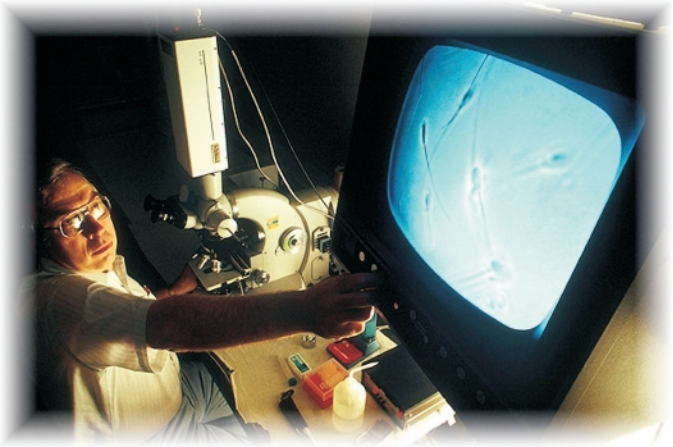
Important Reproductive Technologies

DEVELOPMENTS in reproduction continue to advance. Like humans, animals struggle with reproduction from time to time. Challenges facing the animal industry include the onset of estrus, conception, the ability to maintain pregnancy, and a live, healthy birth. Research continues and advancements come to the forefront each year to better procedures, enhance currently effective methods, and introduce new science. Many believe that the current work being performed in reproduction will aid in feeding the ever-growing world population. The science is controversial according to some groups, but it has proven to be effective and safe and to improve animal agriculture.



(Courtesy, Agricultural Research Service, USDA)

Artificial insemination, a major reproductive technology, is covered in a separate E-unit. This E-unit will discuss estrus synchronization, embryo transfer, cloning, and genetic engineering.

Objective:

Define the processes of estrus synchronization, embryo transfer, cloning, and genetic engineering.

Key Terms:

- cloning
- donor mother
- embryo transfer
- genetic engineering
- GnRH
- progestin
- prostaglandin
- recipient females
- superovulation

Reproductive Technologies

Reproductive technologies are quite advanced. Several techniques have been introduced in past years. These include estrus synchronization, embryo transfer, cloning, and genetic engineering. All four bring different aspects to reproduction and are used for various research projects. Some are even used in the animal industry. The objectives behind much of the research are (1) to use animals to produce more food, (2) to create more efficient animals, and (3) to use animals to better the health of humans. The controversy related to this type of science is that it involves humans. Controversy arises from individuals fearing that cloned or genetically engineered animals will enter the food chain; however, that is currently regulated, prevented, and monitored by the U.S. Department of Agriculture. Some people fear that this type of science could eventually alter or even destroy the human race, while others believe that the unknown risk is worth the reward.

ESTRUS SYNCHRONIZATION

Estrus synchronization is performed by using one or more synthetically created hormones to bring an animal into estrus. The point where the animal is in her estrous cycle will dictate the effectiveness of treatment to synchronize breeding and birth.

Common synthetic hormones used to synchronize estrus include prostaglandin, progestin, and GnRH. **Prostaglandin** is used to stop the production of progesterone by the corpus luteum, resulting in the animal's experiencing estrus. Depending on the animal, it may take two to four days for estrus to be expressed. **Progestin** is a synthetic form of progesterone. It can be used to hold an animal in diestrus for an extended period or to supplement the production of progesterone and maintain a pregnancy. When progestin therapy is ended, the animal typically will move from diestrus to estrus. **GnRH**, or gonadotropin-releasing hormone, causes the pituitary gland to produce the luteinizing hormone and follicle-stimulating hormone. These two hormones induce ovulation. GnRH is commonly injected before or at the time of breeding to help facilitate the proper timing of the ovum and the sperm cell.

EMBRYO TRANSFER

Embryo transfer involves the collecting of fertilized eggs, or embryos, from one female and placing them in the reproductive tracts of other females. This procedure is commonly used in animals with superior genetics to allow for more offspring to be produced in one breeding season.

The female supplying the embryos is the **donor mother**. She possesses traits that exceed those of all other animals and produces highly desired offspring when using a specific mating.

To facilitate embryo transfer, the donor mother goes through a hormonal treatment called **superovulation**. This involves treating her with specific hormones for several days. Estrus and breeding follow. Then, the embryos are collected after a waiting period. Superovulation causes the donor mother to produce a greater than normal number of eggs at ovulation.

Once the embryos are collected, they can either be frozen in liquid nitrogen or be transferred to recipient females. **Recipient females** are at the same phase of their estrous cycle as the donor mother at the time of collection and are able to support offspring. They normally do not possess superior genetics but do a good job of raising offspring. Recipients are typically selected from average animals but have a high milk production and birthing rate.

FIGURE 1. The cow shown here is the surrogate mother of the calf. The calf was born from an embryo transfer. (Courtesy, Agricultural Research Service, USDA)

CLONING

The first animal to be cloned was Dolly, a Dorset ewe, born July 5, 1996, in England. **Cloning** is the production of one or more exact genetic copies of an animal by using one of several scientific methods. Cloning involves high-level scientific techniques and is commonly debated in the scientific and public communities. Many fear the possible results of cloning, while others explore the procedures in the hope of advancing medicine.

ON THE JOB...

CAREER CONNECTION: Genetic Engineer

Careers are readily available for well-educated genetic engineers. New hires into the genetic engineering field will be involved in groundbreaking research that may change the world. People working in the genetic engineering field could participate in the research and development of plants and animals and even in human advancement. Many companies and universities and the government are seeking individuals with appropriate education and training to work in their genetic engineering programs.

A bachelor's, master's, or even doctoral degree in science is needed. An individual with a bachelor's degree should plan to work as a laboratory research technician, with an expected starting salary of $30,000 to $35,000 a year. A person with a master's degree should plan to work as a laboratory researcher or assistant to the head laboratory researcher, with an expected starting salary of $35,000 to $45,000 a year. Someone with a doctoral degree in science would typically work as an assistant, associate, or head researcher, with an expected starting salary of $50,000 to $70,000 a year. Genetic engineering offers much potential for an exciting career with advancement and the opportunity to be at the forefront of research.

Cloning can be done in a number of ways. One method involves letting an embryo develop until it reaches the 32-cell stage and then dividing it into 32 separate embryos that are identical. Another procedure involves using cells from an adult animal. The nucleus is removed from a cell and replaced with the nucleus of another cell. Several identical clones can be created using this method. The final procedure for cloning is using stem cells. Stem-cell cloning involves the collection of immature cells that duplicate themselves rapidly and placing them in an environment for reproduction. This type of cloning can be used to replace damaged cells in an organ or can be used in other procedures. Research and education continue in cloning to help both scientists and the public better understand its potential benefits and applications.

FIGURE 2. These piglets have been genetically engineered through the introduction of genes so that they may supply organs for human transplant someday. (Courtesy, USDA)

GENETIC ENGINEERING

Genetic engineering is the scientific act of adding, removing, or modifying genes in the DNA of an animal. This is done to promote or prevent the expression of a trait. For example, the DNA of a pig could be altered to cause its organs to grow more humanlike in their construction. The pig could then become an organ donor and possibly save somebody's life.

The use of genetic engineering is rather common in plants and is becoming more acceptable as a means of producing larger crops. It is still in the developmental stage for application in animal production. Through continued research, genetically engineered animals might become common in the future.

Summary:

Estrus synchronization, embryo transfer, cloning, and genetic engineering can all be used to enhance reproduction. Currently, animals resulting from estrus synchronization and embryo transfer are acceptable for regular use and application in the animal industry. Cloning and genetic engineering are still in the research and educational phase of science. In the future, all these reproductive technologies may be used to produce more food and better animals or to aid the health of humans.

Checking Your Knowledge:

1. Name three common synthetic hormones used to synchronize estrus in animals.
2. What steps are involved in embryo transfer?
3. Explain three procedures used for cloning animals.
4. What is the purpose of genetic engineering?

Expanding Your Knowledge:

Search online for further exploration of estrus synchronization, embryo transfer, cloning, and genetic engineering. Identify applications currently being used in animal and plant agriculture. Also, search for applications in human health. Look for science-based resources for this type of work and research. While exploring these topics, weigh the positives and the negatives involved. Survey 5 to 10 adults to test their knowledge of the topics. Be sure to ask their opinions on the use of these technologies in food production and human health.

Web Links:

International Embryo Transfer Society
http://www.iets.org/

Cloning Fact Sheet
http://www.ornl.gov/sci/techresources/Human_Genome/elsi/cloning.shtml

Monsanto.com
http://www.monsanto.com