Genetics and Reproduction

ASSIGNMENT 7: GENETICS

Read this assignment. There's no textbook reading for this assignment.

DNA and RNA

Cells are the basic building blocks of an organism. Very simple organisms, like bacteria, are composed of a single cell; more complex organisms, like humans, dogs, and cats, are made up of many cells. To function, an organism's cells must be alive; they must have the ability to grow, develop, and reproduce.

In a complex organism, different cells carry out many different functions. Information within the cells tells the cells what they're supposed to do. This information is stored in the form of *deoxyribonucleic acid (DNA).* DNA is a chemical substance that contains the "blueprints" that determine the function of that cell. The functions of a cell are directed by the action of its proteins, and the code in the DNA of a particular cell specifies what proteins that cell should make. Thus, DNA determines the purpose of each cell.

Heredity is the passing on of characteristics from parent to offspring. *Genes* are the basic units of heredity. They contain the DNA that specifies the proteins to be made. Genes control almost every aspect of an organism. When cells divide, the genes and the information they contain are copied exactly and transmitted to the new cell. In this way, the *progeny* (offspring) inherits identical characteristics and functions from the parent cell. To accomplish this exact reproduction, DNA uses a second chemical substance, *ribonucleic acid (RNA).* The information, or code, that the DNA carries is copied as a form of RNA through a process called *transcription*. This type of RNA is called *messenger RNA*, since it carries information from one cell to its progeny.

LESSON 4

Genetics

The study of heredity is called *genetics*. As veterinary technicians you'll hear the term genetics used quite often, especially when discussing disease conditions with a genetic correlation or a specific phenotype of a species. The basic rules of heredity were studied first by Gregor Mendel, an Austrian scientist. Largely through experiments performed by breeding plants, Mendel established the main principles that are still the basis of an understanding of genetics today. One of Mendel's findings is the principle of *dominance*. This principle states that in an offspring, a gene for a particular characteristic from one parent masks, or hides, the expression of the gene for the same characteristic from the other parent. In other words, that gene is dominant over the other. In conducting his experiments with plants, Mendel bred tall plants with short plants. He assumed that one of the following conditions would result:

1. All plants would be tall.
2. All plants would be short.
3. Some plants would be tall, and some would be short.
4. All the plants would be somewhere between the tall and short plants.

All of the first-generation plants from this experiment were tall. What happened to the gene for the characteristic of shortness? Mendel then bred the plants from the first generation with each other. Approximately one-fourth of the offspring were short.

Let's assume T stands for tall plants, and t represents short plants. In his first experiment, Mendel bred a plant with both genes for tallness (TT) with a plant with both genes for shortness (tt). The offspring will have one gene for tallness and one for shortness (Tt). Since all the plants in the first generation were tall, Mendel theorized that the gene for tallness masked the gene for shortness. Therefore, he called the gene for tallness *dominant* and the gene for shortness *recessive.* A *Punnett square* is a diagram used to show how this inheritance works (Table 4).

Table 4 A Simple Punnett Square		
	Male (T)	**Male (T)**
Female (t)	Tt	Tt
Female (t)	Tt	Tt

In the second experiment, Mendel bred plants from the first generation (Tt) with each other. The four possible combinations from this breeding are TT, Tt, tT, and tt (Table 5). All plants, except those receiving two recessive genes (tt) will be tall, because the dominant gene for tallness (T) masks the recessive gene for shortness (t). As a result, approximately one-fourth of the offspring were short, and three-fourths were tall.

TABLE 5 Punnett Square Showing the Mix of Dominant and Recessive Genes		
	Male (T)	**Male (t)**
Female (T)	TT	tT
Female (t)	Tt	tt

Classification of Animals by Breed

For many species, especially domesticated animals, individuals within a species are further classified into breeds according to common characteristics. Each breed has a standard set of traits that differentiate it from other breeds of the same species. For example, Collies are different from Poodles or German Shepherds.

A *purebred* is an animal in which the characteristics of the breed continue from generation to generation if the animal is bred with another animal of the same breed. In other words, if one purebred is bred with another purebred of the same breed, the animal will pass on the breed characteristics to its offspring.

A breed frequently has conformation characteristics where the members of the breed resemble one another. Additionally, a breed typically has characteristics that relate to its function. For example, various breeds of cattle have different characteristics concerning suitability to environmental conditions, reproductive efficiency, mothering and milking abilities, and meat-producing capabilities. Likewise, breeds of dogs have different strengths. Retrievers are good hunting dogs, Collies can herd sheep, and Rottweilers provide protection. There's no perfect breed, as selecting a breed is truly a personal choice. It's important for the pet owner to understand the breed.

Selective breeding is a process in which two animals are bred to propagate the genetic characteristics from a set of parents to their offspring. The owner may breed for increased milk production in a cow or hunting skills in a dog, or even coat color or skeletal size. Selective breeding involves breeding individual animals that possess certain desired characteristics to be passed on to the offspring.

If this process continues, a population will eventually develop in which every individual carries the genes for the desired traits. When that happens, however, selective breeding can no longer be used, because all members of the population have the same traits. Selective breeding includes two different options: inbreeding and outbreeding. *Inbreeding* involves mating two closely related individuals. The highest degree of inbreeding possible occurs when a brother and sister mate or when a parent and offspring mate. If both of these closely related individuals have the genes for the desired traits, the traits will be expressed in the offspring. If both parents have the same genes for undesirable traits, inbreeding increases the frequency of genetic disease in a population. The genes for these undesirable traits may be recessive. Recessive genes aren't apparent in the parent animals, but they're expressed in the offspring.

Outbreeding, or the mating of unrelated individuals, frequently results in offspring that are better adapted to survival than either parent. If two animals don't share a common ancestor for at least five generations, a cross between them would be considered outbreeding.

Knowledge of the mode of inheritance of both desired and undesired traits, combined with an understanding of both inbreeding and outbreeding, can be used to create a better breed or superior animal.

Self-Check 7

1. *True or False?* Outbreeding is the mating of closely related individuals.

2. _____ was the first to study the basic rules of heredity.

3. *True or False?* Genes are the basic units of heredity.

4. Another word for offspring is _____.

5. *True or False?* Information within the cells is stored in the form of RNA.

Check your answers with those on page 132.

ASSIGNMENT 8: REPRODUCTIVE SYSTEM

Read this assignment. Then read Chapter 11 pages 366–395 in your textbook, *McCurnin's Clinical Textbook for Veterinary Technicians*.

Female Reproductive System

Anatomy

The female reproductive system (Figure 3) includes the *ovaries*, the uterine tubes, the uterus, the vagina, the vulva, and the vestibule, as well as the blood and nerve supply to these organs. The ovaries have two main functions: to produce eggs and to produce the sex hormones estrogen, progesterone, and relaxin. Each female has two ovaries located in the abdomen, just behind the kidneys. They're supported in the abdominal cavity by the *mesovarium,* which also contains the blood and nerve supply for the ovaries. The ovaries are generally round, firm structures that vary in size from 2 cm × 1.5 cm in the dog to 6 cm × 4 cm in the horse and 3 cm × 2 cm in the cow. The ovaries are made of connective tissue and blood vessels. They contain a supply of undeveloped egg cells. The ovaries also contain *follicles,* or capsules, which produce estrogen. As the ovaries mature, the *oocytes,* or undeveloped eggs, develop in the follicles into *ova,* or mature egg cells. Once a follicle releases its *ovum* (singular of ova), the follicle develops into a corpus luteum. The *corpus luteum* is a structure that produces *progesterone,* a hormone important in pregnancy.

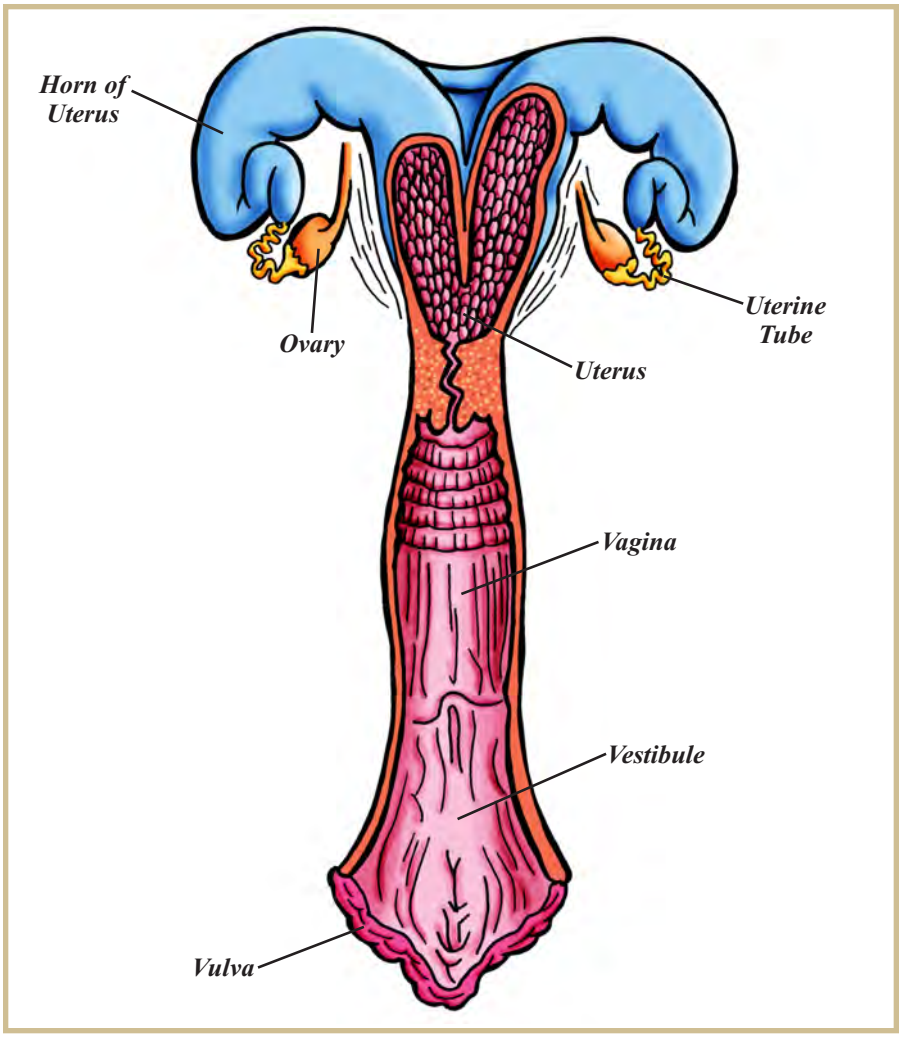

FIGURE 2—The Reproductive Tract of a Cow, Opened Dorsally

The *uterine tubes,* or the *oviducts* or *fallopian tubes,* connect each ovary to the uterus. Each uterine tube has a funnel-like opening on the end near the ovary and is smaller in diameter on the end near the uterus. At the ovarian end, finger-like projections called *fimbriae* extend from the funnel-shaped opening to help catch the ova as they're released from the ovary during ovulation. Fertilization occurs in the uterine tubes.

The *uterus* is a strong, muscular organ designed to receive a fertilized ovum from the uterine tubes. It protects and supports the development of the fetus and helps during the initial stages of birth. The uterus consists of a body and two horns, and the ends of the uterine horns connect with the uterine tubes. In all domestic animals, the *endometrium,* the innermost

layer of the uterus, forms an attachment to the fetus, which provides the nutritional support to the fetus. This attachment is called a *placenta.*

The *vagina* is a muscular structure that serves as a copulatory organ. The vagina also acts as a passageway for the fetus during birth. The *cervix* connects the vagina to the uterus. At the other end, the vagina is connected to the vestibule and vulva. Many females have a delicate membrane that partly covers the opening between the vagina and the vulva. This membrane, called the *hymen,* usually disappears after breeding and/or delivery of a fetus. The vagina is capable of great variation in size during different stages of the *estrous cycle* (breeding cycle) and gestation.

The *vulva* and the *vestibule* form the termination of the female reproductive tract. The vulva includes two *labia* and the *clitoris.* The vestibule, located between the vagina and the vulva, contains the opening of the urethra, through which urine passes from the bladder. The vestibule also contains several circular, sphincter-type muscles that close the vagina to the outside. These muscles also allow the female to elevate the vulva and clitoris to exhibit the characteristic receptive behavior that the male recognizes. These two organs are the only female reproductive organs that contain a well-developed sensory nerve supply.

Oogenesis

Once an egg is fertilized, it soon becomes a growing embryo, which eventually will develop into the offspring. In the early stages of development, an embryo contains primitive gametes, which will develop into either ova or sperm, depending on whether the embryo becomes a male or female. If female, these germ cells first develop into oocytes through a process called *oogenesis.* Hormonal changes in the embryo, specifically exposure to FSH, help determine the number of oocytes produced. Oogenesis is completed before birth in all domestic species. Thus, females are born with their full supply of oocytes, which are never regenerated or replenished. The supply decreases in number as the animal ages. The number of oocytes produced in oogenesis is usually significantly more

than will be ovulated during the female's fertile lifetime. Most oocytes degenerate and die in a process called *follicular atresia.* These follicles are called *atretic follicles.*

Ovulation

Ovulation is largely under hormonal control. Two hormones, FSH and LH, cause follicles within the ovaries to grow and develop. This development occurs many times throughout the life of a female during gestation, before puberty, and even during pregnancy. After puberty the follicles completely mature. Ovulation occurs in response to a reproductive cycle. Ovulation usually occurs only in nonpregnant animals, although horses and sometimes cows ovulate during early pregnancy, as well.

As a follicle matures, it travels toward the surface of the ovary. At the time of ovulation, it breaks through the outer wall of the ovary. Ovulation usually is accompanied by slight bleeding. The ova are washed out, along with fluid from the ruptured follicle, and are caught by the fimbriae at the ends of the uterine tubes. The ova are then deposited into the funnel-shaped portion of the uterine tubes. In most species, ovulation is a spontaneous event. However, in cats, rabbits, and ferrets, ovulation is induced by repeated mountings or copulations, which trigger a release of the hormone LH, which in turn causes ovulation.

The *corpus luteum* is a structure that develops in the follicle at the time of ovulation. It grows very rapidly after ovulation and produces *progesterone,* which is necessary to maintain the pregnancy. In most species, if pregnancy doesn't occur, the corpus luteum degenerates. Then a new wave of follicular growth begins. In a bitch, however, the corpus luteum remains functional even if the bitch isn't pregnant. It slowly disappears over a two- to three-month period.

Estrous Cycle

The *estrous cycle* is the definite physiologic functional rhythm of the reproductive system, which occurs in all females after puberty, regardless of the species to which the female belongs. Species are divided into three classes, depending on their type of estrous cycle. *Monoestrous animals* (usually wild animals) experience one estrous cycle a year. *Polyestrous animals*, which include the cow and the sow, have frequent estrous cycles throughout the year. *Seasonal polyestrous animals,* such as the sheep and the mare, have periodic estrous cycles only during certain times of the year.

The *bitch* (female dog) and the *queen* (female cat) are similar to monoestrous animals in that they have two or three periods of estrus in a year. This may be referred to as a *diestrous cycle* (not to be confused with the part of the estrous cycle called diestrus). The queen has repeated cycles during these periods, if breeding doesn't occur, to stimulate ovulation.

The estrous cycle, or heat cycle, is divided into four phases. *Proestrus* is the period in which the reproductive tract is preparing for breeding. The actual time frame for this period varies greatly from individual to individual. Follicular growth occurs under the influence of FSH and produces increasing levels of estrogen. As a result, the blood supply to the genital tract increases, the cells that line the uterine tubes grow, and the lining of the vagina thickens. In a bitch and a queen, the cells that line the vagina *cornify* (appear rough). The vagina changes as the animal's body readies itself for breeding. The cells of the vagina can be examined with a microscope to determine which state of the estrous cycle the animal is experiencing. In the bitch, a bloody vaginal discharge occurs. In the bitch and the sow, the vulva becomes noticeably swollen. In the cow and the mare, a clear stringy mucus is produced. Late in proestrus, the female starts to exhibit receptive behavior to the male.

The second phase, *estrus*, is the period of sexual desire and acceptance of the male. The supply of estrogen peaks during this period, and the follicles are mature. The vulva is relaxed and swollen in all species. The vagina is thickened and fully cornified in the bitch and the queen. Ovulation occurs during this period, in response to a surge in LH, usually toward the end of estrus.

The third stage, *metestrus* and/or *diestrus,* is the period in which the corpus luteum grows rapidly after ovulation. Progesterone is the major hormone that influences this growth. In the queen, if breeding doesn't take place, the corpus luteum doesn't form, and the follicles degenerate. In other species, the effects of progesterone on the reproductive tract are quite marked: the endometrium thickens, the glands develop significantly, the cervix closes, the lining of the vagina becomes pale, and the uterus relaxes. Late in metestrus, the corpus luteum begins to regress. In animals that have multiple estrous cycles, follicular development occurs and proestrus begins again.

The final phase, *anestrus,* is a period characterized by an inactive, functionless reproductive tract and ovaries. It occurs in mares during the winter and in ewes during late spring and summer. In bitches and queens, anestrus occurs for several months between cycles. In bitches, anestrus is an important period that allows the uterus to repair from the hormonal effects of the previous cycle.

The estrous cycle of queens is unusual. Queens are induced ovulators, and their bodies attempt to stay in estrus until they mate. Mating stimulates ovulation, which ends the heat cycle. If they don't breed, they may cycle out of heat in a few days, or they may remain in heat for a variable length of time. Some queens seem to stay in heat almost continuously. The average length of time in heat for queens is probably between three and seven days, and the average time between cycles is a little less than three weeks.

Hormones

One reproductive hormone, *FSH,* is necessary for the growth of the follicles and the production of estrogens in the ovaries. *LH* causes ovulation and growth of the corpus luteum from the ruptured follicle. The time and relative amounts of FSH and LH are very important to the onset of ovulation and may help determine the number of ova released.

Oxytocin, another important reproductive hormone, is produced in the posterior pituitary gland. This hormone causes smooth muscles to contract in the uterus during *parturition* (birth) and in the mammary glands to stimulate *lactation* (production of milk).

Other important female reproductive hormones are produced in the ovaries. These include estrogen, progesterone, and relaxin. *Estrogen* is responsible for giving females their secondary sex characteristics, like mammary gland development and the typical distribution of body fat. Estrogen also helps regulate the estrous cycle. It acts on the reproductive tract, causing those changes necessary to allow mating, and they help in the transport of sperm into the uterine tubes. During pregnancy, estrogen produced by the placenta helps prepare the body for the impending parturition. *Progesterone,* which is produced mainly by the corpus luteum, is essential for the maintenance of pregnancy. In most species, progesterone is produced by the corpus luteum throughout pregnancy. However, in the mare and the ewe, it's produced by the placenta late in the pregnancy. In the bitch, the production of progesterone by the follicle begins just before ovulation. *Relaxin* is produced by the ovaries and in the uterus and placenta. Late in pregnancy, relaxin (along with estrogens) is responsible for relaxing the pelvic ligaments and cervix to allow parturition.

Male Reproductive System

Anatomy

The *penis* is the copulatory organ of the male. A double covering of skin, called the *prepuce,* surrounds the *glans,* or head, of the penis and normally hides it from view. The *scrotum* is a sac of skin on the outside of an animal's body, located between the thighs of most male domestic animals. The scrotum contains the testes and the epididymis. The *testes* descend into the scrotal sac soon after the animal is born. Sperm are produced in the testes and then pass into the *epididymis,* which is a tube attached to each testicle. The sperm continue to mature in the epididymis and are stored there until *ejaculation* (the expulsion of sperm through the penis). The *ductus deferens* is a tube that extends from the end of the epididymis to the urethra. The sperm are transported through the ductus deferens during ejaculation. The *ampulla* is the wide end of the ductus deferens.

Males have several different accessory sex glands that produce the fluid portions of the ejaculate during *coitus* (the act of mating). The secretion, which is a combination of sperm

from the testes and fluid from the accessory sex glands, is called *semen.* The accessory sex glands, located close to the urethra, include the seminal vesicles, the prostate gland, and the bulbourethral glands. The *seminal vesicles* secrete fluid containing mucus, amino acids (which cause semen to coagulate after it's deposited in the female), fructose (which provides energy for the sperm), and prostaglandins (which stimulate female uterine contractions to help move the semen to the uterus). The *prostate gland* secretes a thin alkaline fluid directly into the male urethra. This fluid balances the acidity of urine remaining in the male system and the acidity of the vagina. The *bulbourethral glands* secrete a viscous fluid before sperm emission. Male dogs have only one accessory sex gland, the prostate gland. Male cats have very small bulbourethral glands. Figure 4 depicts the reproductive system of a bull.

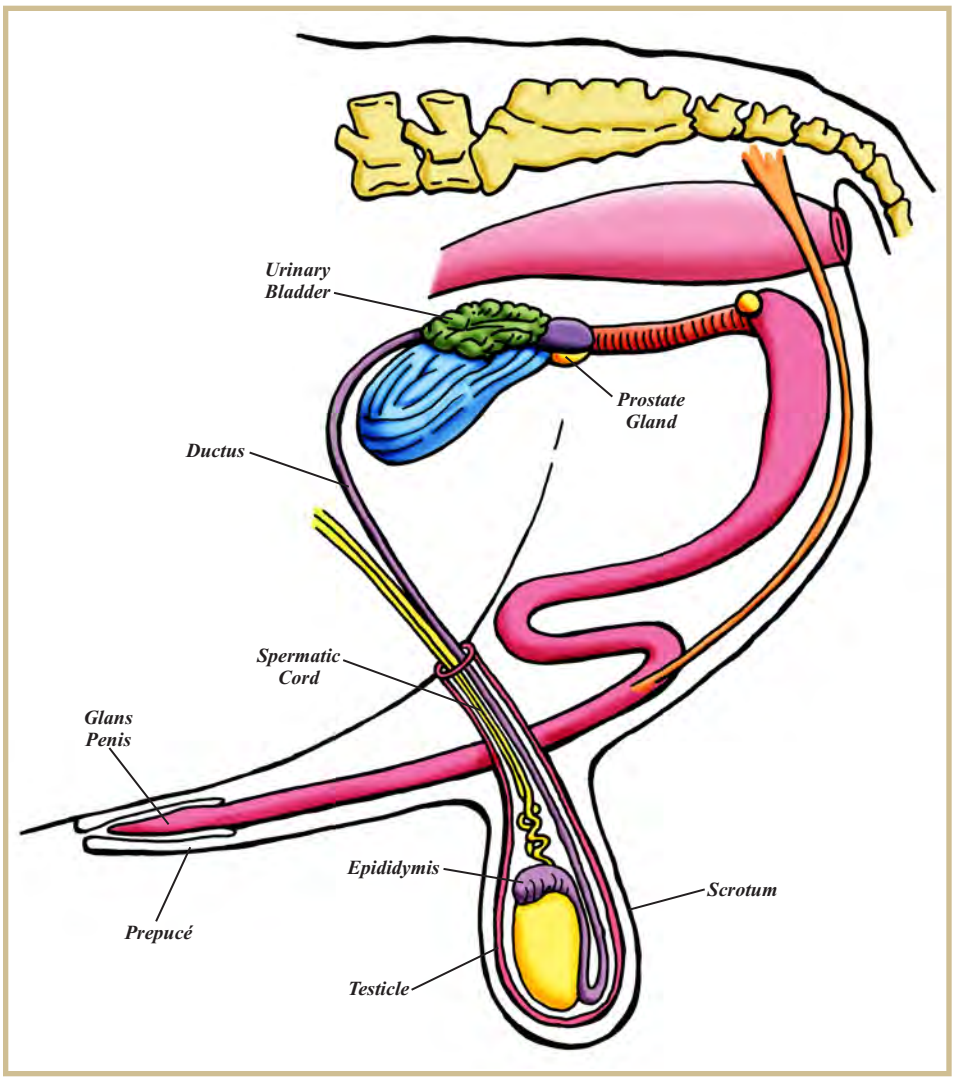

FIGURE 4—A Bull's Reproductive System

Hormones

Hormones, which are secreted by various glands in an animal's body, control almost all phases of reproduction in mammals. The hormonal system, which is linked to the nervous system, is affected by many outside stimuli, such as light, sounds, odors, state of nutrition, stress, environmental temperature, and other factors. Although many hormones are involved in reproduction, only the most important male hormones are discussed here.

The anterior pituitary in the brain produces two hormones that are important to the male reproductive system. *FSH (follicle-stimulating hormone)* and *LH (luteinizing hormone,* also called *interstitial cell stimulating hormone* in the male) act on the testes to stimulate spermatogenesis and to produce high levels of testosterone. *Testosterone* is necessary for sperm formation and the production of male secondary sex characteristics, like aggression.

Spermatogenesis

In most domestic animals, sperm are produced all the time, so the male is capable of fertile matings year-round. However, some animals, such as the ram and the stallion, are seasonal breeders. In these animals, sperm production tends to decrease during the nonbreeding season.

Spermatogenesis is a complicated process in which *spermatozoa* (sperm) are formed. The first part is controlled by the release of FSH from the anterior pituitary gland. The second part of the process is controlled by releasing LH from the anterior pituitary gland and testosterone, produced in the testes. Sperm are produced in a continuous, orderly system within the cells of the testes. Sperm may be found in testes at different stages of development. Once produced, the spermatozoa are carried into the epididymis, where they mature.

Physiology

Erection is the first step in the ejaculatory process. Prior to mating, blood rushes to the penis and fills large caverns within it. The concentration of blood causes the penis to become firm, or erect. Erection persists with the aid of muscles that hold the blood in the penis.

The penises of both the stallion and the dog are slow to become erect. Therefore, foreplay prior to mating is essential to the development of a normal erection. In contrast, the penises of the bull, the ram, and the boar become erect rapidly, and foreplay isn't usually necessary.

Ejaculation is the process by which the sperm cells are forced out of the penis. Sperm travel from the epididymis to the ductus deferens, where the sperm then combine with fluid from the accessory sex glands. The fluid then empties into the urethra. Temperature, friction, and pressure play an important role in maintaining erections and producing ejaculation. The dog, the stallion, and the boar produce a large volume of ejaculate and have a long period of coitus. The bull and the ram, however, have small volumes of ejaculate and therefore mate for shorter periods of time.

In all domestic species, the ejaculate consists of three parts. The first part is sperm-free and is usually seen during the initial period of sexual arousal. The second part is sperm-rich and is usually a smaller quantity of fluid produced over a fairly short period of time. The third portion is sperm-poor and often makes up the largest volume of the ejaculate.

Fertilization, Pregnancy, and Birth

Fertilization

Fertilization is the process by which the egg and sperm are united. We've discussed how the ovum moves to the uterine tubes, the site of fertilization. When breeding takes place, sperm are transported from the vagina into the nurturing environment of the cervical mucus, and then through the cervix into the uterus. Uterine contractions help propel the sperm into the uterine tubes. During each breeding, millions to billions of sperm are usually ejaculated into the female tract. Most, however, don't make it into the uterus, and even fewer gain access to the uterine tubes. In most species, spermatozoa are *viable* (alive) for only about 24 hours in the female genital tract. One exception is the dog, in which sperm often remain viable for five or six days.

Fertilization usually occurs in the uterine tubes within a few hours after ovulation if viable sperm are present. In some species, the sperm must undergo a process called *capacitation* within the uterus or fallopian tubes. Through this process, the sperm achieve the ability to fertilize. Once capacitation occurs, one sperm penetrates the egg, and the egg membrane then closes to prevent more than one sperm from entering. Once the sperm has entered the egg, the egg is said to be fertilized. The fertilized ovum then begins to develop. Within three to eight days, depending on the species, it's transported from the uterine tube into the uterus. At this point, under the influence of progesterone, the uterine glands have produced fluid that helps support the early development of the embryo.

Pregnancy Diagnosis

An early and accurate diagnosis of pregnancy is very important to the establishment of a successful breeding program, whether you're breeding dogs, cats, horses, cows, or any other animal. Several different methods are available to help in making this diagnosis, including observation of outward signs, internal examination of the reproductive tract of the female, ultrasonography, and biologic and/or chemical *assays* (tests).

In species that are polyestrous, such as the cow, the mare, the ewe, and the sow, the first outward sign of pregnancy is the ceasing of estrous cycles. However, this method can sometimes be incorrect.

In cows and mares, a veterinarian can detect pregnancy by performing rectal palpation of the reproductive tract to identify changes that are consistent with pregnancy. The veterinarian watches for characteristic changes in the reproductive organs, which reliably indicate the likelihood of pregnancy even before the fetus is detected.

In the mare, *ultrasonography* is often used to detect pregnancy.

This procedure uses sound waves to outline structures deep within the body. Ultrasound is also used for pregnancy diagnosis in ewes, often to help determine if a multiple pregnancy (twins or triplets) exists, which would require special care at lambing.

Finally, two different biological assays are available for pregnancy diagnosis in the mare. One measures equine *chorionic gonadotropin,* a substance produced by the placenta between days 40 and 120 of gestation. The other method measures a form of estrogen produced by the fetus, which will be elevated as long as the fetus is healthy. To diagnose pregnancy in bitches and queens, veterinarians often perform palpation of the reproductive tract through the wall of the abdomen at mid-gestation. Ultrasonography can also be performed midway through the pregnancy. An ultrasound is more accurate than a palpation and gives more information about the well-being of the fetus or fetuses. Later in pregnancy, a radiograph may be taken to determine the exact number of fetuses, which is useful to know for managing the delivery.

Gestation is the period of development of an offspring from the moment of fertilization until birth.

Parturition

To help predict the date of parturition, breeders use the breeding date and the approximate length of gestation for the animal in question. For example, the duration of gestation for a cow is 273 to 296 days. To determine the approximate date of birth, breeders can simply add 273 to 296 days to the date of mating.

Just prior to the day of parturition, most animals tend to separate themselves from other animals. The sow, the queen, and the bitch usually nest, trying to create a suitable bed in which to deliver their offspring.

Changes in the pelvis, the genital organs, and the mammary glands can be observed. These changes include relaxation of the pelvic ligaments and the cervix and the production of milk in the mammary glands. Behavioral changes, such as nervousness, pacing, and restlessness, can also be observed.

Parturition begins largely from the influence of hormones. As the placenta ages, the fetus becomes stressed and releases a form of cortisone. This hormone acts with estrogen to decrease the level of progesterone, which in turn leads to the end of gestation. The release of oxytocin stimulates actual labor.

During the first stage of labor, the uterus begins to contract and the cervix *dilates* (widens). Straining often isn't seen during this period.

During the second stage of labor, the fetus enters the birth canal, the fetal membranes rupture, the female experiences abdominal contractions, and the fetus is expelled through the vulva.

The third, and final, stage of parturition is the expulsion of the fetal membranes and the *involution* (return of the uterus to its nonpregnant state) of the uterus. The fetal membranes are usually passed within a few hours after birth. However, involution of the uterus may take several months.

Complications at Birth

During parturition, complications sometimes occur, such as infections, trauma to the newborn or to the mother, nutritional deficiencies, and parasite infestations. *Dystocia* is a common complication of parturition encountered in veterinary medicine. Dystocia is a condition in which the female is unable to deliver her offspring without outside help. Sometimes dystocia is caused by hereditary factors. For example, the female may have a small pelvis that won't allow her to easily pass a fetus. This problem is common in bulldogs. In cattle, an inherited condition called *double muscling* may produce a huge fetus, which may be too big to be delivered, especially in a first-time mother. Infections and trauma can result in dystocia as well. Another common cause of dystocia is the position, or *presentation,* of the fetus just before birth (for example, it might be situated sideways in relation to the uterine opening). Even though the fetus is alive and healthy and the uterus is normal, the fetus can't fit through the vagina unless its position is returned to normal. Dystocia generally requires veterinary intervention to be resolved.

Mammary Glands and Lactation

The *mammary glands* produce milk in a female after she has given birth. They're considered to be accessory glands of the reproductive tract since they're under the direct control of reproductive hormones. They're very important to the life

of a newborn. The milk they produce provides a source of nutrition for a newborn. In addition, the milk contains antibodies that help the newborn fight disease.

In the mare, cow, ewe, and goat, the mammary gland is located in the *inguinal region* (the underside of the body near the rear). In the mare, ewe, and goat, the gland is divided into two halves that open into two separate *teats* (nipples). In the cow, the udder is divided into four quarters, each with its own teat. *Supernumerary* (extra) teats and glands are common in the cow. The mammary glands are independent, or separate, from each other. Therefore, there's no communication between the halves or quarters of the mammary glands. In the sow, bitch, and queen, mammary glands are located on the under surface of the body. The glands are arranged in pairs, usually between four and nine.

The growth of the mammary glands and the production and secretion of milk are influenced mainly by hormones. Estrogens and progesterone produced in the ovaries and placenta cause mammary development. The onset of lactation at the time of parturition coincides with a drop in the level of progesterone and estrogen at the end of gestation, as well as the production of prolactin from the pituitary gland in the brain.

Reproductive Failure

There are many conditions that may cause a female to fail to reproduce.

Let us review three of these:

- Congenital causes
- Physiological and psychological causes
- Infectious diseases

Congenital Causes

Problems in the reproductive system of either a male or a female animal may result in reproductive failure. If the problem exists from the time of birth, it's called a *congenital,* or inherited, cause. For example, either the male or female may have an anatomical defect in the reproductive organs.

Should the testes not descend into the scrotal sac, the sperm produced won't be viable. If this condition affects both testes, a condition known as *bilateral cryptorchidism,* the animal is sterile. Perhaps part of the animal's reproductive tract hasn't formed completely, a condition called *hypoplasia.* Or perhaps a reproductive organ hasn't formed correctly.

Other inherited conditions that can cause reproductive failure include

- Chromosomal abnormalities, in which mating and fertilization can occur but the embryo isn't viable because of an abnormal number of chromosomes
- Inherited tendency toward reproductive disease
- Inherited behavior problem that stops an animal from breeding normally

Physiological and Psychological Causes

Reproduction is a complicated process that involves the reproductive organs, hormonal changes, and accurate reproductive behavior. Sometimes, even when animals are born with the capacity for normal reproduction, one or more parts of this complicated process fail. When this happens, the female won't conceive. Failure to conceive may be due to acquired abnormalities of the reproductive tract, such as tumors or damage to the organs from trauma. Failure may also occur if the proper hormones aren't released in the correct amounts or at the correct time.

Breeding behavior is also necessary for conception to occur. The female must display receptive behavior during her fertile period. Likewise, the male must be able to detect the proper time to breed and be physically capable of copulation. A failure in any of these will result in a lack of conception.

Infectious Diseases

Many infectious diseases can adversely affect normal reproduction. Some of these are *systemic diseases,* which affect the entire body, including the reproductive tract. Examples of systemic diseases are tuberculosis in cattle and distemper

in dogs. Other infectious diseases affect only the reproductive tract. Many of these are *venereal diseases*, which are sexually transmitted during breeding. Examples of venereal diseases are trichomoniasis and brucellosis. Brucellosis may also be transmitted through the consumption of food contaminated with infected birth fluids. Both trichomoniasis and brucellosis may result in *abortion* (the expulsion from the uterus of the products of conception before the fetus is able to live).

Any combination of infectious diseases may occur at the same time in an individual animal. Sometimes, these diseases may be treated with antibiotics; other times the affected animals must be removed from the breeding population to prevent the disease from spreading.

Self-Check 8

1. Fertilization is the union of a/an _____ from the mother and a/an _____ from the father.
2. *True or False?* The period of development from the time of fertilization until birth is parturition.
3. *True or False?* FSH and LH act on the testes to stimulate spermatogenesis.
4. Female reproductive hormones are produced in the _____ and the _____.
5. Milk is produced in the _____.

Check your answers with those on page 132.