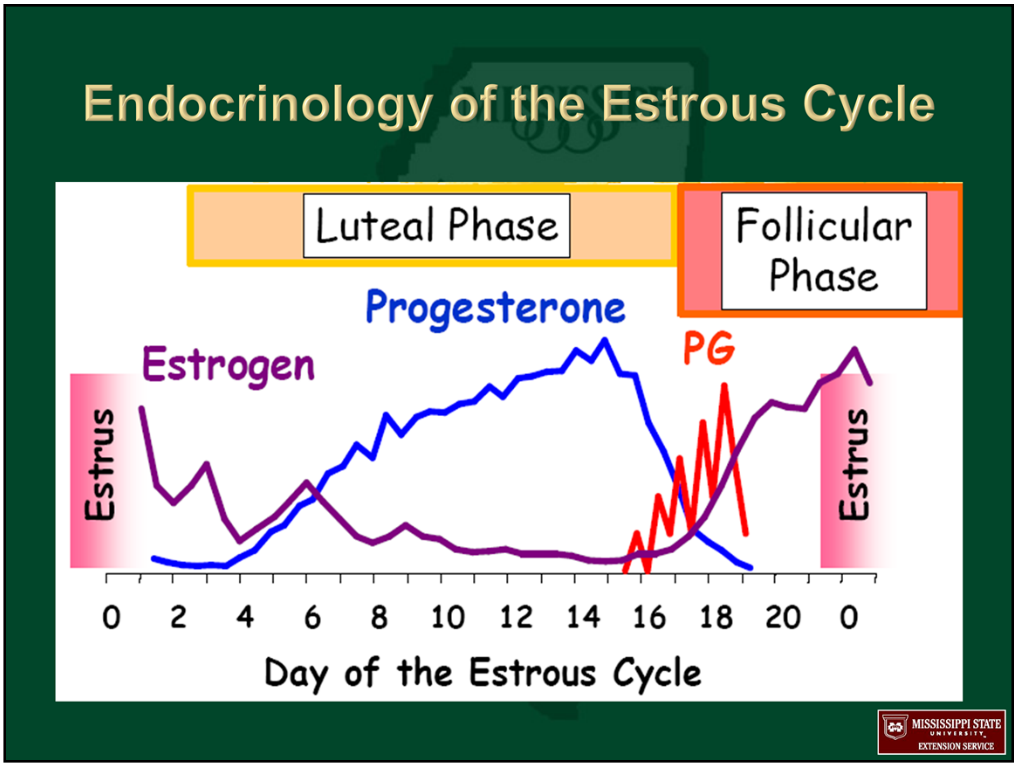

LH is also the hormone that stimulates ovulation. If progesterone is gone from the blood (CL has been lysed), LH is allowed to reach a higher concentration in the blood and triggers ovulation.



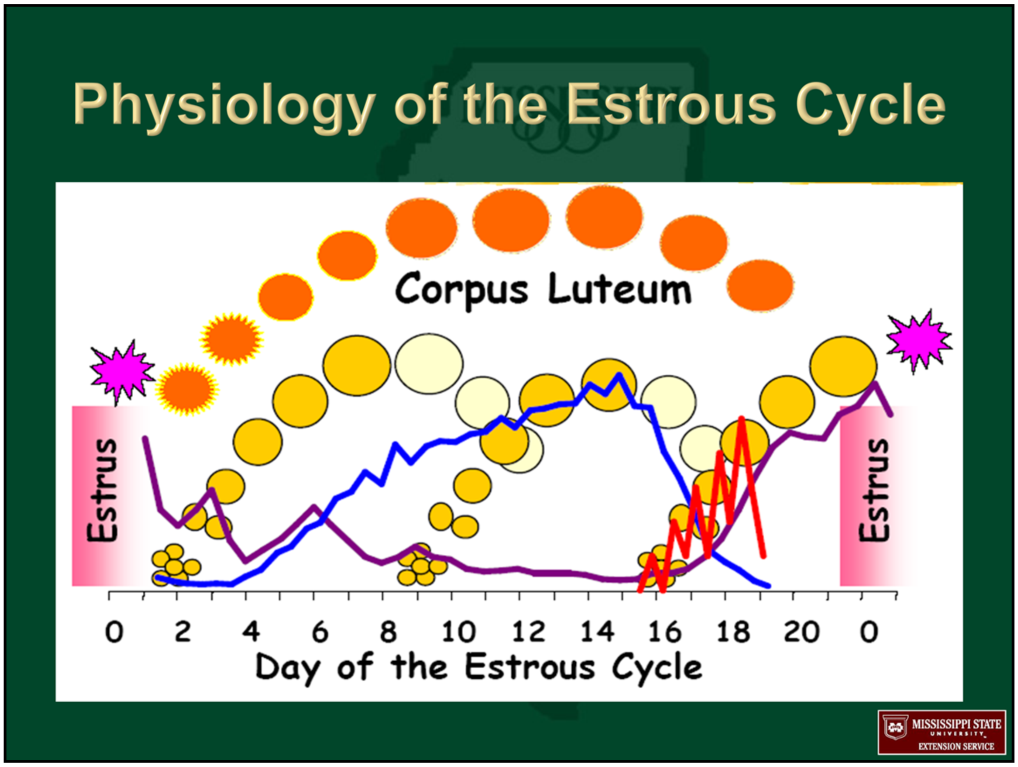

Usually, there are two or three groups of follicles recruited before the CL is gone and ovulation occurs.




Estrogen, produced by the follicle, travels to the brain to stimulate that final rise in LH that triggers ovulation. This estrogen also changes the behavior of the heifer or cow to make it sexually receptive. It will stand to be mounted by another cow or heifer and will stand to be serviced by a bull.




Here are the blood concentration patterns of some of the major hormones of the estrous cycle. Progesterone is dominant during the middle of the cycle but is removed toward the end of the cycle (CL lysed) by prostaglandin. This allows estrogen to increase and trigger ovulation and estrus.




This illustrates how those hormones relate to the relative size of the ovarian structures that produce them.

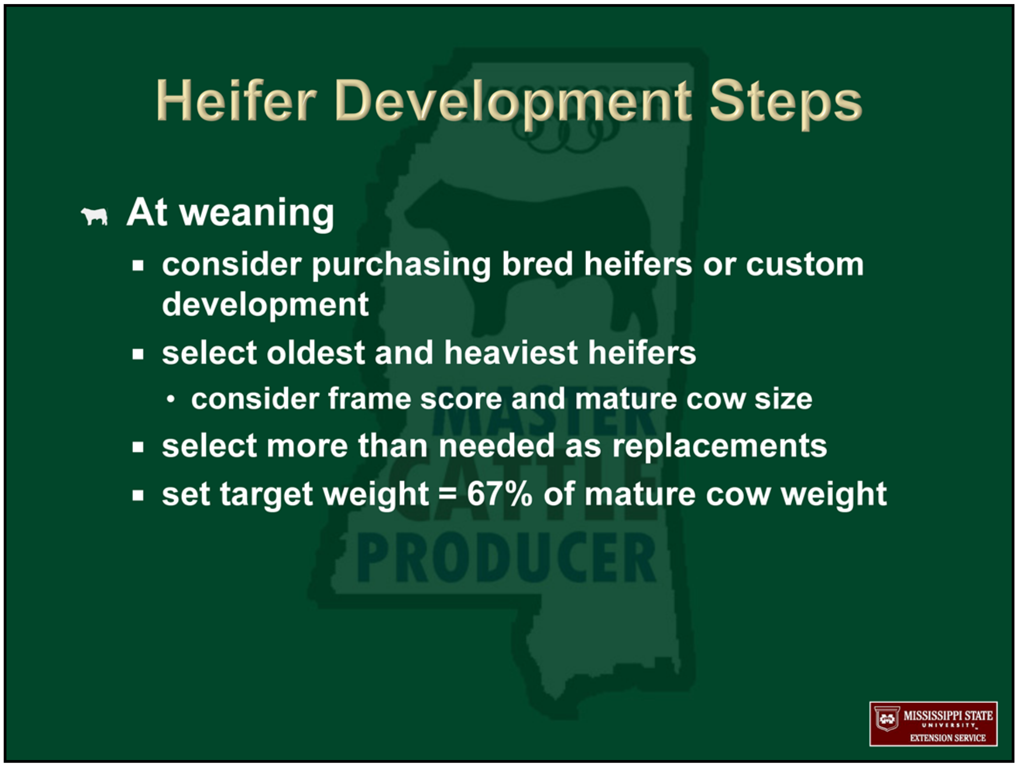
It might seem complex, but a sound understanding of the estrous cycle allows cattle producers to troubleshoot reproductive problems. That understanding is also important when using estrous synchronization and other reproductive technologies.

Mississippi State University Extension Service Publication 2616, “The Estrous Cycle of Cattle” discusses the estrous cycle in detail.


Developing replacement beef heifers is an extremely important part of a successful cow-calf operation. If a heifer is managed properly in the period from weaning to the first breeding, it will conceive earlier in the first calving season, have more time to recuperate in the first postpartum period, breed early as a first-calf heifer, and stay in the herd longer than cows.

Properly developed heifers that calve earlier every season will also wean a heavier calf and have the opportunity to generate more revenue.


This is a list of recommended heifer development program objectives. Following the practices listed here should ensure meeting these objectives.



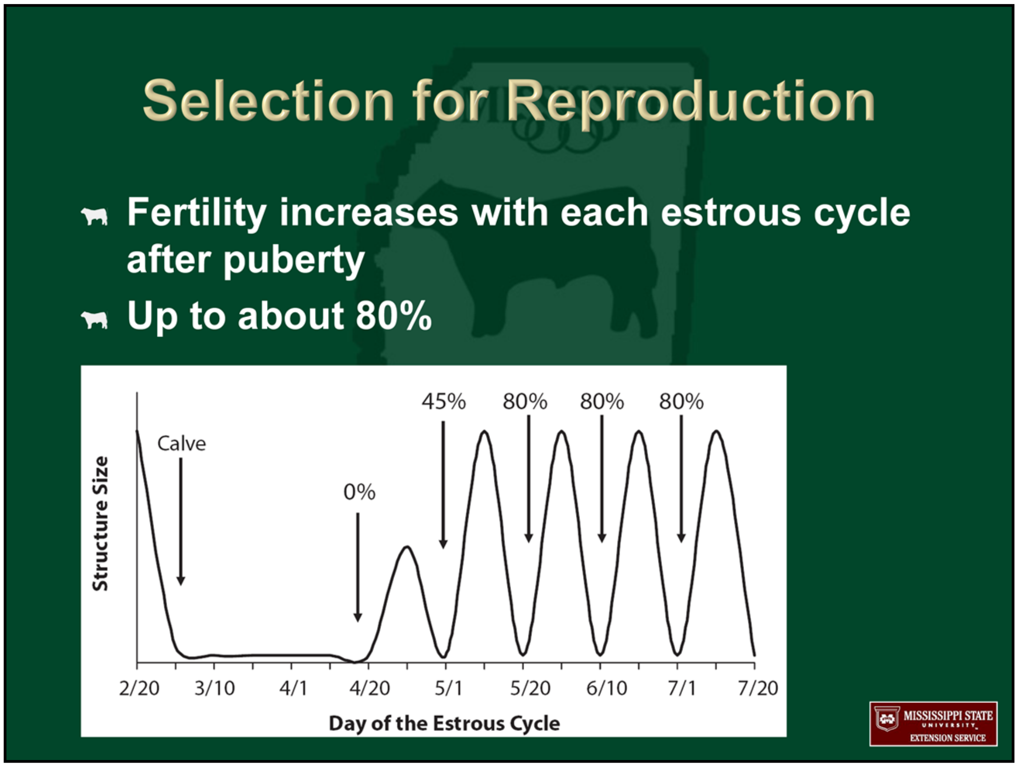

One of the most important decisions about replacement heifers is whether the producer has ample resources and time to properly develop them. It could be more economical to sell all the heifers in a calf crop and purchase bred replacements. This is especially useful for making rapid genetic improvement in the cow herd. Another alternative is to send selected heifers to a custom developer and have them returned fully developed and confirmed pregnant for a per-head fee. Investigate the "Miss. Premium Heifer Development Program" administered by the Mississippi State University Extension Service.

Selecting older and heavier calves makes it easier to reach target weights, but be careful not to only pick genetically larger calves that will increase the mature cow herd size beyond an efficient size.

Always select more heifers than will be needed, usually 15% more, because some will be culled during the process for various reasons.

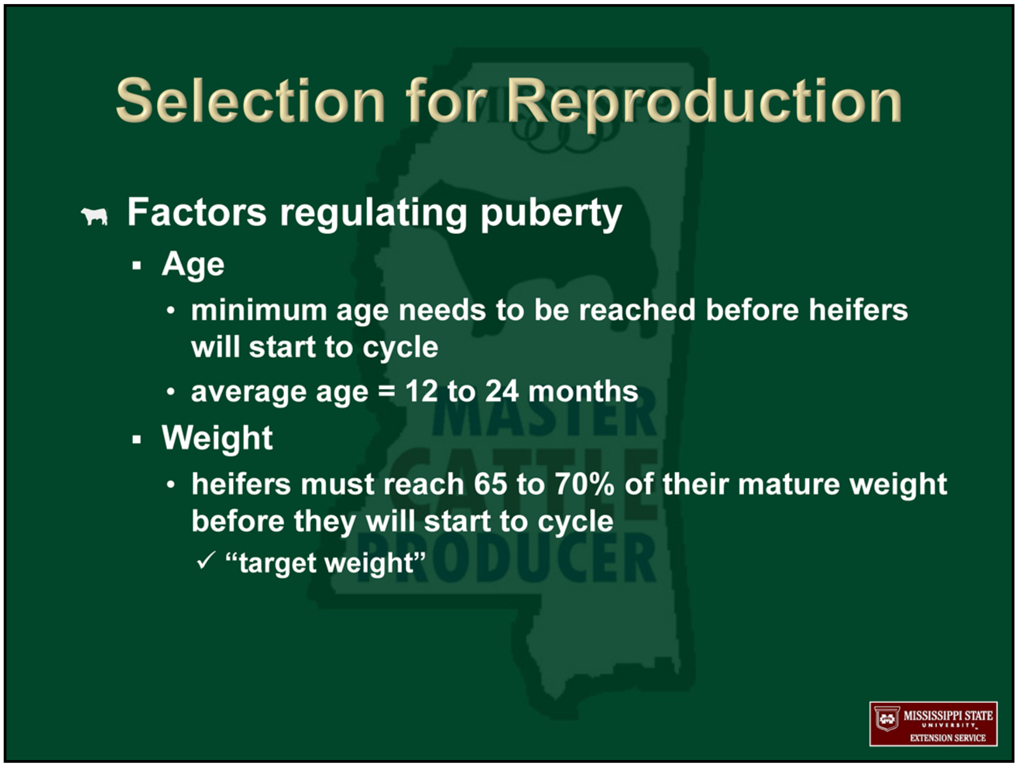
Determine the target weight, and develop an nutrition program that will ensure it is reach prior to beginning the breeding season. Refer to the nutrition section of this training for details on heifer development nutrition.

Mississippi State University Extension Service Publication 2488, "Replacement Beef Heifer Development" discusses heifer development in detail.




Focus selection of replacement beef heifers on genetic improvement and phenotype. Also focus on indicators of reproductive performance when selecting replacements.

Fertility for estrous cycles improves after prepubertal anestrous. It is important to have heifers cycling prior to the first breeding season to ensure the highest possible fertility at first service. This means that heifers should reach puberty as soon as is reasonably possibly.




The main factors that regulate puberty in cattle are age, weight, and breed.

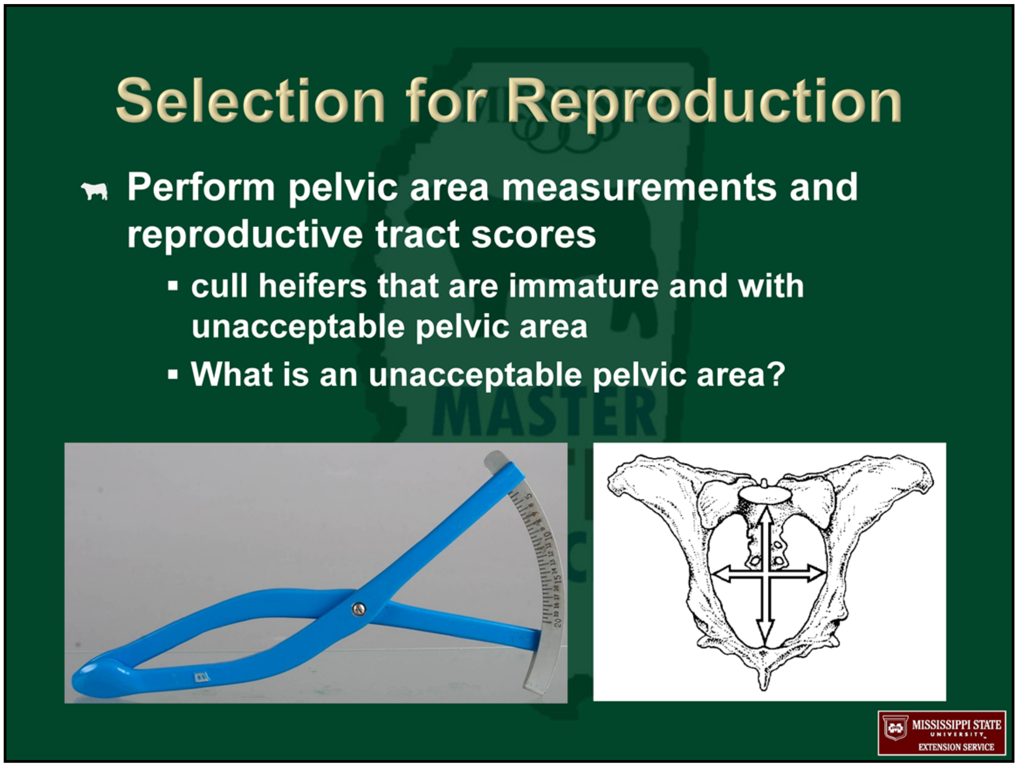
The average age at puberty ranges between 12 and 24 months, depending on these other factors. Early in a heifer's life, most of its nutritional intake is used for skeletal growth. Once a certain percentage of that skeletal growth is reached, it will begin to deposit fat. Hormones from that fat signal the heifer's brain that it is far enough along in its growth curve to support reproduction. This usually happens at 65 to 70% of the heifer's expected mature weight (often referred to as "target weight" when discussing heifer development).

Selecting older and heavier heifers to keep as replacements help to reach projected target weights sooner. However, repeatedly selecting genetically larger heifers can also increase mature cow weights beyond that which is economically sound.


Breed has a strong impact on age at puberty. Generally, breeds that milk heavy experience puberty relatively early. British breeds usually go through puberty earlier than Continental breeds, and Zebu-influenced breeds go through puberty relatively late.

Producers who select for early puberty over many years can shift the age at puberty within breed or breed type. Therefore, this rule of thumb might not apply to every population within breed.

Heterosis or hybrid vigor obtained through crossbreeding has a profound effect on decreasing the age at puberty along with many other reproductive traits.




Other management practices that are selection tools are pelvic area measurement and reproductive tract scoring.

A pelvic area measurement estimates the size calf a heifer will be able to deliver, without assistance, at 2 years of age. The calipers pictured above left are used to take a vertical and horizontal measurement at the narrowest point in the pelvis. These measurements are multiplied together to calculate the $cm^2$ area of the birth canal. In its original use, this measurement was divided by a factor derived from the heifer's age and weight at measurement to estimate the size of calf it could deliver unassisted. The more common use now is to set a cutoff score below which heifers are culled from the group. Common recommended cutoffs are 150 $cm^2$ for 700 pound yearling heifers or 180 $cm^2$ for heavy-bred 900 pound heifers. Using these cutoff values and a proven, bull with calving ease genetics ("heifer bull") will almost eliminate calving difficulties.

A reproductive tract score (RTS) estimates the sexual maturity of the heifer.


Perform reproductive tract scoring one month prior to breeding, and use this information to cull heifers that are determined to be sexually immature.

## Description of Reproductive Tract Scores

| Reproductive Tract Score | Uterine Horns | OVARIES Approximate Size (mm) Length | Height | Width | Ovarian Structures |
|---|---|---|---|---|---|
| 1 | Immature <20mm diameter no tone | 15 | 10 | 8 | No palpable follicles |
| 2 | 20-25mm diameter slight tone | 18 | 12 | 10 | 8mm follicles |
| 3 | 20-30mm diameter good tone | 22 | 15 | 10 | 8-10mm follicles |
| 4 | 30mm diameter good tone | 30 | 16 | 12 | >10mm follicles possible corpus luteum |
| 5 | >30mm diameter good tone, erect | >32 | 20 | 15 | >10 mm follicles Corpus luteum present |

Source: Anderson et al., 1991

The RTS is assigned from a 1 to 5 scale, with 1 indicating a sexually immature heifer and 5 indicating a heifer that has already reached puberty. The score is based on palpating the uterus and ovaries for size, tone, and presence of follicles or a CL. A good practice is to cull heifers below a RTS 3 if progesterone will be used to synchronize estrus. Otherwise, keep only RTSs 4 and 5.


It is extremely important to build immunity to diseases that commonly affect cattle. In replacement heifers, consider vaccinating and boostering for Vibriosis and Leptospirosis. These are two bacterial diseases that lower fertility and stimulate early abortions. Consult a local veterinarian to determine the best herd health program.

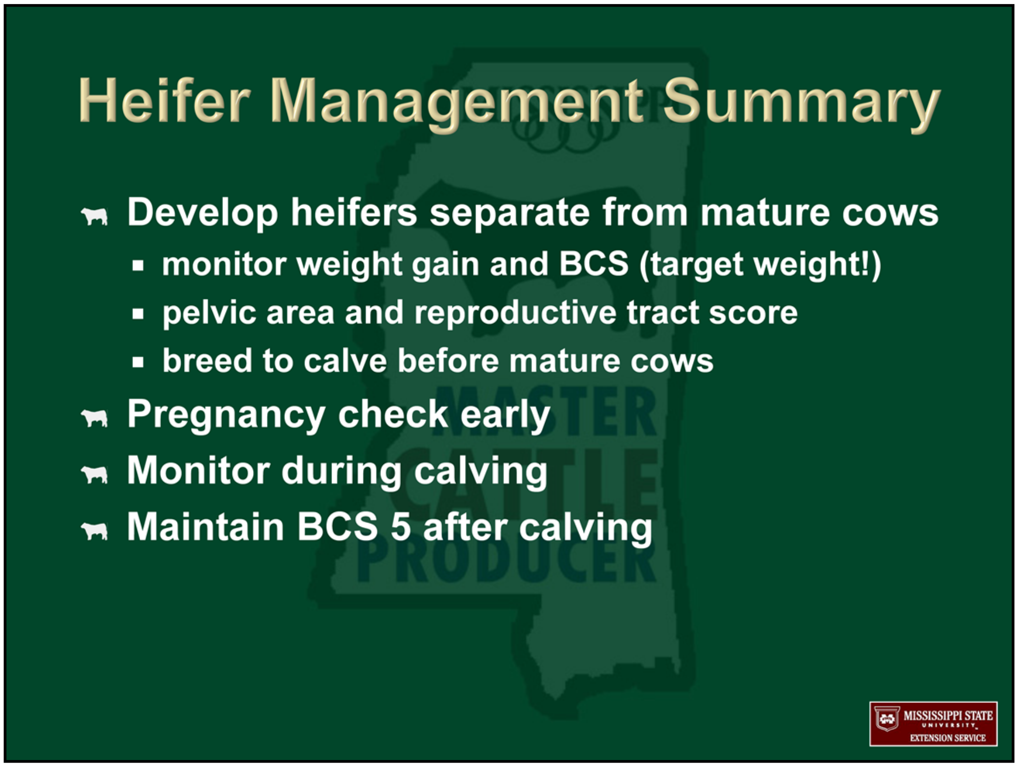
Many producers decide to artificially inseminate replacement heifers. In AI programs, use estrous synchronization to tighten the first service breeding period. Using a progestagen (progesterone-acting hormone) improves conception to AI and the first natural services after AI. Some producers use synchronization for natural service if they have adequate bull power (bull:cow ratio).

Consider breeding replacements 20 to 30 days ahead of the mature cows. This gives them more time to recover nutritionally and increases pregnancy rates as first-calf heifers.


Diagnose pregnancy as early as possible after removing the bull. Ultrasound is effective at diagnosing pregnancy as early as 30 days. Culling open (non-pregnant) heifers early reduces the overall cost of developing a group of heifers by reducing feed cost. Using ultrasound at the appropriate time can also differentiate between AI and natural service pregnancies. This allows producers to keep AI pregnancies first and, if enough replacements are pregnant, market the bull-bred heifers.


Heifers should weigh 85 to 90% of their expected mature weight when they calve. This usually means they will need to gain 1 pound per day during gestation. Maintain a body condition score (BCS; refer to nutrition training section) 6 until calving. After a heifer calves at 2 years of age, she is still growing and now must devote some nutrition to lactation. This is a highly demanding time for first-calf heifers, and they may require supplemental nutrition to ensure that they re-breed on time in the next calving season.

A common misconception is that restricting feed prior to calving will reduce calving difficulties. This is incorrect. The fetus will continue to grow at a rapid rate toward the end of gestation and restricting nutrition will decrease a heifer’s chance of re-breeding in the subsequent season. Restricting nutrition prior to calving can also result in a weak heifer that exhausts easily during calving.




Proper management practices are fundamental for a successful replacement heifer development and breeding program. Whether developing retained heifers, purchasing bred heifers, or providing custom development services, the practices outlined here are the foundation for a successful program.


This section outlines reproductive management and goals for the mature cow herd.

First, implement a comprehensive and easy to use record keeping system to identify problem areas and focus efforts on the correct issues.

The most reliable measure of reproductive efficiency is the number of calves weaned per cow exposed to breeding. This takes into account pregnancy rate, calving rate, and weaning rate. An unreasonable goal is to have every cow calve on the first day of the calving season, but a realistic goal is to have 90% of the cows calving in a 60-day season. Assuming a conservative 5% death loss from calving to weaning (95% weaning rate), the percent calves weaned per cow exposed would be 90% x 95% = 85.5%.


Controlled calving season = Exposing the cow herd to AI or natural service for a defined period of time; results in a more uniform calf crop, condensed labor at calving and some open cows each year.

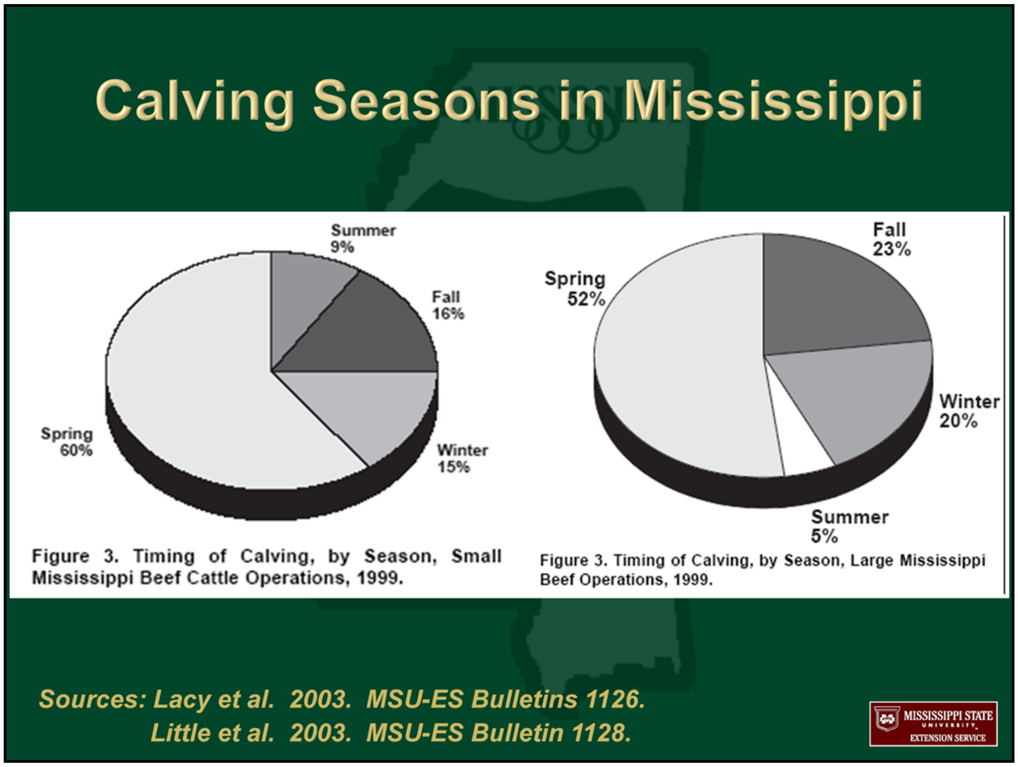
Conception rate = Number of cows pregnant divided by the number of cows inseminated.

Pregnancy rate = Number of cows pregnant divided by number of cows exposed to breeding (total number with bull or total number synchronized).

Calving rate = Number of cows calving a live calf divided by the number of cows confirmed pregnant; factors in fetal loss.

Calving interval = Time between calving. The objective should be for each cow to have a calf at least every 365 days. With a gestation length of approximately 283 days, this means a cows has roughly 80 to become pregnant after she calves to calve at the same time next year.

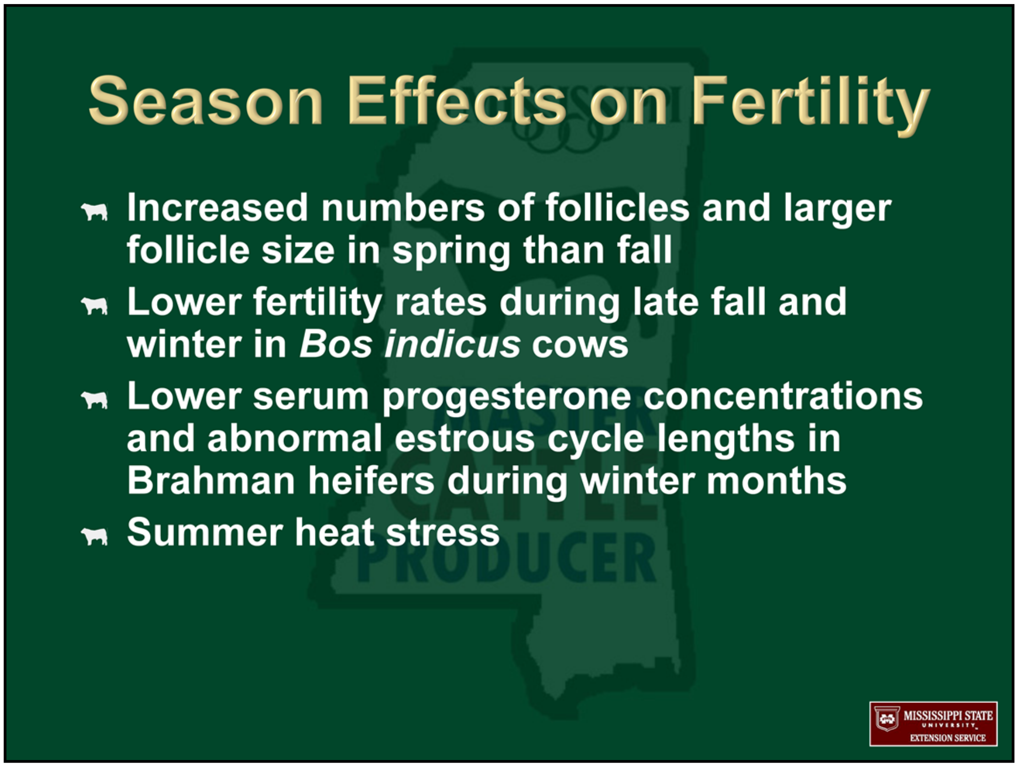
Mississippi State University Extension Service Publication 2615, “Reproductive Management of Beef Cattle Herds” discusses reproductive management in detail.



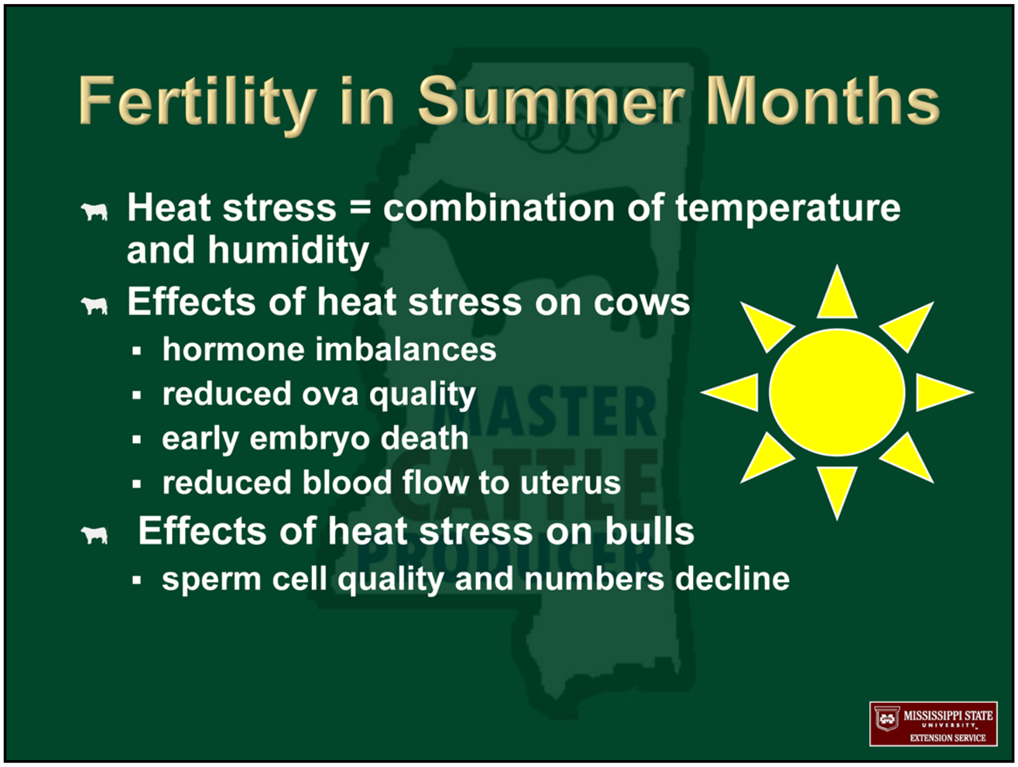

These graphs indicate the calving season distribution for small and large herds in Mississippi in 2003. A majority of the cattle in Mississippi are calved in the spring. This is convenient time to calve because forage availability is increasing and cows need less supplemental feed to maintain body condition and re-breed within 80 days.

A growing number of producers, especially those with more than 250 head, are calving in the fall. This shifts marketing weaned calves to a time in the yearly market cycle when supply is low compared to marketing spring-born calves. Marketing calves during this dip in supply typically demands a higher price per pound. An important consideration is that calving cows in the fall requires intense winter forage management or increased supplemental feed, increasing the cost of production for that more valuable calf.

Refer to Mississippi State University Extension Service Publication 2501, “Calving Season Selection Considerations” for more detail on calving seasons.

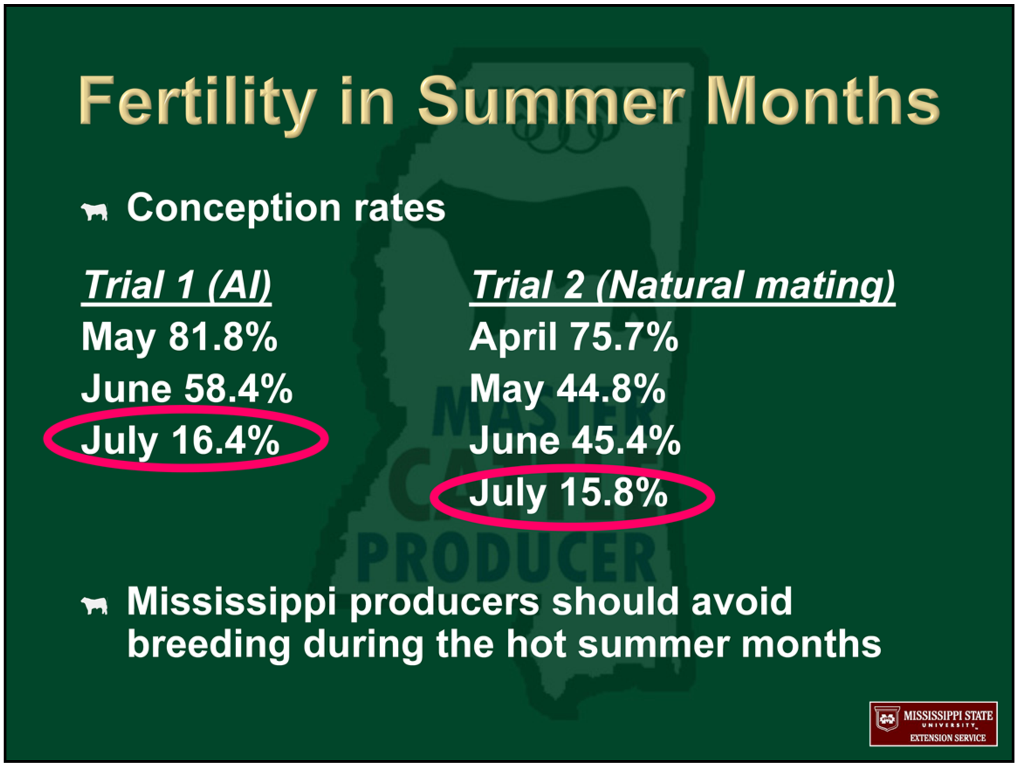



There are several direct seasonal effects on reproductive function. Summer heat stress contributes to these seasonal effects.

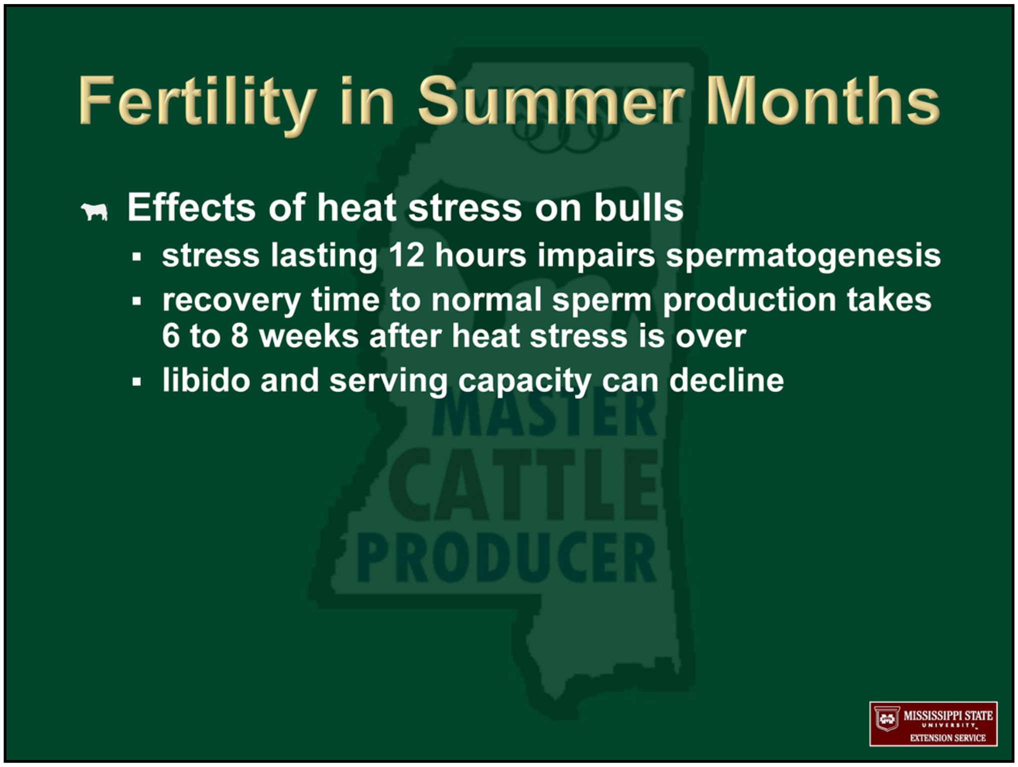



Heat stress, the combination of both temperature and humidity, has a drastic negative impact on fertility in cows by disrupting hormone profiles, egg quality, blood flow and increasing embryonic loss.

Heat stress also reduces bull fertility by disrupting sperm cell production.

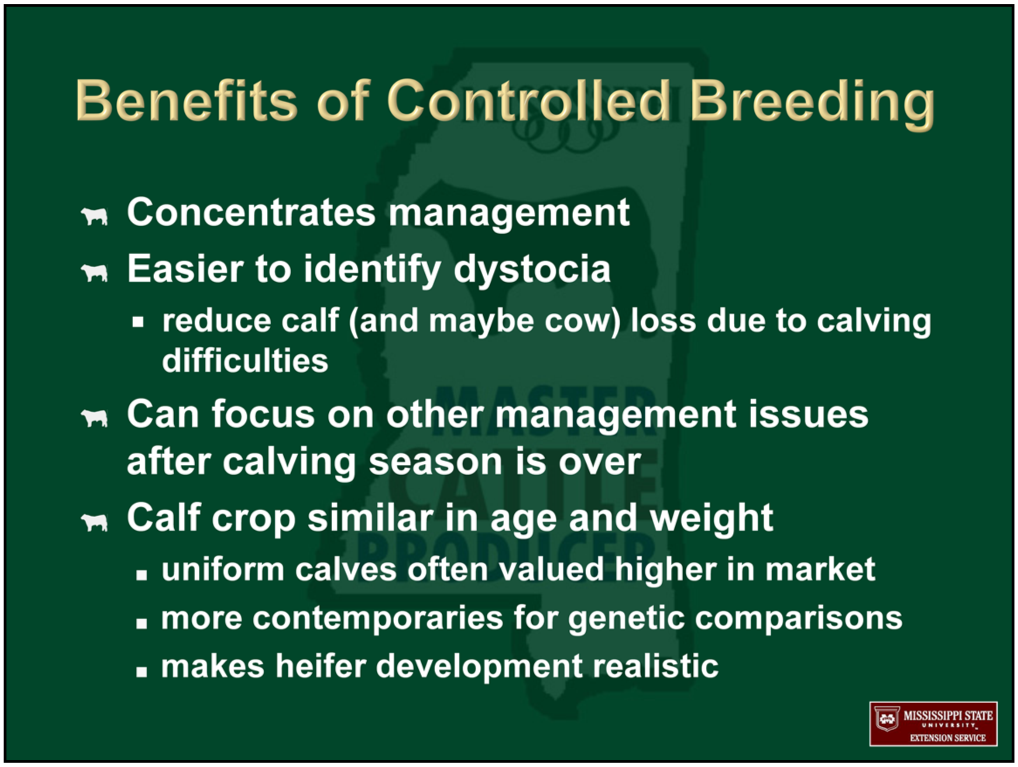



These Texas data illustrate the impact of the typical summer conditions of the Gulf Coast states on beef cow conception rates. The spring breeding season in Mississippi should be concluded by late April or early May. Breeding cows during the summer months in the Southeastern U.S. is usually unsuccessful.




A bull regulates testicular temperature by contracting or relaxing the scrotum. If the ambient temperature overcomes this cooling ability for more than 12 hours, sperm quality is decreased. Impaired sperm production lasts for up to 60 days after the last insult.

Another important part of bull fertility and serving capacity is libido, the bull's desire to cover or service cows. In extreme ambient temperatures, bulls are more focused on shade and water, to reduce core body temperature, than servicing cows.




The benefits of a controlled breeding season are many. It concentrates management, makes it easier to identify dystocia (calving difficulty) when calving, reduces calf (and maybe cow) loss due to calving difficulties, frees up more time to focus on other management issues after the calving season is over, and results in a more uniform calf crop. A uniform calf crop can often be marketed for more dollars per pound. Genetic comparisons are more meaningful with larger contemporary groups. A tighter group of heifers can be selected to be developed as replacements.

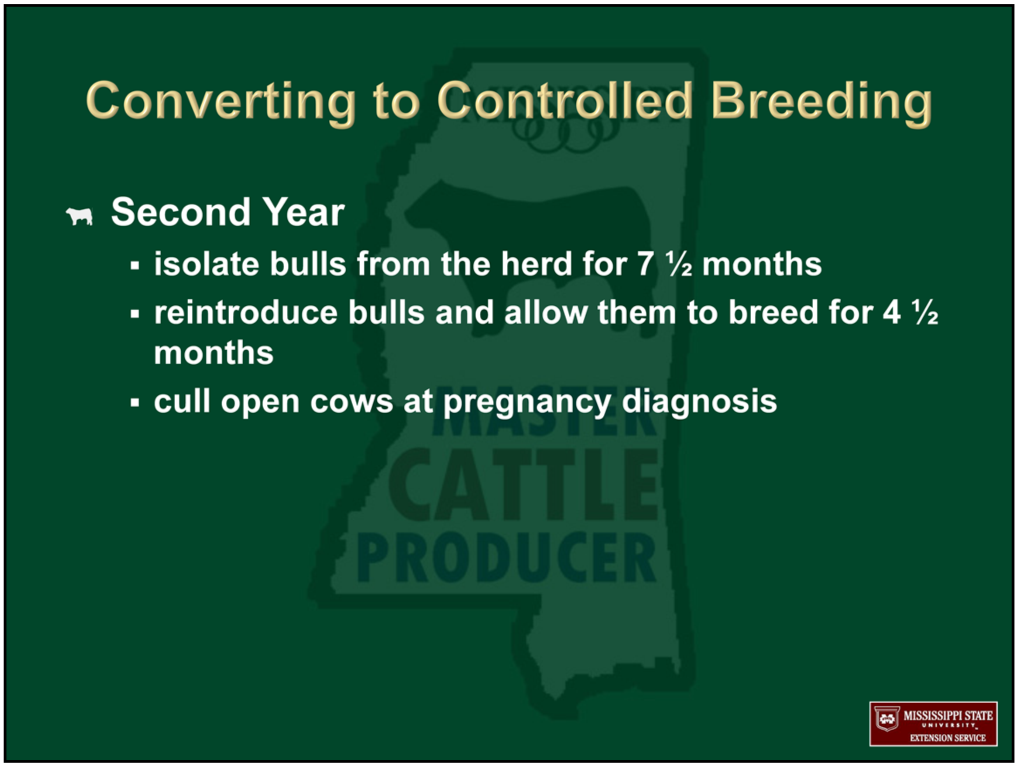

The next few slides give an example of how to move from a year-round to controlled calving season.

First, pick a desired calving season based on the environment, market trends, labor, and seasonal impacts on reproduction.

Identify the most opportune weaning date, subtract 205 for lactation, and then subtract another 283 days for gestation to find the corresponding breeding season.


A strong bull pen is essential for maintaining a controlled breeding season. In the first year of this 3-year transition, put the bull in that pen on what will be the last day of the target breeding season. Pregnancy check all the cows 60 days after bull removal, and cull any dry (non-lactating) cows (and +18 month old heifers) without a calf. Also cull open cows with calves old enough to wean (+5 months).


After the bull has been separated from the breeding herd for 6 months, return it to breeding pastures for the next 6 months. Again, 60 days after bull removal, pregnancy check and cull as before. If heifers have been kept for replacements, breed them 3 to 4 weeks before the cows to give them more time to recover after calving for the first times.




In the second year, leave the bull out of the breeding pastures for 7.5 months and in for only 4.5 months. Again, 60 days after removal, pregnancy check and cull open cows.

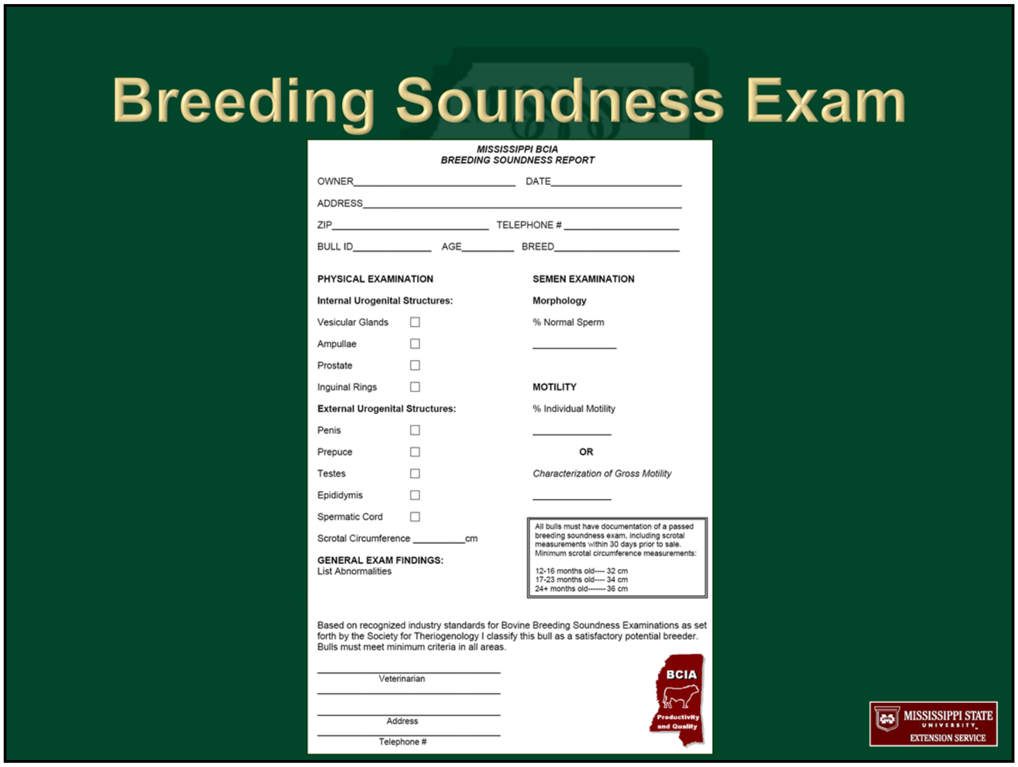
## Converting to Controlled Breeding

- **Third Year**
  - remove bulls for 9 months after the previous breeding season
    - results in desired 90-day breeding season
  - cull open cows after bulls are removed
  - if desired, further reduce the breeding season by leaving the bull out longer

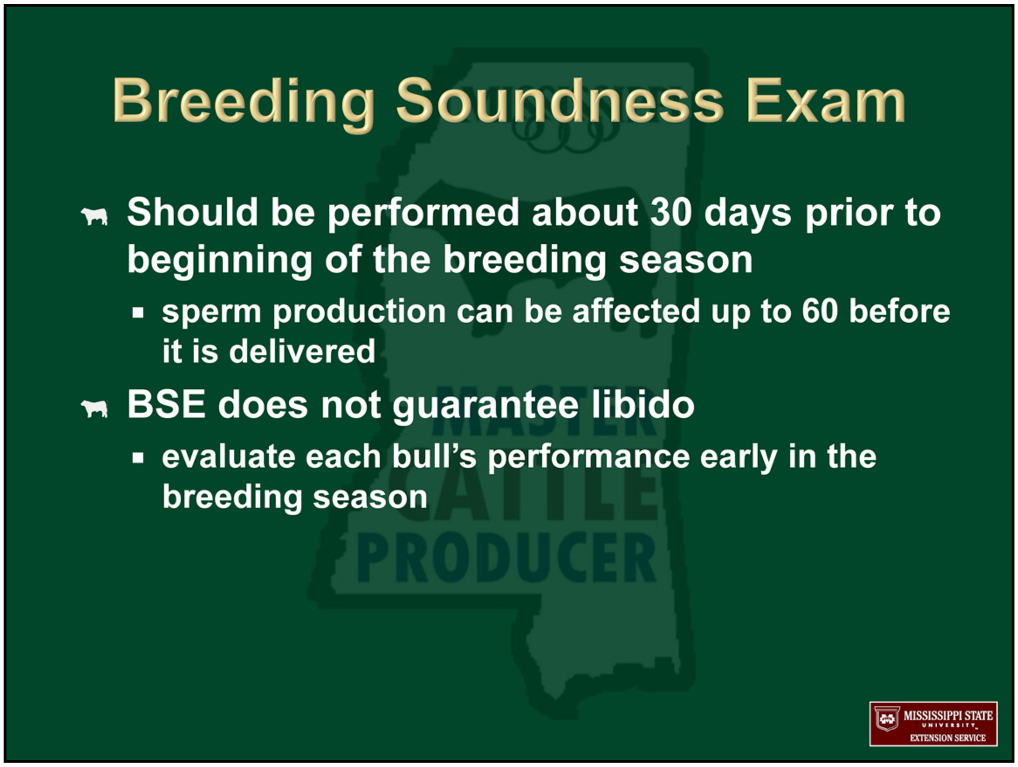
MISSISSIPPI STATE UNIVERSITY EXTENSION SERVICE

Similarly, reduce the breeding season to 3 months in the third year, and cull open cows after pregnancy check. This defined breeding season can continue to be reduced in subsequent years.


The most critical reproductive management practice for bulls is the Breeding Soundness Exam (BSE). This is an overall evaluation of a bull’s ability to breed cows with an acceptable conception rate. These exams are performed by veterinarians who appraise overall structural soundness, scrotal circumference (indicator of serving capacity), health of the reproductive tract, and viability of ejaculated semen.

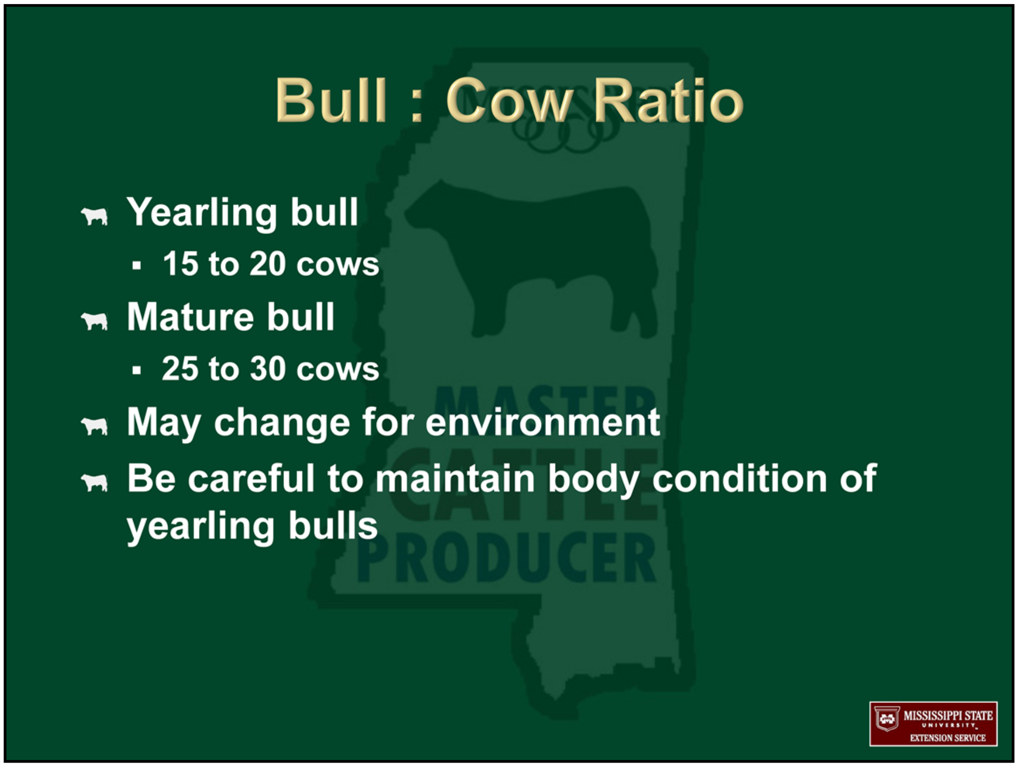



This is an example of a BSE report that would be filled out by a veterinarian. This particular form is for nomination to a Mississippi Beef Cattle Improvement Association sale.




The breeding soundness exam should be performed prior to every breeding season, because sperm production can be negatively impacted for 60 days after illness or injury.

A BSE does not evaluate libido (the bull's willingness to breed). It is a good idea to watch a bull early in the breeding season to make sure that he is sexually active.

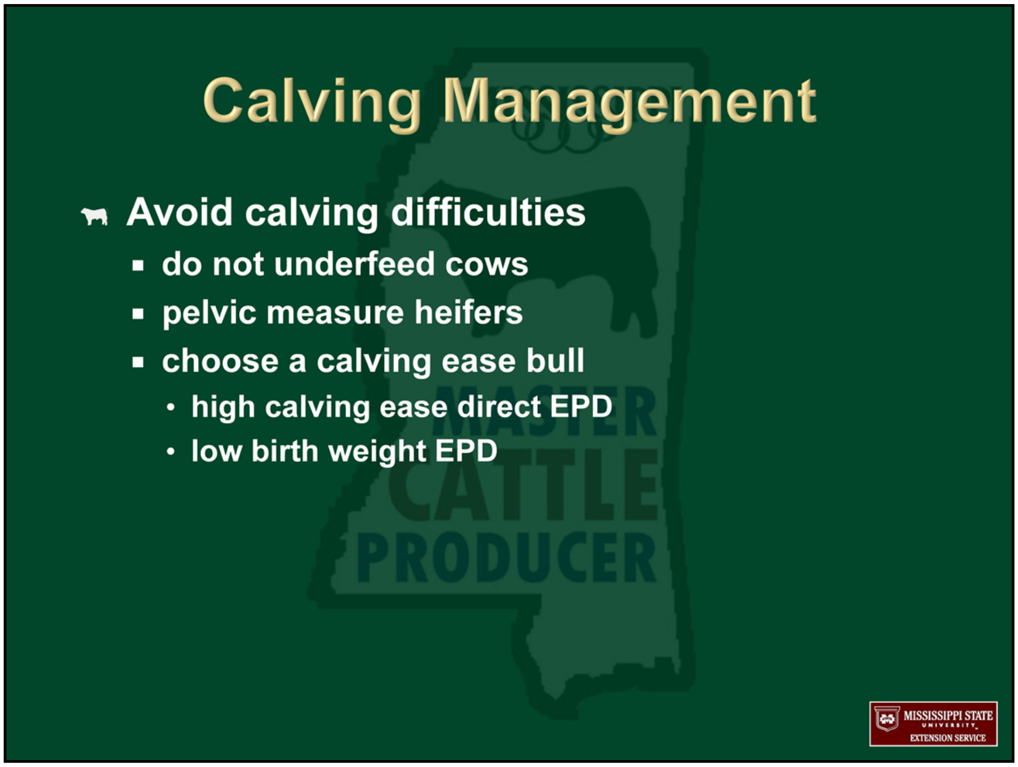



Bull:cow ratios are often referred to as "bull power". Rules of thumb for bull:cow ratios are:

1:15-20 for a yearling to 18-month-old bull

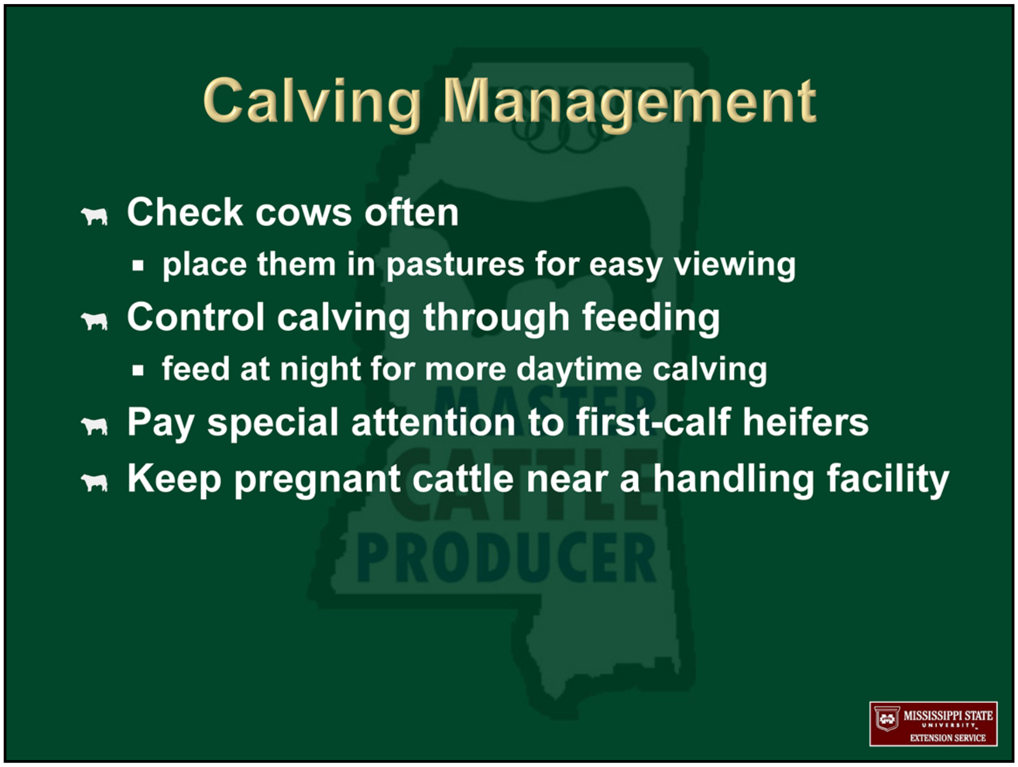
1:25-30 for a mature (+2-year-old) bull

Adjust this if the cows are synchronized or if the cows are spread over a large range situation. Also evaluate the bull's body condition score. Thin bulls generally have a reduced libido and serving capacity. Furthermore, the fertility of an overused yearling bull can be permanently compromised.




Calf losses associated with calving difficulty can be economically devastating for a herd of any size. In addition to calf losses, weak calves and longer postpartum intervals (the time between calving and return to cycling) can result from difficult calving. Underfeeding cows and heifers prior to calving will not decrease calving difficulty but can instead reduce calf vigor. Thin cattle may have difficulty calving if they lack muscle and stamina to expel the calf.

Avoiding calving difficulty starts long before the calving season with proper bull selection, proper heifer development, and culling of females with extremely small pelvic openings. A calving ease bull should be mated to first-calf heifers. If a significant problem with calving difficulty has been experienced in the past, then it is time to reevaluate the herd sires being used. Keeping good calving ease score and birth weight records is important for evaluating calving difficulty within the herd. When available, use calving ease direct EPDs in sire selection. Use birth weight EPDs when calving ease direct EPDs are unavailable.




Place cows and heifers ready to calve in a pasture where they can be easily viewed and checked often. Research indicates that nighttime cattle feeding will result in most of the calves being born during daylight hours, so consider the effects of feeding management strategies on calving. It is a good idea to **pay special attention to first-calf heifers**, because they are the most likely members of the herd to experience calving difficultly. Consider placing heifers in the pasture closest to the house or where most easily viewed. Make sure that cattle approaching calving are near effective cattle handling and restraint facilities including a squeeze chute with head catch in case calving assistance is needed.

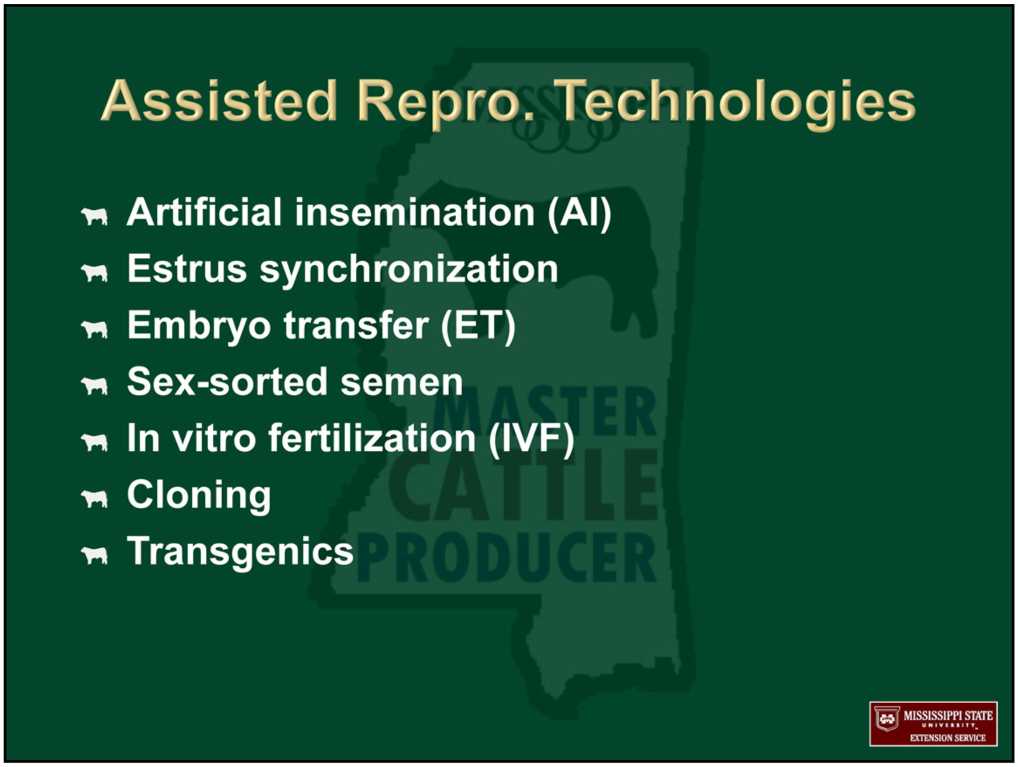

Check that all calving areas are clean and free of items that might injure cattle. Move cow-calf pairs from calving grounds out to clean pasture as soon as possible to reduce disease exposure. Consult with a veterinarian on a calf scours prevention program and to plan future calf vaccinations and parasite control.


Be able to recognize the signs that calving is near. **Observe cattle frequently and have calf pulling and disinfectant supplies readily available**, because timing is critical if assistance with delivery is required. Udder filling, springing (relaxation and swelling of the vulva) and loss of the cervical plug can happen at varying times prior to calving but indicate that calving season is around the corner. Relaxation of the pelvic ligaments and strutting of the teats usually occur within 24 hours of calving. Cows and heifers will become uneasy and seek a quiet place as calving approaches.

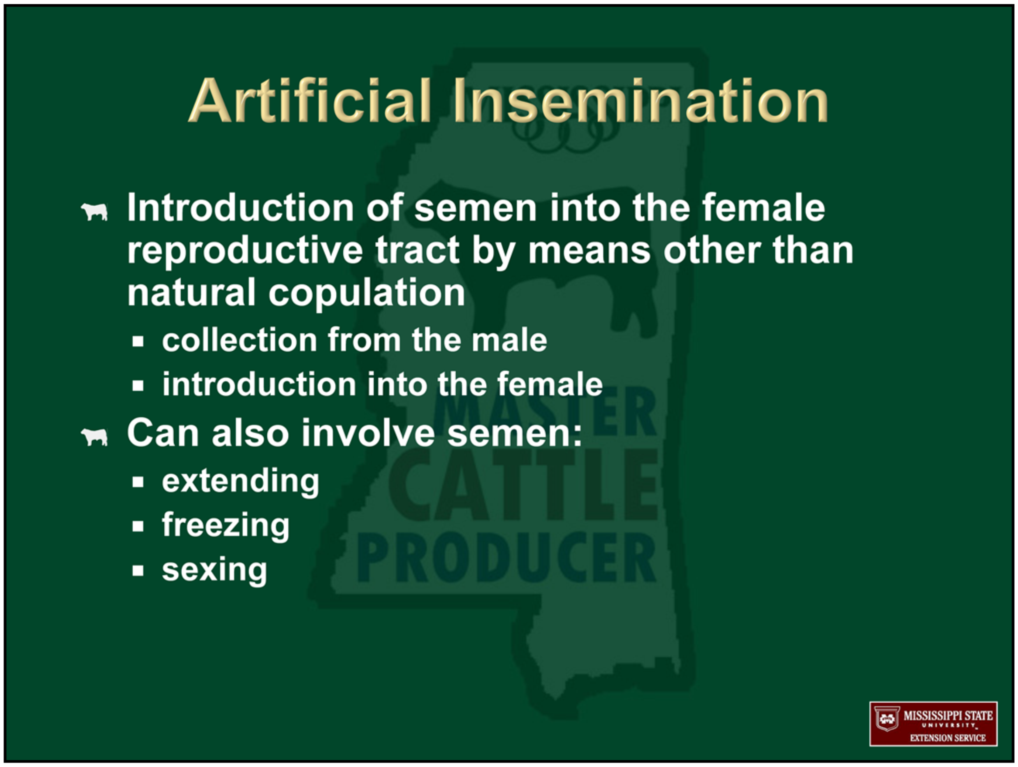
Complete dilation of the cervix, serious straining and calf delivery normally takes 60 to 90 minutes for heifers and 30 to 60 minutes for cows. Assistance may be needed if reasonable progress stops after the feet or water bag appear. Contact a veterinarian if a calf cannot be safely delivered without help. After calving, monitor cows and heifers for retained placentas.

Mississippi State University Extension Service Publication 2558, “Beef Cattle Calving Management” discusses calving management in detail.

Mississippi State University Extension Service Publication 2675, “Providing Assistance at Calving” discusses calving assistance in detail. It outlines corrective actions to be taken for assisting with a variety of different calving presentations.

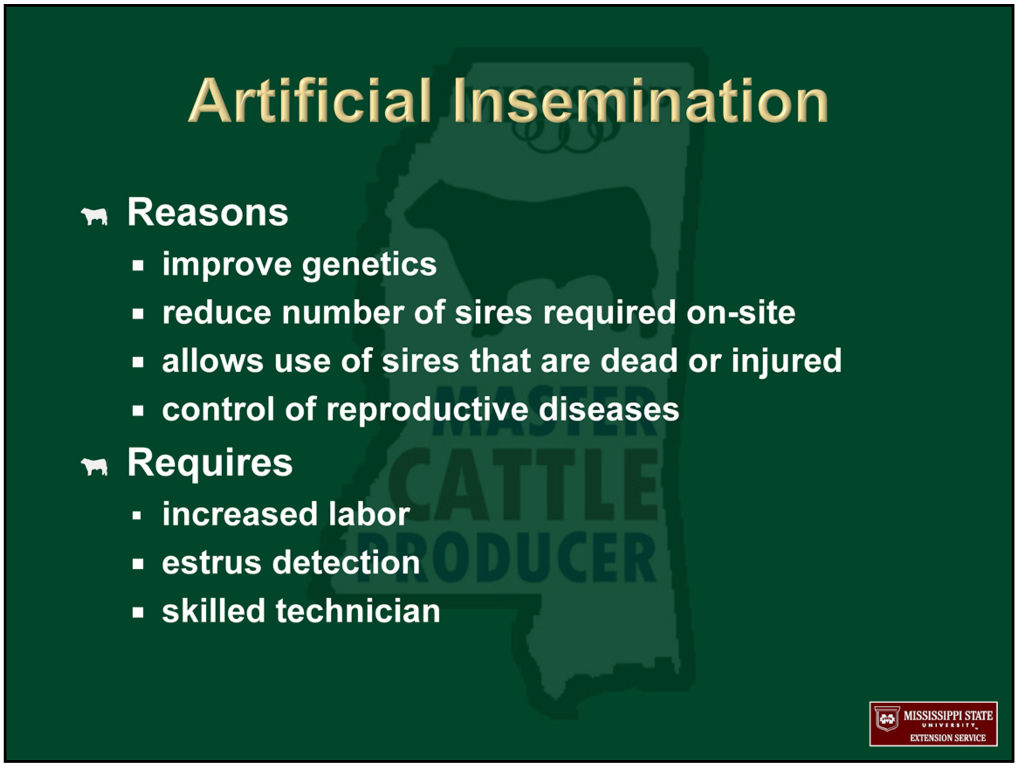



Assisted reproductive technologies are available to improve reproductive function, decrease the generation interval, and/or improve the availability and influence of superior genetics.




Artificial insemination (AI) is the most widely used assisted reproduction technology. It much more widely used in dairy herds than beef herds because dairy producers handle their cattle at least twice daily. For most beef cattle producers, the idea of handling their breeding herds as often as is needed to implement AI seems too laborious. However, exhaustive economic analysis of AI (and estrous synchronization) shows it to increase net revenue in most situations.

Artificial Insemination is the process of collecting sperm cells from a bull and manually introducing them into the reproductive tract of a cow or heifer. In commercial application, this also involves extending one collection into several doses and freezing it in liquid nitrogen to be stored indefinitely and/or shipped. A more recent development is the ability to sort sperm cells into fractions that will yield primarily either heifer or bull calves.

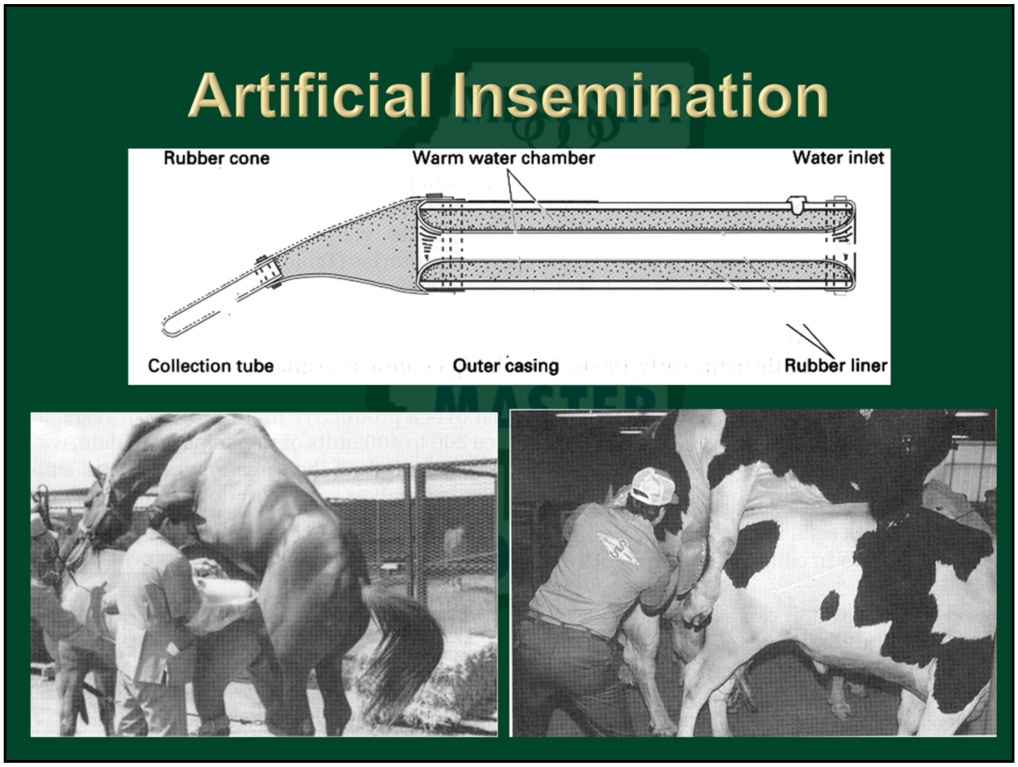



The primary reason for implementing AI is to gain accesses to sire genetics that would be too expensive to get from a live bull. For example, a cattle producer in Mississippi can use a bull valued over $100,000 for $20/dose. Furthermore, that bull might be located in California and not available for live cover. This also amplifies the number of calves that bull can sire in a given year from 35 to 60 calves to thousands of calves.

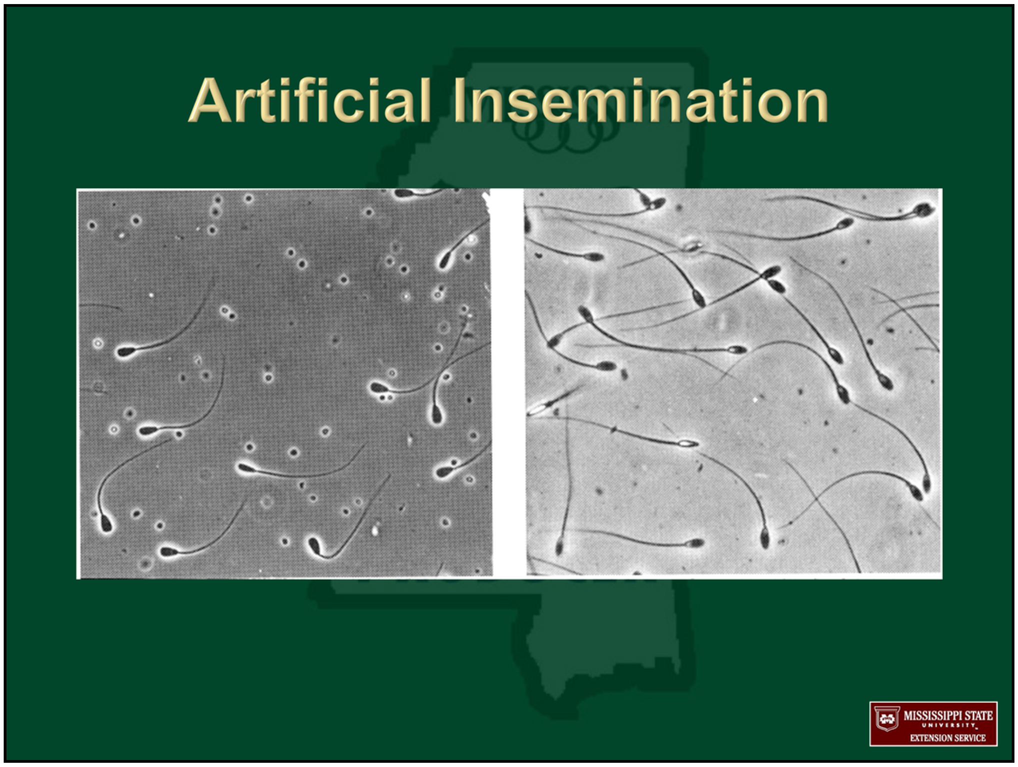
Artificial insemination can also reduce the number of bulls, and associated bull maintenance costs, required for a single cow herd. Semen can be stored and used form dead or injured. Using AI can also eliminate the introduction of sexually transmitted diseases from infected bulls.

The added requirements for implementing AI are increased labor and training in estrus detection and semen deposition.

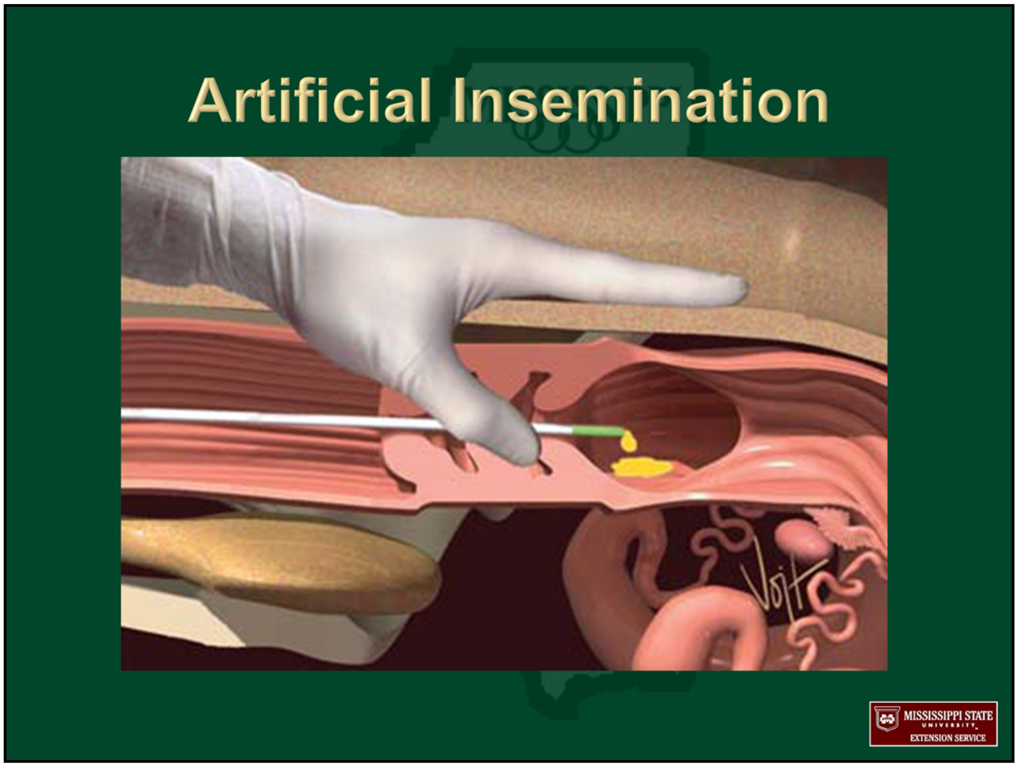
Refer to Mississippi State University Extension Service Publication 2486, “Economic Impact of Artificial Insemination vs. Natural Mating for Beef Cattle Herds” for more detail on the economics of AI.




Most commercially available semen is collected using a teaser animal and an artificial vagina that directs the ejaculate into a collection vial.




A sample of the collected semen is then evaluated under a microscope for the number of sperm cells and their motility (movement) and morphology (shape) as indications of fertilizing capacity. If the sperm cells in that ejaculate are of a high enough quality to be frozen, the semen is extended into several doses, packaged in straws, and frozen in liquid nitrogen for storage.




Proper frozen semen handling and deposition are skills are learned through hands-on training and a great deal of practice. Look for AI schools or short courses in the local area. These are usually 3- to 4-day training sessions that teach basics of reproductive anatomy and function while providing practice in semen handling and passing an AI rod through the cervix.

When the straw of semen is properly thawed, it is loaded into an AI rod and covered with a protective sheath. The rod has a plunger that, when depressed, pushes the semen from the straw. That rod is then inserted into the cow’s vagina and maneuvered through the folds of the cervix. The semen is deposited in the body of the uterus.

It is important to deposit the semen in the uterus (rather than the vagina or cervix) because the number of sperm in a single dose is greatly reduced when a single ejaculate is extended. Normally, when the bull deposits an ejaculate in the cow’s vagina, the volume is 4 to 5 cc and there are 1 to 1.5 billion sperm per cc. The normal volume of frozen semen in the U.S. is 0.5 cc with a total of 30 to 40 million sperm. Many of these sperm die before reaching the oviduct, so giving them a “head start” through the cervix greatly improves conception rates.

Mississippi State University Extension Service Publication 2628, “Artificial Insemination Programs for Cattle” discusses AI in detail.

## Estrous Synchronization

**Table 1. Hormones commonly used in estrous synchronization and trade names they (or similarly acting compounds) are marketed under**

| Hormone (Abbreviation) | Trade Name |
|---|---|
| Gonadotropin Releasing Hormone (GnRH) | Cystorelin®, Factrel®, Fertagyl®, OvaCyst® |
| Progestin | EAZI-BREED™ CIDR®; Intravaginal insert<br>Melengestrol acetate (MGA®); Orally-active |
| Prostaglandin $F_2\alpha$ (PGF) | Lutalyse®, Estrumate®, ProstaMate®, estroPLAN™, In-Synch™ |

Synchronizing estrus is the act of controlling heats and ovulation so that a group of cows cycle within a few hours of each other. Controlling the estrous cycle involves administering hormones (in the form of injections or implants) that control different aspects of reproductive function. The table in this slide lists the main hormones used for estrous synchronization and some of the trade names under which they are marketed.

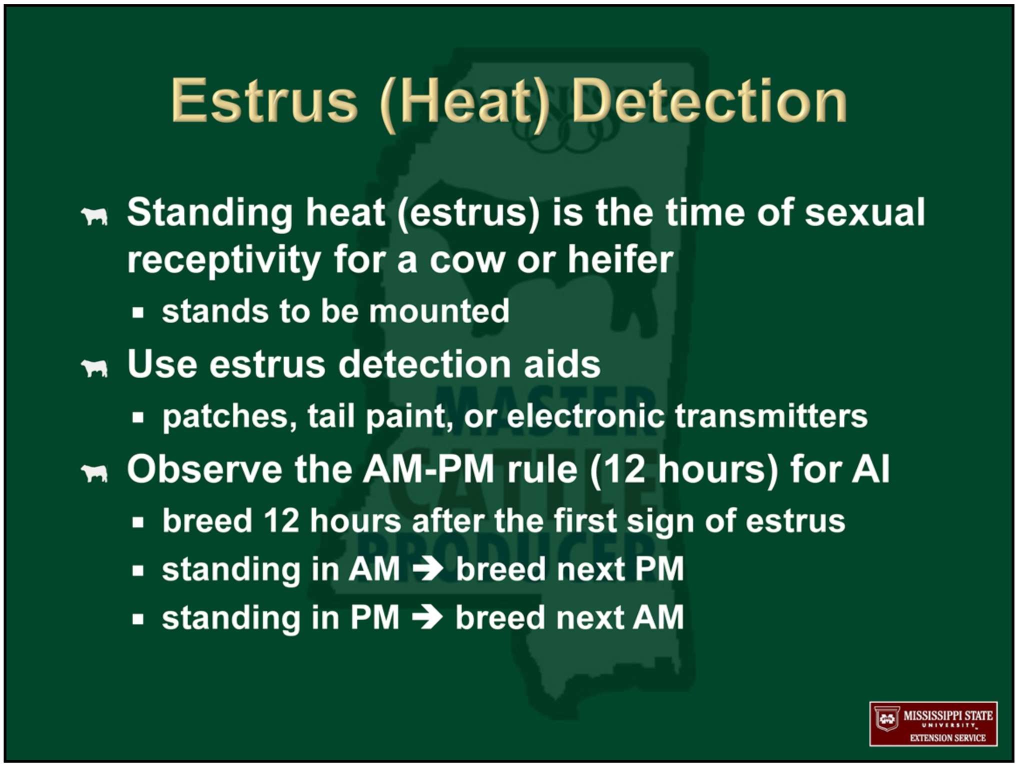
There are many different ways and combinations to use these hormones, but each has a specific function. Understanding the function of each one makes it easier to know how and when to use these hormones.

**GnRH (gonadotropin releasing hormone):** This is an injectable hormone that is normally produced at the base of the brain. GnRH stimulates ovulation through the release of LH.

**Progestin:** These are hormones that are or act like progesterone. Progesterone is produced by the CL and inhibits estrus and ovulation.

**Prostaglandin $F_2\alpha$:** This is another injectable hormone that lyses (removes) the CL. Removing the CL removes progesterone form the blood and lets ovulation occur.

Mississippi State University Extension Service Publication 2614, “Estrus Synchronization in Cattle” discusses estrous synchronization in detail.

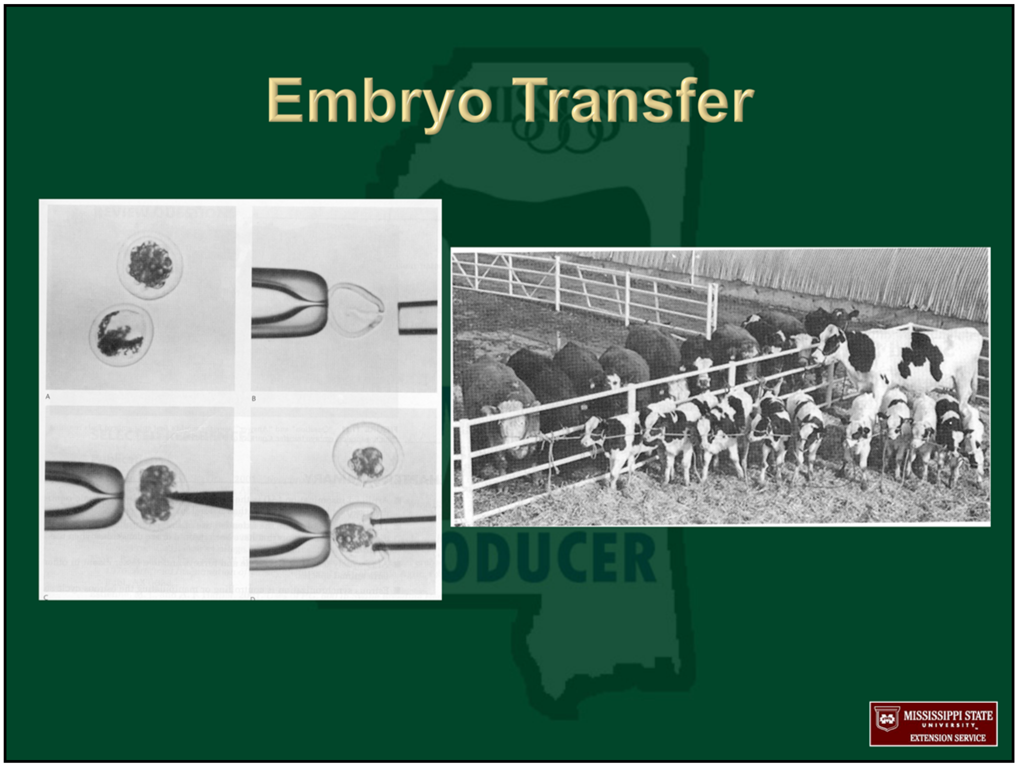



Another important aspect of AI is depositing the semen at the appropriate time in relation to ovulation. If semen is introduced too early, most of the sperm cells will die before the egg reaches the oviduct. If the semen is deposited too late after ovulation, egg quality will decrease and result in poor fertility.

Estrus, also referred to as standing heat, is the willingness of a heifer or cow to stand to be mounted by another cow. It indicates that ovulation will occur in a matter of hours. The predominant rule of thumb for timing AI is called the AM-PM Rule. Checking heat twice daily, breed anything that come into heat in the morning that afternoon and anything that come into heat that afternoon the next morning.

Several estrus detection aids are commercially available. They can be relatively simple, like chalk or paint that is applied to the tail head. When it is rubbed off, that indicates the animal has been mounted. Patches are available that can be glued to the tail head and, when mounted, a dye is released or the surface is scratched off to reveal a vibrant color. The HeatWatch system works by attaching an electronic transmitter to the tail head. When the transmitter is depressed by a mounting animal, a signal is sent to a receiver and the activity is logged into a computer.

Mississippi State University Extension Service Publication 2610 ,"Estrus (Heat) Detection in Cattle" discusses heat detection in detail.

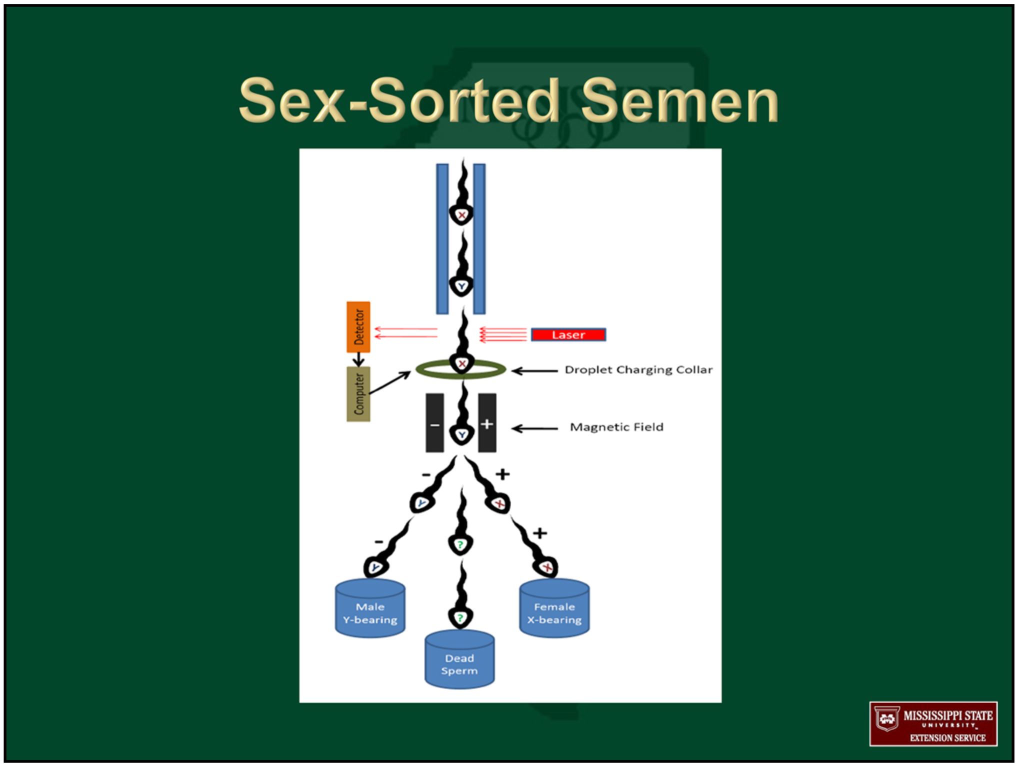



Like AI, embryo transfer (ET) is a tool that amplifies the genetic impact of a desirable animal. But in this case it increases the number of calves a cow can produce in a year. The cow goes through a superovulation protocol, a series of closely timed FSH injections that stimulate her to ovulate more than one follicle. The resulting eggs are fertilized in the cow (usually through AI), and the embryos are allowed to develop for 7 days.

After 7 days, the embryos have moved out of the oviduct and into the uterus. At this point, a catheter is passed through the cervix and fluid is flushed into the uterus. That fluid is then run through a filter that traps the microscopic embryos in a dish. The dish is placed under a microscope where the embryos are assigned a stage and quality grade, washed, and packaged in a straw for immediate transfer or freezing in liquid nitrogen. To transfer, estrus is synchronized in recipient cows, and the embryos are deposited in the appropriate uterine horn 7 days after standing heat.

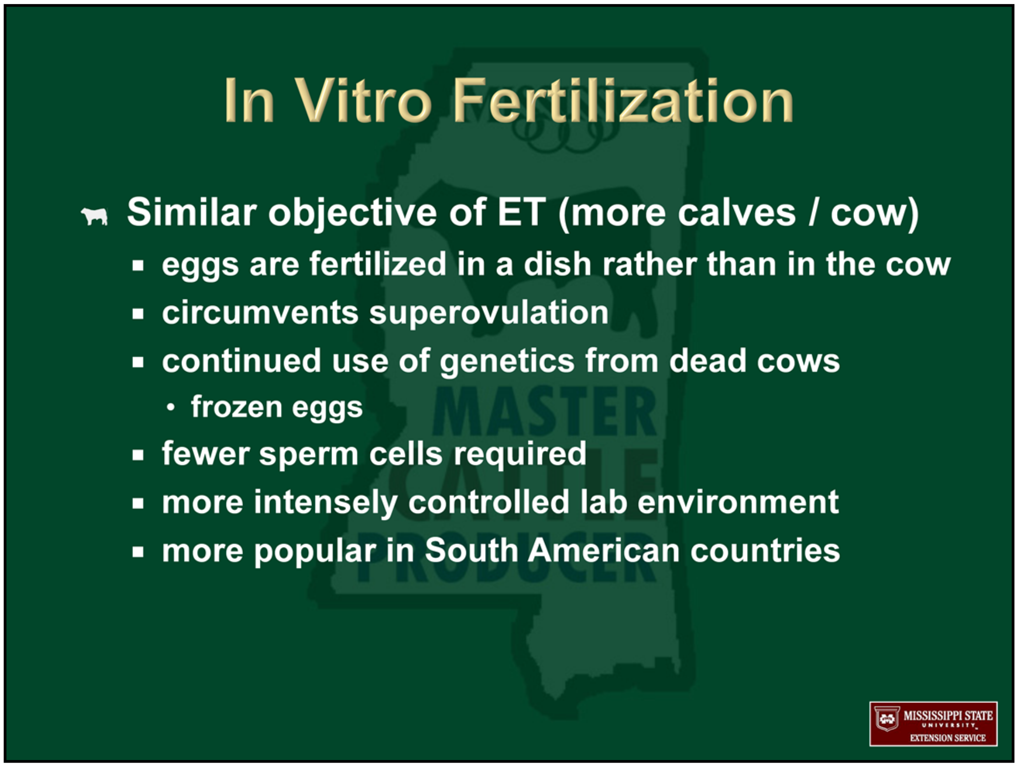
There are several additional technologies that can be added to ET such as splitting and sexing embryos.

Mississippi State University Extension Service Publication 2681, “Embryo Transfer in the Beef Herd” discusses ET in detail.

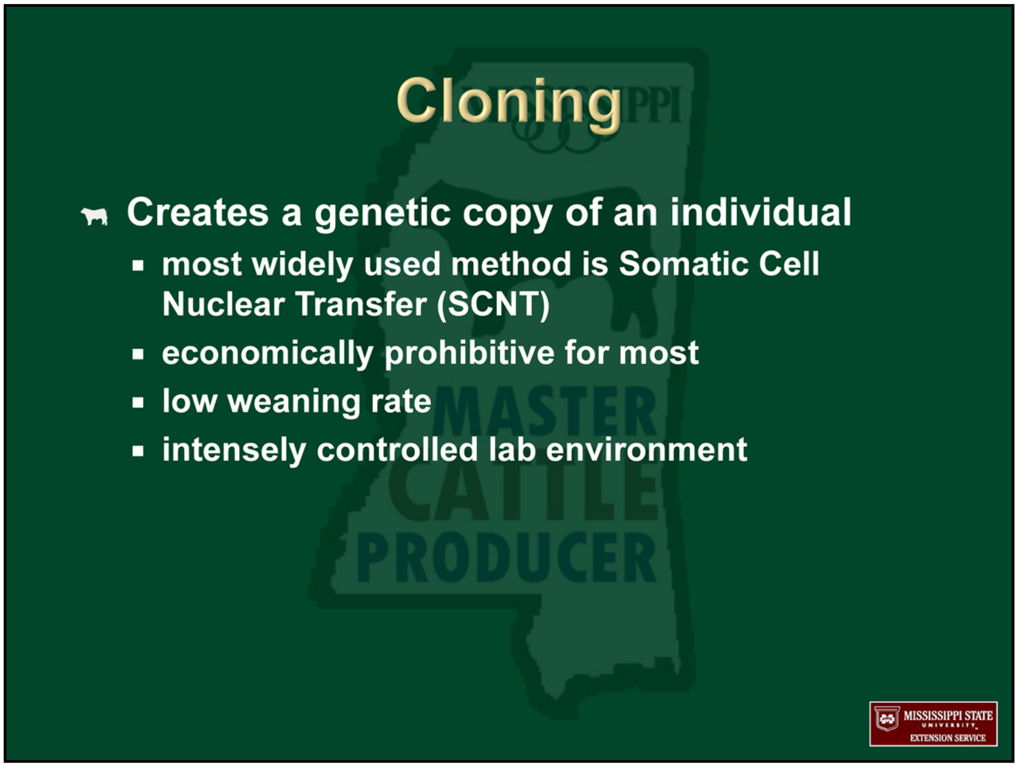



The principle of this method relies on the fact that X-bearing (female) sperm contain 3.8 percent more DNA than Y-bearing (male) sperm. Before sorting, the sperm cells are stained with a florescent dye and then passed through the flow cytometer as drops of liquid containing a single sperm cell per droplet. Because of the difference in amount of DNA, the X-bearing sperm shine brighter than the Y-bearing sperm when exposed to light. This allows the cytometer's laser and detector to determine the gender of the sperm cell based on the amount of light it emits. A positive or negative charge is then applied to the droplet containing the single sperm cell. Positively charged drops are deflected one way, negatively charged drops deflected the other, and uncharged droplets pass straight through. The uncharged drops may contain multiple sperm, damaged material, or cells that were not aligned in the proper direction.

Mississippi State University Extension Service Publication 2569, "Sex-Sorted Semen for Beef Cow-Calf Production" discusses sexed semen in detail.

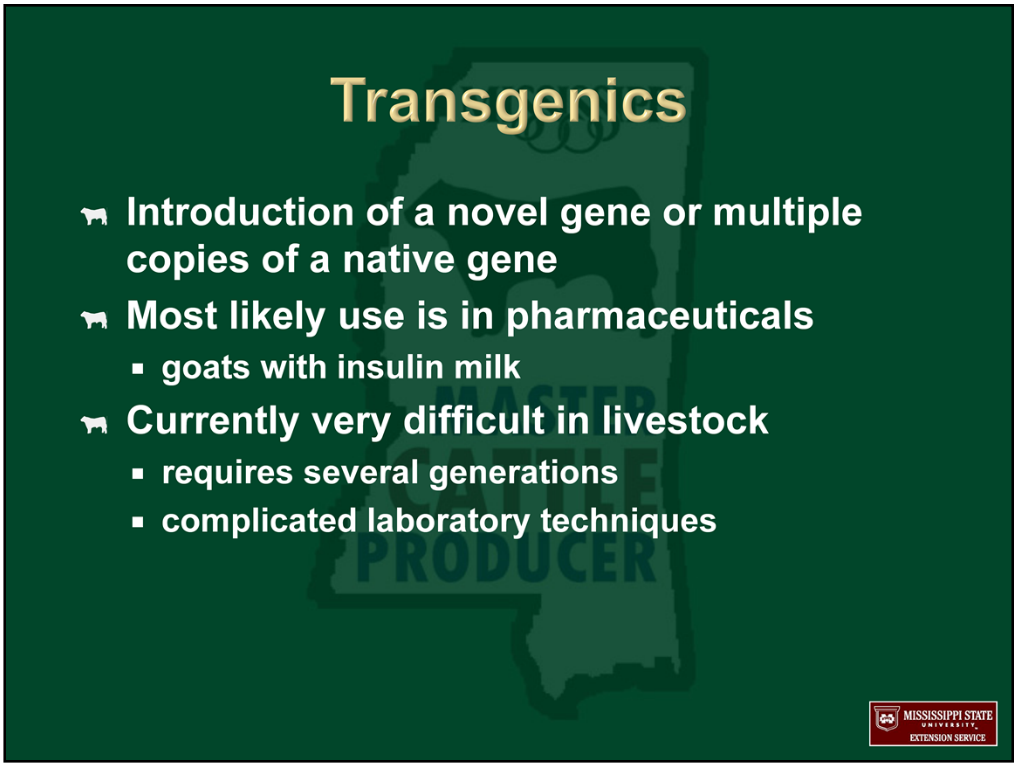



In vitro fertilization (IVF) is also used to increase the number of calves a cow can produce over its lifetime. It differs from ET in that the eggs are mechanically removed from the ovary and fertilized in a dish. This process requires a well- equipped lab, is costly, and pregnancy rates from the resulting embryos are relatively low. However, this technique has become popular in many South American countries, and pregnancy rates there are steadily improving.



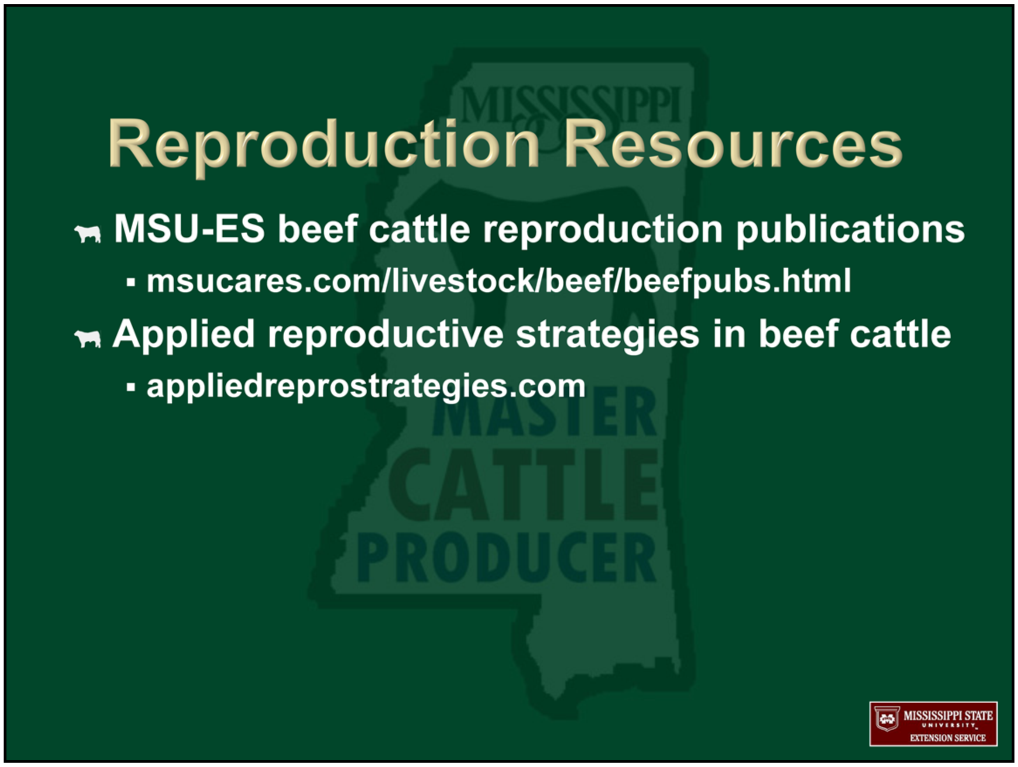

Cloned cattle are now being marketed in some purebred and “club calf” markets. A cloned animal is essentially a genetic copy of the animal that donated the genetic material to create it. Identical twins are naturally-occurring clones. Two calves from a single split embryo are also clones.

The most widely used method for cloning is Somatic Cell Nuclear Transfer (SCNT). In this method, an oocyte (egg) is taken from a cow and the nucleus (genetic material) is removed. The nucleus from a somatic cell (often a mammary cell) is inserted into that egg and the factors in it direct that nucleus to become a new embryo. This procedure is costly because it requires a very specialized lab and many embryos to produce a single live calf. Many of the calves that are born alive have other problems and die early.




Transgenic technologies are farther from commercial application than cloning. In this procedure, genes from an entirely different organism, or multiple copies of a native gene, are inserted into a developing embryo. One example in livestock is work that is being done to insert the gene that produces insulin into the mammary tissue of goats. The goats can be milked normally, and the insulin isolated from the milk is to be used in diabetics.

While this technology might not ever become widely used in beef cattle production, it is something to be aware of in the future.




Mississippi State University Extension Service **beef cattle reproduction publications** are available online at http://msucares.com/livestock/beef/beefpubs.html. This includes the publications referenced in this training module.

The Applied Reproductive Strategies in Beef Cattle website also contains a wealth of beef cattle reproduction information. It is online at http://appliedreprostrategies.com.