Objectives

1) To provide an overview of the process of artificial insemination (AI) in cattle.
2) To gain an understanding of the proper methods of handling and thawing frozen semen.
3) To provide “hands-on” experience passing an AI pipette through the cervix to the proper site of semen deposition in cattle.

What are the advantages and disadvantages of AI?

Advantages

1) Allows for widespread use of genetically superior sires that would normally not be available to breeders because they are too expensive to purchase.
2) Allows for faster and increased genetic improvement in cattle allowing for improved herd performance and productivity. The dairy industry’s use of AI is a good example of how it can be used for herd improvement, i.e.) milk production.
3) Allow for the practical use of gender selected semen where high percentage of progeny (> 90%) born are either male or female.
4) Allows for accelerated progeny testing of sires to determine their genetic potential.
5) Allows for control of venereal disease within a herd.
6) Allows for the elimination of dangerous dairy bulls from the farm.
7) Reduces number of bulls needed for natural service.
8) Allows the producer to use larger and heavier bulls on smaller animals without the danger of injury to the females.
9) Progeny derived from the insemination process can be worth more money.
10) Introduction of new genetic material via importation of semen from outside the country. No expensive handling, quarantine, and shipping costs of live animals.
11) Frozen semen can be stored and used long after the donor or sire is dead. It also allows for the use of semen from an injured sire that is unable to breed naturally.
12) Allows for more efficient use of estrous synchronization, the process of breeding cows over a 3 to 7 day period compared to 21 days in unsynchronized animals.

Disadvantages

1) Economic. Most semen is inexpensive at $5.00 to $15.00 per unit. However, semen from popular bulls can be expensive and is often greater than $25.00 per unit. Other additional costs associated with AI are the labor required for estrus detection, the need for an experienced AI technician, and drug cost of estrus synchronization. On average it cost between $15 to $20 to synchronize and inseminate a cow.
2) Management skills are necessary to effectively implement an AI programs.
3) Facilities that allow proper restraint of cattle are required so that cattle can be inseminated. Adequate physical facilities and nutritional resources are also required to handle a large number of cattle during the time period when cattle are being AI.
**Liquid Nitrogen Tank**

1) Frozen semen is stored in liquid nitrogen -196°C or in liquid nitrogen vapor -180°C. Therefore, always proceed with caution when using liquid nitrogen.

2) Store the tank in a dry, clean, well-ventilated area, off the floor and out of the sunlight.

3) Maintenance - check the liquid nitrogen level frequently and make sure the tank is filled on a regular basis. Semen that has been thawed is no good. Frost or sweat on the tank is indicative of a tank that has developed a leak or has lost its vacuum.

4) Extended and packaged semen can be stored indefinitely in liquid nitrogen.

**The Process of Artificial Insemination**

**Thawing Semen and Loading an AI Gun**

1) Pre-warm AI gun and make sure thaw bath is 95°F.

2) Check the breeding records to match the cow with semen she will be inseminated with.

3) Move one straw of semen from the liquid nitrogen tank to the thaw bath as quickly as possible.
   - 0.5 ml or 0.25 French straws are thawed for 30 - 40 seconds at 95°F (37°C).
   - Minimize exposure of the straw to sunlight.
   - Don't leave the semen in the water bath for an extended period of time > 15 min.
   - Don't attempt to refreeze semen if you do not use it. Throw it away!!

4) Note: The farther up the neck of the tank the semen is held, the greater the temperature (Figure 1) and the increased risk of heat shock and the semen being damaged. Do not hold a canister or cane of semen above the neck of the AI tank any longer than 10 seconds. If you do, immerse the semen in the nitrogen for a short period of time. There is a frost line in the neck of the tank that indicates where a large temperature changes occurs and you want to try and keep the semen below when removing straws from a cane.

---

*Figure 1.* Example of the temperature gradient in the neck of a semen tank. Notice that the temperature gets warmer farther up the neck of the tank.
5) Wipe all water from the straw; check the bull name on the straw. Is it CORRECT?
6) Clip the crimped end (opposite cotton plug) either with scissors or a cito-cutter.
7) Place straw in a prewarmed AI gun and place a sterile sheath over the gun & straw.
8) Initiate the insemination process by rectally palpating the cervix through the rectum and prepare it to receive the insemination gun.
9) Use a clean paper towel to wipe away any fecal material or mud from the external genitalia of the cow.
10) Place the AI gun into the vagina at a slight angle with the tip of the AI gun pointing upward to avoid the opening of the urethra.
11) Traverse the cervix with the AI gun and deposit the semen right at the tip of the cervical/uterine junction, (Figure 2). Deposit the semen slowly (5 seconds).

Figure 2. Anatomy of the female reproductive tract indicating the target location (depicted by the circle) where semen is deposited during AI. Also described in figure below.
What type of information appears on a straw of semen?

1) Information that identifies the semen (i.e., 1AN001).
   Bulls Breed (AN), AI Center Code (1), Bulls ID within AI Center (100)

2) Sire’s name and registration number from his breed association.

3) Collection date/freeze code: tells when the bull was collected, processed, and frozen.

4) Gender of sperm cells packaged as either male or female.

5) If the abbreviation CSS (Certified Semen Services) is on the straw, it means that the semen was processed under the very strict health guidelines of CSS. Semen that is typically exported is processed according to CSS guidelines.

What is the concentration of sperm cells in a straw of semen?

- The concentration of sperm in a straw is dictated by factors that affect semen quality, which are usually based on how the semen survives the freezing and thawing process. Factors include breed of bull, bull to bull variation, and the time of the year the bull is collected. Dairy bulls usually freeze better than beef bulls.

- Average number of sperm cells/straw: \(20-40\) million sperm per straw

- Percentage of sperm that survive the thawing process is between 30 and 80%, which is dependent on the factors listed above. The good AI studs will usually not release semen that has a post thaw survival rate less than 30%.

- Average number of live sperm cells/insemination dose: \(5-10\) million live sperm/straw.

- If the semen is gender selected, the straws will contains approximately \(2\) million sperm cells. Additionally, only 30% of the sperm survive the freezing & thawing process. Therefore, most companies that sell gender selected sperm recommended that it only be used on virgin estrous cycling yearling heifers.

When do I inseminate the cow/heifer relative to the onset of estrus?

- Twice a day breeding (AM/PM Rule)
  
  Breed 8 - 12 hours after standing estrus was observed. If estrus was observed in AM, breed the following PM. If heat was observed in PM, breed the following AM.

- Once a day breeding: Breed in the AM.
  
  Heat check 2x day with breeding 0 to 24 hr after onset of estrus.

- Important physiologic factors to keep in mind (Figure 3).
  
  Duration of standing estrus is approximately 8 - 16 hours.
  
  Ovulation occurs 24 - 30 hours after the onset of estrus.
  
  Life span of the sperm is 16 to 24 hours.
    
  Sperm must be capacitated before it is capable of fertilization. Therefore, sperm capacitation needs to be timed with ovulation of the oocyte. For that reason, inseminate about 12 hours after the onset of estrus, which is approximately 15 hours before ovulation.
  
  Life span of the oocyte is 6 to 10 hours.
Figure 3. Schematic that displays the timeline of the best time to inseminate cattle after an observed estrus to achieve maximum pregnancy rates.