EMBRYO BIOLOGY

Patrick M. McCue
DVM, PhD, Diplomate American College of Theriogenologists

Fertilization and early embryonic development are regulated by a complex series of events. In addition, embryo biology of the horse has several unique features not found in other domestic animals. The goal of this column is to review the normal course of equine embryology.

The events of pregnancy begin with ovulation. Mares usually ovulate a single large follicle near the end of estrus. One oocyte or egg is released from the follicle at ovulation and is 'collected' by the large funnel-shaped infundibulum of the oviduct and transported toward the uterus.

If the mare has been bred or inseminated, sperm work their way up the oviduct toward the newly ovulated egg. Although mares are usually bred with 500 million to several billion spermatozoa, only a few thousand sperm actually make it into the oviduct.

Sperm must undergo a series of changes in the mare reproductive tract, a process called capacitation, in order to gain the ability to fertilize an egg. Capacitated sperm bind to specific proteins in the outer coat (zona pellucida) of the egg. Binding to the egg triggers an event in the sperm termed the acrosome reaction, in which enzymes present in a specialized compartment located on the head of the sperm are released. These enzymes enable the sperm to penetrate through the zona pellucida. The plasma membranes of the sperm and egg subsequently fuse and the sperm is eventually engulfed into the egg. The egg then undergoes a series of changes to prevent additional sperm from penetrating. Fusion of the pronuclei of the sperm and egg, which contain chromosomes or DNA from the stallion and mare, respectively, results in formation of the genetic blueprint of the new embryo.

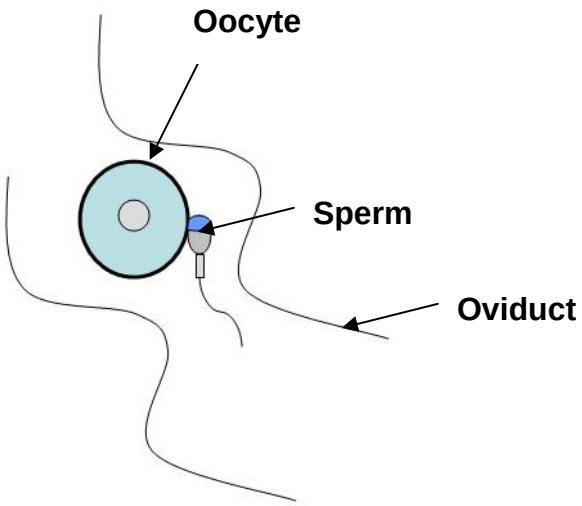
The embryo next begins a series of cleavage divisions in which the single-celled zygote divides into 2 cells, then 4 cells, etc. The embryo continues to develop as it travels down the oviduct. Horses are unique among domestic animals in that only fertilized eggs or embryos are transported into the uterus. Equine embryos produce a hormone called prostaglandin E2 which relaxes the circular smooth muscle of the oviductal wall and allows an embryo to continue movement toward and eventually into the uterus. Unfertilized eggs do not product prostaglandin E2 and are retained in the oviduct and eventually degenerate. Occasionally an unfertilized oocyte will be recovered from the uterus during an embryo flush if it 'followed' an embryo through the oviduct.

Equine embryos enter the uterus through a narrow passage called the uterotubular

junction (UTJ) approximately 6 days after ovulation. At this time most equine embryos are in either the morula or early blastocyst stage of development.

Contractions of the uterine musculature cause the equine embryo to be transported throughout the entire uterus multiple times per day. During this mobility phase, the embryo secretes a factor that signals the endometrium or uterine lining that a pregnancy is present. The pregnancy recognition factor has been identified in cattle, sheep, pigs and other species, but has yet to be identified in the horse. This embryo-uterus interaction is called maternal recognition of pregnancy and is a key component of pregnancy maintenance in the mare.

Failure of the embryo to produce a sufficient signal or failure of the uterus to recognize the signal will result in the release of prostaglandins produced by the endometrium. Prostaglandins will travel through the blood stream and cause regression of the ovarian corpus luteum (CL) of the mare. The CL produces progesterone, which is critical for support of pregnancy in all animals. Regression of the CL will result in a cessation of progesterone production and loss of any pregnancy that may be present. The window for maternal recognition of pregnancy in the mare is 10 to 16 days after ovulation. Embryo migration ceases at approximately 16 to 17 days after ovulation and the embryo is then 'fixed' in position at the base of one uterine horn.



Success of assisted reproduction techniques such as embryo transfer and oocyte transfer are based on understanding of these normal physiologic events in the mare.