

In-Vitro Fertilization (in-vitro = "in a dish")

The usual process of reproduction in the cow (in-vivo) involves estrus (heat), ovulation (release of a mature egg from the ovary), and fertilization of the egg in the oviduct. The egg, once fertilized goes through cellular divisions for the first five days before forming a cavity (blastocoel). This cavity swells and assists the embryo with hatching out of its protective shell. The embryo then attaches to the uterine wall, establishing a pregnancy.

Sometimes nature breaks down and science can step in. Cows that develop reproductive problems can have their valuable genetic lives extended through in-vitro fertilization (IVF). Also, valuable cows can continue to reproduce while they are pregnant (up to 120 days) with the aid of IVF. The IVF procedure begins with oocyte (egg) recovery. Ultrasound technology is used to extract the eggs from the ovary, while still in the cow. The eggs that are harvested are ones that the cow has not matured or ovulated, therefore, they must be matured. The immature oocytes are placed in a hormone bath consisting of natural hormones LH (luteinizing hormone) and FSH (follicle stimulating hormone) for 22 hours. The mature eggs are washed and placed in a media that enhances fertilization. Sperm from the intended sire are treated to enhance motility and fertilization potential, and are incubated with the eggs for 18 hours.

With normal in-vivo reproduction, the embryo starts to develop in the cow's oviduct. IVF uses a co-culture system with Buffalo Rat Liver cells (BRL) to grow with the embryos. This occurs in a controlled environment, an incubator at 39°C and 4% CO₂. BRL cells mimic the environment which embryos need to develop, by providing valuable nutrients and growth factors, while eliminating toxic substances. After 5-7 days of incubation IVF embryos look similar to their in-vivo counterparts by producing a blastocoel as well. At this point, the embryo is removed from culture and can be sexed, frozen, or transferred to a recipient like conventionally produced embryos.

The "average" cow, when flushed after stimulation, produces 6-7 good embryos per flush. This can be done every 8 weeks with hormones used to superovulate her ovaries. These averages are made up of good, average and poor donors. In general, 40% of the donors yield 75% of the embryos, with approximately 10% of donors producing nothing. An "average" IVF collection yields 8-10 good oocytes which have the potential to produce embryos. With a 75% fertilization rate and 35% blastocyst formation rate, one can expect 1-2 usable embryos per collection. Collections, however, can be done much more frequently and if a large number of eggs are recovered more than one sire can be used at one time to fertilize eggs, unlike in-vivo embryo production. The average IVF results are also comprised of good, average and poor donors. An important factor is follicle population, which is the number of potential eggs a cow has on her ovaries at any given time. Animals with many follicles tend to be good donors and animals with few follicles tend to be poor donors.

Success rates for IVF embryos are generally lower than those embryos produced by conventional embryo transfer. Pregnancy rates are variable, but in general, fresh IVF embryos have a 55-60% success rate. Unfortunately, IVF embryos have a higher than normal pregnancy loss that results in a calving rate of approximately 45%. Results with frozen IVF embryos are still disappointing at a 30% pregnancy rate. We highly recommend using fresh IVF embryos whenever possible. Sexing IVF embryos is also an option. This requires taking a biopsy of the embryo, which in turn will decrease its viability. The pregnancy rate for sexed fresh IVF embryos is approximately 10% lower than non-sexed embryos. We estimate it takes between 6 and 8 embryos to produce a female pregnancy. In general, the birth weights of IVF calves are about 10% higher than in-vivo calves. Occasionally a very large calf will be born. This means that calving IVF pregnancies is more of a challenge and extra vigilance is required to achieve success in an IVF program.

In summary, IVF is an exciting and potentially advantageous technique for the modern cattle breeder. Salvaging genetics from infertile animals or producing embryos during pregnancy are IVF's main applications. As with all breeding techniques, there are advantages and disadvantages that should be closely examined when considering IVF. Please feel free to call us for consultation about your potential IVF needs.

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