

Topic 11: Canine Breeding and Perinatal Care, 2008

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There are many recommendations that can be made to guide breeders in the important task of breeding dogs that will produce the next generation of the breed. The following is an outline of some practical considerations, remembering that if we want to produce the best dogs in the breed, we should start with the best dogs we have and continue to choose the best. This is true for genetic traits that are important in the show ring as well as those that control reproductive success.

CHOOSING THE BREEDING PAIR, FROM A REPRODUCTIVE POINT OF VIEW

Choosing a stud dog:

Remember that a foundation male, the male that is the principal founder of a line, will contribute a significantly large proportion of his genetic makeup to the dogs in that line. There should be some evidence that he has valuable genetic characteristics to contribute to the breed, such as being certified clear of mutations for inherited eye disorders by yearly CERF examinations. In breeds where hip dysplasia is a problem, it is desirable for a foundation sire to have Grade Excellent hips, as certified by OFA or PennHIP evaluation. He should not be affected with any inherited disorders that are known to occur within the breed, as determined by specific testing, such as DNA testing. In addition to having the traits that you want to pass on to your line, a stud dog will transmit those that affect reproductive success. Some of these traits affecting reproduction are not obvious, and require some investigation into health history.

First, he should be in good reproductive health and have a good personal and family history of reproductive success. Second, the average litter size produced by the prospective stud dog, his father, or full brothers should meet or exceed the breed average. The stud dog you choose must have two testicles in the scrotum. Inquiry into the family history should include whether the prospective stud dog, his father or any of his full brothers had cryptorchidism (failure of one or both testes to descend into the scrotum) or delayed testis descent. If they have, this is a concern, as infertility and testicular tumors are frequent consequences of cryptorchidism. Therefore, one should avoid propagation of this trait. Confirm, if possible, that both testes of the prospective stud dog were descended into the scrotum before 6-8 weeks of age.

The size of the testes is a good indicator of sperm production capacity, with larger testes being capable of producing more sperm than smaller ones. For the adult stud dog (older than 2 years of age), the size of his testes (Figure 1) and his sperm count should be within the normal range for his body weight. For example, for fertile dogs weighing 10 to 34 pounds, the total scrotal width ranges between 33-40 mm, and the total sperm count between 290-510 million per ejaculate (Amann 1986). For dogs weighing 35-59 pounds, the total scrotal width ranges between 49-52 mm, and the total sperm count between 990-1250 million per ejaculate (Amann 1986). For dogs weighing 60-84 pounds, the total scrotal width ranges between 54-58 mm, and the total sperm count between 970-1890 million per ejaculate (Amann 1986).



Figure 1: Method for measuring canine total scrotal width, as an indicator of testis size. The width across both testes at their widest point, shown here as the distance between the yellow dots, is measured with a caliper. (photo copyright Dr. Vicki Meyers-Wallen, Cornell University)

To be certain that the semen quality is sufficient for reproduction, a complete semen evaluation performed by a veterinarian is recommended for all dogs before they contribute to a breeding program. While males frequently have sperm in the ejaculate before 1 year of age, one should evaluate them after they have become an adult in order to be sure that a representative semen sample is being obtained. A complete semen evaluation should minimally include three criteria: the total number of sperm in the ejaculate (an actual sperm count), the percentage of progressively motile sperm, and the percentage of normal and abnormal sperm morphology (Figure 2). Semen evaluations to determine a stud dog's average semen quality are recommended by the time he is 2-3 years of age. Further semen evaluations should be performed if any bitches bred to him fail to become pregnant or if litter size is smaller than average for the breed. If banking frozen semen is being considered, it is best to freeze semen when the semen quality is excellent. Semen collections for this purpose should be performed when the dog is a young adult (2-4 years old for most dogs). Semen quality in older dogs, or those in failing health, is often poor.



Figure 2: High power microscopic images showing canine sperm morphology (original magnification 1000x). Normal sperm are shown on the left. The sperm with abnormal morphology (coiled tail) on the right would be unable to swim sufficiently to reach the oviduct, and is thus unlikely to participate in fertilization of the oocyte. (photos copyright Dr. Vicki Meyers-Wallen, Cornell University)

If the semen quality is poor, the semen evaluation should be repeated after the male has become accustomed to the collection procedure. Furthermore, it takes approximately 2 months for a whole new population of sperm to be produced in the ejaculate, which includes the time for completion of one spermatogenic cycle in the testis and sperm transit to the tail of epididymis where sperm are stored. Therefore, semen evaluations taken at least 2 months apart are needed to determine whether the semen quality has changed (for better or worse). Recovery after an insult to spermatogenesis can take at least 4-6 months (2 or 3 spermatogenic cycles) before a significant change in sperm quality and quantity in the ejaculate can be clearly identified.

Choosing a breeding bitch:

In addition to having the traits that you want to pass on to your line, the bitch will transmit those that affect reproductive success. Therefore she should be in good reproductive health and have a good personal and family history of reproductive success. There should be some evidence that she has valuable genetic characteristics to contribute to the breed. In addition, she should not be affected with any inherited disorders, such as inherited eye disorders, as documented by yearly CERF examination, or specific DNA testing for example. In breeds where hip dysplasia is a problem, she should be evaluated (OFA or PennHIP) and cleared for breeding.

Inquiry into the family history should determine whether the average litter size produced by the prospective bitch, her mother, or full sisters meets or exceeds the breed average. Inquire whether she, or any of these close female relatives, have had difficulty in becoming pregnant or maintaining pregnancy, difficulty giving birth without assistance, had episodes of uterine or breast infections (pyometra or mastitis), had problems producing sufficient milk for the litter, or had difficulty in raising pups to weaning age. If many of these problems are present in females of the line, consider changing to a different female.

The bitch should have a history of regular cycles (see below, stages of the estrous cycle). For example, the period of vulvar swelling and bloody discharge from the vulva that is followed by receptivity to mating (“heat” or estrus) generally lasts less than 3 weeks, and appears at regular intervals (7 months on average for bitches in general). Therefore for the average bitch, regular cycling would be the occurrence of an estrous period approximately every 7 months (interestrus interval). Each bitch will have her own average for this interval.

The bitch should have good conformation in the reproductive organs. The vulva should be located in the normal position (below the rectum, not tilted, not tucked up in skin folds). Before her first breeding, she should be examined by a veterinarian to determine whether there are any internal structural abnormalities that may interfere with breeding, artificial insemination, or vaginal delivery of pups. Ideally, each mammary gland should each have a single, round nipple that can easily fit in a pup’s mouth.

BREEDING MANAGEMENT

Although some dogs can breed successfully by allowing nature to take its course, it is best to monitor all stages of the breeding program and have a backup plan ready to go in case complications in breeding, pregnancy, delivery or puppy care are encountered. There are methods now available to accurately identify the period of peak fertility. Thus *ovulation timing* (see below) is now used to time insemination or natural breeding, as well as to calculate whelping date (parturition date, day of birth). Precise timing can substantially reduce anxiety for the breeder and the veterinarian when unexpected events or complications arise, as well as providing the best chance for a good outcome for the bitch and pups. While proceeding through

the breeding management process, it is important that the breeder keeps accurate records on all aspects of the program for the bitch, the stud dog, and the pups produced.

Recording cycles: Record every season (estrus) that the bitch has, whether or not you plan to breed her on that season. Make sure that you check your bitch at least once or twice weekly for evidence that she may be coming into proestrus: swelling of the vulva or bleeding from the vulva (see below). Also record when she apparently went out of season - so that you can identify the average length of her proestrus and estrus periods. Consistently use measures that are evident to you for a particular bitch, such as the day she no longer was attractive to males, the day that she quit flagging, or the day all vulvar swelling and bleeding disappeared.

Stages of the canine estrous cycle

There are four stages of the canine estrous cycle, which have these characteristics:

Proestrus- The vulva swells and there is a blood-tinged to bloody vaginal discharge and cornified cells begin to appear in vaginal cytology (Figure 3). Average duration is 9 days.

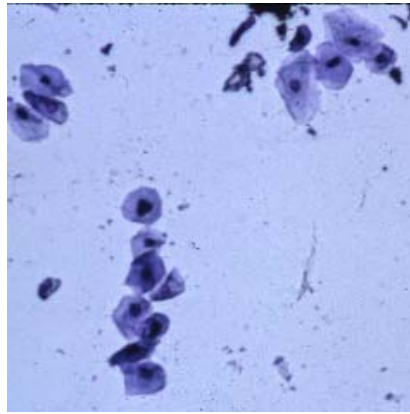


Figure 3: Swelling of the vulva at proestrus (left): Bloody discharge from the vulva is characteristic at this stage but is not appreciable in this picture. Mostly noncornified epithelial cells are present in the vaginal cytology (right), but cornified cells start to appear (right upper corner). (copyright Dr. Meyers-Wallen, Cornell University)

Estrus- The bitch is receptive to mating. Ovulation normally occurs once during this period. The vulvar swelling is still present at this stage and the bloody vaginal discharge has subsided or may be scant. However, bloody vaginal discharge continues during estrus in some bitches. Greater than 90% cornified cells are present in vaginal cytology (Figure 4). Average duration of estrus is 9 days, but at the extreme of normal, it can be 21 days. (If it is nearing 21 days of estrous behavior without beginning to wane, consult your veterinarian.)

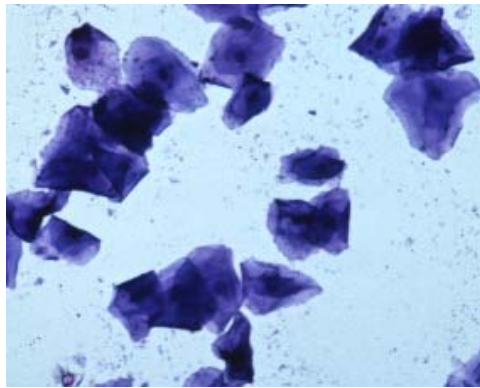


Figure 4: Appearance of the vulva at estrus (left): Note prominent swelling of the vulva. Bloody discharge from the vulva is usually decreased by this stage. Greater than 90% of the epithelial cells are cornified in the vaginal cytology (right). Cornified cells are large, flat cells having angular cell borders and have

a small nucleus or no nucleus. (copyright Dr. Meyers-Wallen, Cornell University).

Diestrus- No external signs are generally shown, but over 1-2 days as estrus subsides, vaginal cytology changes back to predominantly noncornified cells. Vulvar swelling subsides. In pregnant dogs, this stage ends at whelping. In nonpregnant dogs this stage may last over 60 days. In the diestrus stage, serum progesterone (P4) concentrations are normally elevated, whether the bitch is pregnant or not. That is, there is no significant difference between the P4 levels in pregnant or nonpregnant diestrus dogs, except before whelping, when the P4 falls significantly in pregnant bitches, after which it remains low. In nonpregnant bitches the P4 decreases slowly at the end of diestrus. Therefore serum P4 is not useful as a canine pregnancy test

Anestrus- After a pregnant diestrus, the bitch will lactate for several weeks. After a nonpregnant diestrus, some lactation may occur for a short period, but otherwise no external signs are associated with anestrus. During this period of reproductive rest, concentrations of ovarian hormones in the serum fall to low (baseline) levels. This stage should last at least 3 months, but can be longer. The variable length of anestrus accounts for the difference in the length of estrous cycles between bitches. For example, if anestrus is long, the interval between estrous cycles (interestrus interval) will be greater than the average 7 months.

Ovulation timing

Ovulation is the term used to indicate the release of the eggs (oocytes) from the ovarian follicles. All oocytes released from both ovaries enter the oviducts (Figure 5) where they mature and become capable of being fertilized. This period where they are capable of fertilization (period of peak fertility) lasts a few days in the bitch. If the oocytes are not fertilized during this period, they degenerate. Although healthy canine sperm from a fresh ejaculate can live a few days in the oviduct, waiting for the oocyte, sperm will degenerate if they do not participate in fertilization. Apparently, sperm from frozen semen insemination do not live as long in the oviduct as freshly ejaculated sperm. To maximize the chances of fertilization and pregnancy, it is important to time the insemination such that healthy sperm are present in the oviduct at the same time as healthy oocytes. Even though a single natural mating performed several days before ovulation or several days after ovulation can occasionally result in pregnancy, the resulting litter size is generally small. With such poorly timed breedings there is also a good chance that pregnancy will not be achieved because either the sperm or the oocytes have degenerated to the point that they cannot produce a healthy embryo. Thus ovulation timing is used to identify the period of peak fertility because it is the best time for insemination, providing the best chance of achieving pregnancy and a normal litter size.

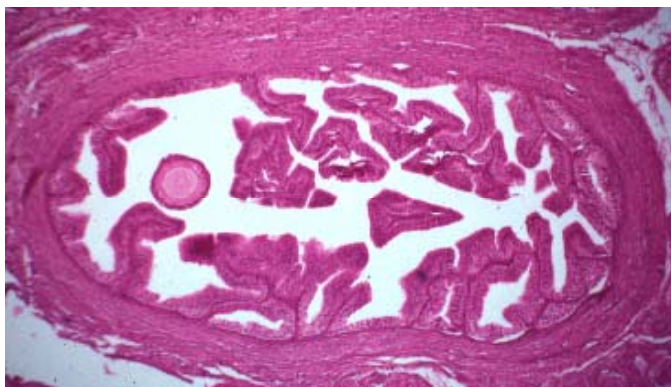


Figure 5: An ovulated canine oocyte (round structure on left) within the oviduct. The oocytes remain in the oviduct, where they are fertilized during the period of peak fertility. (copyright Dr Meyers-Wallen, Cornell University)

Although there are many ways to time ovulation, some are more accurate than others. For example, serum progesterone (P4) can be estimated with various kits [enzyme linked immunoassay (ELISA) tests], but these are not as accurate as quantitative laboratory tests for progesterone concentrations [chemiluminescent immunoassay (CLIA) or radioimmunoassay (RIA) tests]. On the other hand, an ELISA kit that *measures LH*, can provide a good estimate of d0, *provided* it is used *daily* according to the manufacturer's directions.

The LH peak

The signal for ovulation is a hormone secreted by the brain (pituitary) that is delivered through the blood stream to the ovaries. As a result, all the oocytes from both ovaries are released at the same time. This signal for ovulation is luteinizing hormone (LH). In the bitch, serum LH concentrations reach a peak sufficient to induce ovulation over a 24 hour period. We call the day upon which this occurs day 0 (d0). In order to detect this "LH peak," blood samples must be collected *every day* during proestrus and estrus until d0 is detected (Figure 6).

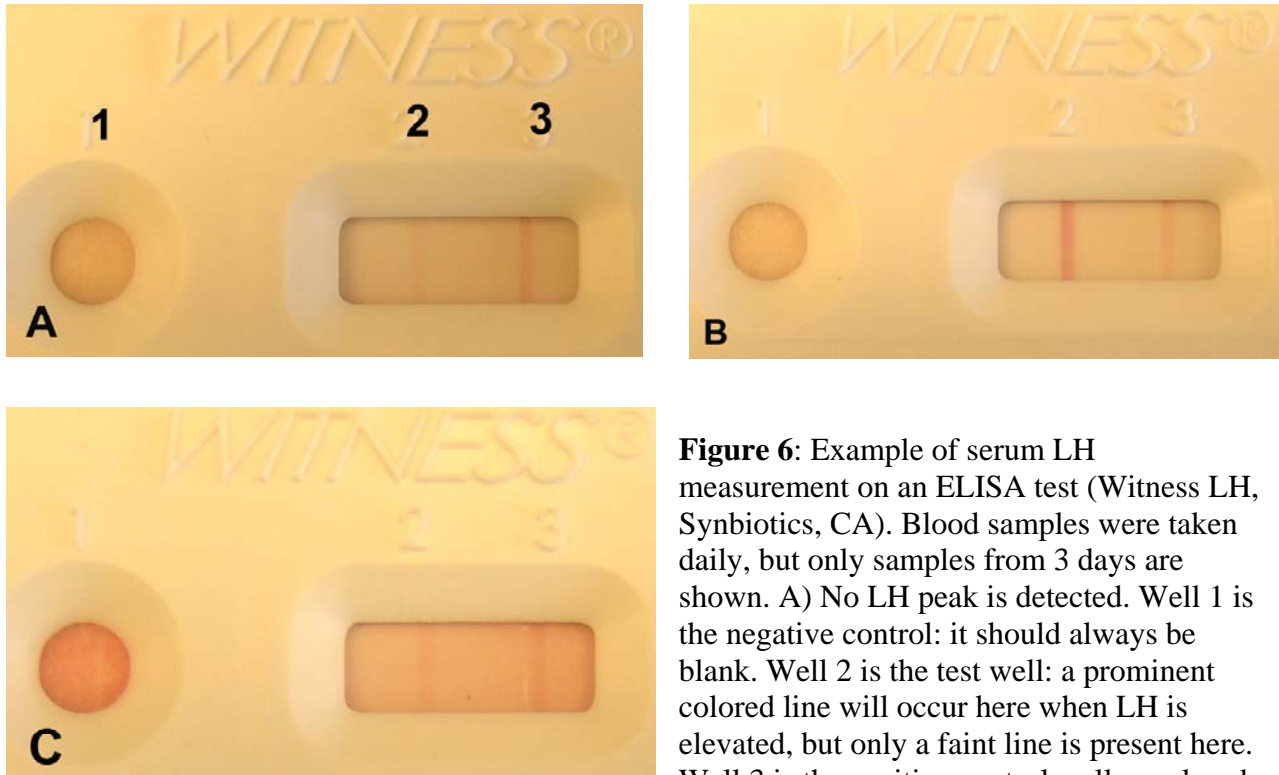


Figure 6: Example of serum LH measurement on an ELISA test (Witness LH, Synbiotics, CA). Blood samples were taken daily, but only samples from 3 days are shown. A) No LH peak is detected. Well 1 is the negative control: it should always be blank. Well 2 is the test well: a prominent colored line will occur here when LH is elevated, but only a faint line is present here. Well 3 is the positive control well: a colored

line as shown here should always be present in well 3 if the test is working properly. B) Note that a prominent colored line appears in well 2, and is more prominent than the positive control (well 3). This indicates that the LH peak occurred on the day this blood sample was drawn, which would be day 0 (d0). C) On d1, the line in well 2 is very faint, indicating that the LH peak has subsided. This series of results illustrates why the blood samples for this test must be taken daily in order to accurately detect the LH peak. (copyright Dr. Vicki Meyers-Wallen, Cornell University).

The progesterone (P4) rise

Fortunately in the bitch, a rapid rise in P4 begins on the *same day as the LH peak*, after which P4 continues to rise. Therefore for practical reasons, day 0 is most frequently calculated from this initial P4 rise for the purpose of ovulation timing (Figure 7).

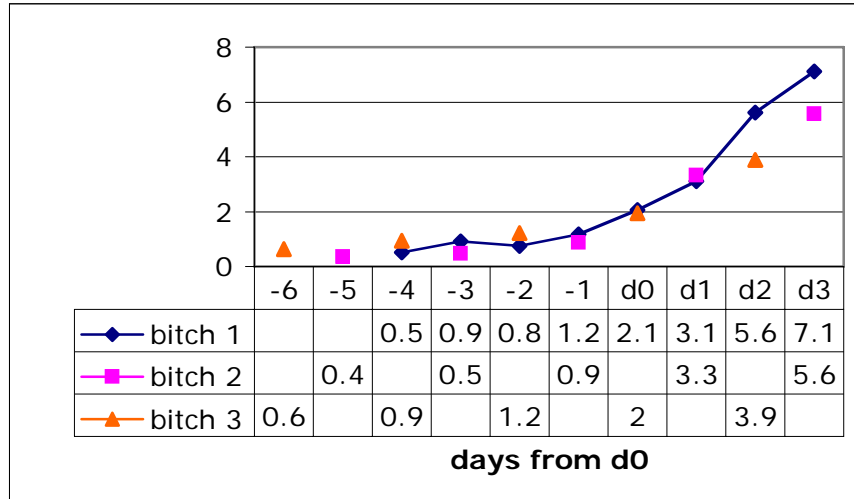


Figure 7: Serum progesterone (P4) concentrations observed on samples taken daily from bitch 1 and every other day from bitches 2 and 3 during proestrus and estrus. Day 0 (d0) is identified as the day that serum P4 concentrations rise to 1.5-2.5 ng/ml. In normal bitches, one can obtain an accurate estimate of d0 from the P4 concentration by taking blood samples every other day, provided that they are assayed by CLIA or RIA. Although these curves look very similar, variation in P4 concentrations after d1 can be significant between bitches. Therefore, d0 should not be estimated from P4 values obtained “late,” in other words if you start sampling after d1 has already occurred (Kutzler et al 2003a). (copyright Dr. Vicki Meyers-Wallen, Cornell University)

Because the time of ovulation *cannot* be reliably estimated from the onset of proestrus or estrus, even when judged by vaginal cytology, it is best to start the ovulation timing process within 2-3 days after the first signs of proestrus are noted (vulvar swelling and/or bloody discharge). Regardless of whether d0 is calculated from the LH peak (by the ELISA test) or the initial P4 rise (by CLIA or RIA), all subsequent events are calculated from d0. Identifying d0 is very important because all timing for the breeding and the pregnancy thereafter depends upon accurately identifying it! Therefore it is important to start taking samples **BEFORE** d0. Starting after d0 has already occurred, and then estimating backwards, is inaccurate (Kutzler et al 2003a). The following protocol can be used when P4 samples are collected *every other day* and measured by CLIA or RIA.

Vaginal cytology and a serum P4 are first taken within 2-3 days after the first signs of proestrus are noted to confirm that she is in proestrus or estrus and that she has not yet ovulated. Then blood samples are taken *every other day* to identify when serum P4 begins to rise (1.5-2.5 ng/ml), which is day 0 (d0). This can be identified if sampling is done at least *every other day* (Figure 7). Because we need to confirm that the P4 continues to rise after d0, P4 sampling is continued *every other day* until the P4 concentration exceeds 3-5 ng/ml. Vaginal cytology is usually taken on the same days as blood sampling to help determine that the cycle is proceeding normally. Counting from d0:

- Ovulation occurs on d2.
- Natural breeding or intravaginal AI (fresh semen in the vagina) should be performed every other day, at least twice (d3 and 5, or d4 and 6) because this is the when the oocytes are mature and capable of fertilization (period of peak fertility).
- Frozen semen insemination (intrauterine deposition of the semen) is usually performed on d5, but this can vary depending upon the protocol recommended by the company that originally froze the semen.
- Ultrasound examination for pregnancy diagnosis should be performed between d28-30.
- Whelping should occur at d65 +/-2 days (between d63-67, with the majority occurring on d65.)

Note: no matter when the natural matings or inseminations were performed, you should expect the whelping date to be within the d63-67 interval. Remember that the embryo is timing gestation according to the oocyte, and it starts counting from the day of ovulation, not from the day of insemination. Thus when estimating the whelping date by this method, it is important to count from the d0 you obtained during ovulation timing and not from the day of breeding or insemination. For example, if you counted from any one mating to the day of whelping, the dog could whelp anytime between 57-72 days (at the extremes), depending upon if that mating was performed several days after ovulation (d57 whelping) or several days before ovulation (d72). However, for the same pregnancy, the whelping date counting from d0 would occur between d63 to 67.)

PREGNANCY

Pregnancy diagnosis

Pregnancy can be identified by palpation (examination by the veterinarian d28-35), a serum relaxin test (after d28), or ultrasound examination (Figure 8). After d44, fetal skeletons can be detected on a radiograph (Figure 9). Ultrasound examination can be used to monitor the fetuses anytime after the initial pregnancy diagnosis.

Each method has an optimum time for pregnancy diagnosis, but I prefer ultrasound (US) examination between d28-30 because:

- gestation is sufficiently advanced to conclude whether the bitch is pregnant or not
- this is the ideal time to measure fetuses during the ultrasound exam and estimate gestational age (i.e., to compare the gestational age estimated by the US fetal measurements with the estimate obtained by progesterone estimate of d0). The two methods should agree within one day if fetuses are growing normally.
- fetal heart beats should be present at this time, an indicator that pups are alive
- fetuses can be counted at this stage more easily than at later stages
- fetal resorptions can often be identified at this stage, as well as later

Although pregnancy can be diagnosed by ultrasound at other times during gestation, the most accurate estimations of gestational age from fetal measurements taken during US examination were obtained at d30. Even at this age, correction must be made for the body weight of the dam (Kutzler et al 2003b). Other investigators use mathematical formulas to estimate gestational age from fetal ultrasound measurements in early gestation with similar accuracy (Beccaglia and Luvoni 2006).

Gestational age could not be accurately estimated by the ultrasound method for fetuses older than d39 in our studies (Kutzler et al 2003b). The reason is that fetal growth is exponential after d30, but fetuses in toy breeds grow more slowly and are significantly smaller, while those of giant breeds grow more rapidly and are significantly larger.



Figure 8: Ultrasound examination of a pregnant bitch at d28. Yellow dots mark the limits of the gestational sac. The fetus is the white object lying in the fluid (black) within the gestational sac. (copyright Dr. Meyers-Wallen, Cornell University)

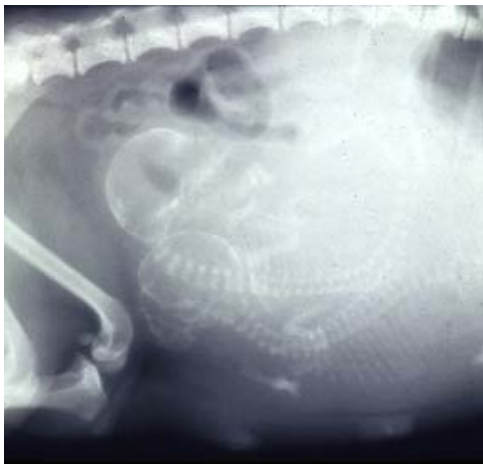


Figure 9: Radiograph taken in late gestation showing complete fetal skeletons. (photo copyright Dr. Vicki Meyers-Wallen, Cornell University)

CARE DURING PREGNANCY

Feeding the bitch

A high quality diet (adult maintenance quantity) should be started well before the bitch enters proestrus and then continued until pregnancy is first diagnosed (d28-30). The same diet should be maintained after pregnancy diagnosis. However in the last 3 weeks of pregnancy (after d44), the fetuses grow rapidly. To accommodate this growth, the bitch will require increased intake of a high density, easily digestible diet (growth or puppy type diet). This type of diet is usually maintained after whelping until the pups are weaned. Underfeeding before and during pregnancy will result in pups with low birth weight and poor survivability. On the other hand, obese bitches can have difficult deliveries, particularly if they have also received little exercise. *Medications and supplements*

Remember that something that seems harmless to humans or adult dogs may be detrimental to growing canine embryos, fetuses, or newborn pups. Vaccinations should be given well before the bitch enters proestrus, and not during pregnancy. Furthermore, no supplements or drugs should be given during pregnancy unless required to maintain the bitch's health, as discussed with your veterinarian. Consult your veterinarian before giving any type of medications or nutritional supplements, whether they are given by mouth, placed on the skin, or given by injection. This includes medication for itching skin, hormonal preparations, or insect control. For example, your veterinarian can advise you regarding the safety of using specific heartworm preventatives, flea/tick medications, or insecticides during pregnancy.

Milestones in pregnancy:

- Period of the embryo
 - Preimplantation (up to approximately d19)- Fertilization occurs in the oviduct (d3-6) and the zygote begins to develop into an early embryo in the oviduct. By the blastocyst stage the embryos are floating freely in the uterus. Embryos emerging from each oviduct can migrate to either uterine horn (transmigration), then space themselves evenly along the uterine horns.
 - Postimplantation (approximately d20-d34) – The embryos attach to the uterine wall (implantation). The placenta develops. This is the period at which most organ systems are being formed, and when embryos are most susceptible to environmental insults (teratogens, viral infections, drugs).
- Period of the fetus (approximately d35-65)

Most organ systems have developed and now begin to enlarge and/or refine by further differentiation. A notable exception is the eye, which continues to develop even after birth.

PERINATAL AND PUPPY CARE:

Perinatal Observation of the Bitch

By d58 (one week before the estimated d65 due date)

- Set up a clean whelping box, complete with bedding (papers for example) and a heat lamp located over one corner of the box (not over the middle of the box).
- Introduce the bitch to the box and let her get used to it.
- Start taking the bitch's rectal temperature once a day.
- Clip hair away from the breasts and the vulva.

Starting by at least day 62

- Take the bitch's rectal temperature twice a day: For those that are 100F in late gestation, the temperature may fall to 98-99°F about 24 hours before whelping (Figure 10). However, not all bitches have a temperature drop before they whelp.
- Observe for signs of labor (nesting, not eating that day, vaginal discharge, increased activity such as digging or pacing)
- Observe breasts for presence of milk
- Ensure that the heat lamp is on and located only over one corner of the box so that pups and bitch can move away if they get too warm. Make sure it is placed high enough that the bitch will not be burnt by it or chew on the electrical cord.
- Check the whelping box temperature directly under the lamp with a thermometer (80-85°F maximum) and raise or lower lamp as required.
- Ensure fresh bedding (clean and dry) is in the box.
- Assemble clean whelping materials: such as bath towels to dry and rub pups, sterile suture or white cotton thread, sterile scissors, latex gloves, Karo syrup, milk replacer.

Between d63-67 (estimated whelping date from d0, average is d65)

- Check the bitch several times during the day and night for signs of labor.

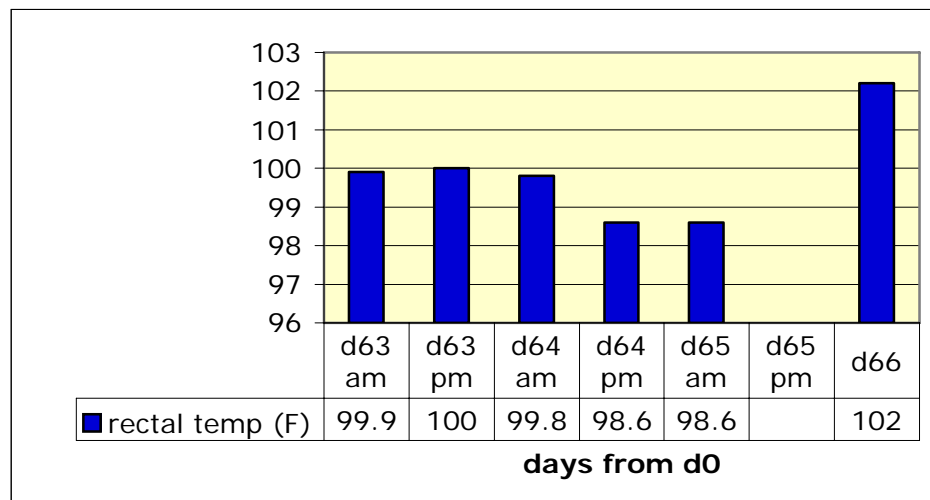


Figure 10: Example of significant rectal temperature drop in a bitch before whelping. Whelping occurred on the evening of d65 and the temperature was not taken at that time. Note that the temperature drop occurred approximately 24 hours before whelping and rebounded on the day after whelping. Not all bitches will exhibit a temperature drop. (copyright Dr. Vicki Meyers-Wallen, Cornell University)

Guidelines - when to call the veterinarian (from Schweizer and Meyers-Wallen 2000):

- Although it is possible that the bitch may normally whelp as late as d67, the veterinarian should be informed if the bitch has reached d65 and there are no signs of a temperature drop or labor. She/he may wish to check fetal viability by ultrasound examination.

- If a temperature drop has occurred (Figure 10), but no signs of labor are seen within 24 hours.
- If there is a black-green vaginal discharge (same color as the placenta) but no pups have yet been delivered.
- If the bitch has shown signs of labor (restlessness, nesting), but after 6-8 hours the bitch has not proceeded to the pushing (second) stage of labor.
- If the bitch has been actively straining (pushing) for more than 20 minutes or has weak contractions for an hour and has not expelled a pup, or only the fetal membranes are showing through the lips of the vulva.
- If it has been an hour since delivery of the last pup but there are no further signs of active straining (pushing). Most bitches give birth to one puppy per hour on average, but some are faster or slower. In general, if the time between pups is increasing and it is a large litter, the pups at the end may be weak upon delivery. Call your veterinarian if pups are becoming increasingly weaker by birth order.

On the Day of Whelping:

- If there is any question whether all the pups have been born or not, call the veterinarian.
- If the bitch does not promptly remove the fetal membranes over the mouth and nose, do it for her and resuscitate the pup as follows.
- Wipe pup's nose with clean towel, then stimulate it to breathe by rubbing it along both sides. Pause to see if it takes a few breaths. Repeat until it is breathing regularly and the gums or footpads are pink. Dry the pup well, then return it to the whelping box, under the lamp. Observe every few minutes to be sure breathing continues to be regular and gums are pink. If not, rub pup again, remove any fluid in nose, keep it warm and stimulate it.
- Trim umbilical cord to a length of approximately one half inch. Tie it about one quarter of an inch from the body with sterile suture or white cotton thread. Trim suture ends well so that the bitch will not chew the suture.
- Place each pup on a breast to nurse within the first 8 hours after birth so that they can absorb colostrum.
- Make a separate record for each pup to record all findings below. Note sex, distinguishing marks, obvious external characteristics: color, rear dew claws, etc. Check for problems like cleft palate, umbilical hernia, open fontanelles (hole in the top of the skull bone).
- Check pups for suck reflex, noting if strong or weak.
- Using a warm, moist cotton ball, stimulate urination and defecation.
- Weigh all pups, including stillbirths. Use a scale that reads in grams, as it is more useful for the small weight changes that occur in small pups.
- Check the bitch and write in her record: total number of pups whelped (live and stillborn), color and consistency of her vaginal discharge, number of breasts producing milk, any abnormalities in mothering (failure to remove fetal sacs, chewing of umbilical cords too close to body, not lying down with pups so they can nurse, excessive carrying of pups, traumatizing pups, etc.).

On Days after whelping, until weaning:

Bitch- record all observations in her record

- Check vulvar discharge, general health and appetite. On the day after whelping the vaginal discharge may still be black to green (like the placentas), but after that it should become reddish brown.
- Take the bitch's rectal temperature daily for the first 3 days after whelping. It may go up to 103°F on the day after birth, but should fall to 101-102F after that.
- Note milk quantity and quality in the first 3 days by gently getting 1-2 drops from each breast. Gently feel the breasts- they should be spongy and pink. If any are firm, reddened, or painful, check the rectal temperature and call the veterinarian, as this could be an indication of mastitis (breast infection).
- The bitch will require increased food intake for at least 3 weeks during the period that pups are nursing and rapidly gaining weight. The amount may be 2 to 4 times her normal ration, depending upon the litter size. For large litters, if the bitch does not have sufficient milk, it will help to start supplementing pups. First, in addition to allowing them to suckle, bottle feed them with a commercial canine milk replacer, at room temperature or warmed to be comfortable by testing on your wrist. As they approach 3 weeks of age, offer them moistened puppy food mixed with the milk replacer.
- Signs of hypocalcemia (milk fever, low serum calcium) are trembling of the muscles that progresses to stiff limbs and can look similar to a seizure except that the bitch appears conscious. Most cases occur within 3 weeks after giving birth. In this disorder, the muscles continuously contract, so the body temperature becomes dangerously high. Call your veterinarian if there is any question, as this is a medical emergency that can lead to death of the bitch.

Pups- record all observations in each pup's record

- From birth to 3 weeks of age: Weigh pups daily and assess their skin turgor as a measure of hydration.
After 3 weeks of age, you can weigh pups every few days or weekly if they are doing well. Smallest pups or those on supplemental formula should be weighed more frequently.
- Normal pups gain steadily from first nursing or lose less than 10% of their birth weight in the first 48 hours. Pups should double their birth weight in the first 7 days of life. So if the pup is 300 grams on the day of birth for example, it should be 600 grams by day 7. (which means it should gain about $300/7 = 42$ grams per day.)
- If any pup fails to gain, see *feeding* below.
- Allow pups to stay with their mother as much as possible, even if they are being fed by bottle, as the mother gives them warmth, cleans them, and so forth, which is just as important as being fed.
- Healthy pups should be either eating or sleeping quietly.
- Pups that are continuously crying and moving around are of concern- check whether they are too cold, too hot, hungry, sick, or the mother is not attending to their elimination needs (urination & bowels).
 - ✓ If it is too cold, the pups are usually piled up on one another. Check whether the whelping box temperature is too cold and make sure the box is dry and clean.

- ✓ If it is too hot, the pups are generally spread out and moving away from the heat source. Make sure they can get away from the heat lamp. Check the temperature under the lamp. It is better for them to be a little cool than too hot.
- ✓ Check the mother for problems (breasts, vaginal discharges, rectal temperature). Check each pup- for example: the umbilicus for infection, the color and consistency of the stools.

Feeding/Nursing

- If bitch is not lying down to nurse the pups very well, try gently lying her down while pups nurse for 15-20 minutes at a time (Figure 11). (If there are very small pups, or pups are not able to nurse well right away for any reason, supplement the pups in addition to allowing them to nurse from the mother. It is all right to feed a 10% sugar solution in a baby bottle for a day or two if there is a delay in getting canine formula. You should use 1 part clear Karo syrup plus 9 parts of warm water in a baby bottle. Mix well and check solution temperature on your forearm before feeding.)
 - ✓ On the first day that a pup fails to gain weight- it should be supplemented!
 - ✓ Check suck reflex, color of gums or footpads, activity level, rectal temperature. Rectal temperature in first week of life should not be lower than 98F. If colder, warm up by holding pup on your skin (your tummy is a good place).
 - ✓ Check the bitch- especially her milk and rectal temperature.
- A pup that fails to gain (or loses weight) should be supplemented frequently each day with formula until it gains consistently every day. If it continues to lose weight, call your veterinarian.



Figure 11: Example of a bitch that is lying in a position that allows pups to easily suckle. The bitch is quiet and comfortable and lifting one rear leg to accommodate the pups. In the background note the ledge on the inside of the whelping box wall that helps prevent the bitch from inadvertently injuring a pup by squeezing it between herself and the wall. (copyright Dr. Meyers-Wallen, Cornell University)

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