presence of stressors including parasites, weaning, change of feed, variation in ambient temperature and humidity, and weather. Clinical signs depend on age of the animal, organism(s) involved, and stage of the disease. Bovine respiratory disease is closely linked with fever; it is one of the most common causes of fever in cattle and fever may be the first sign of disease in affected cattle. Other signs include mental dullness, lack of appetite, rapid shallow breathing, and discharge from the nose and eyes (watery to purulent to bloody). Coughing will be mild and tentative early in the disease course and prominent ("honking") later in the disease course.

Leptospirosis

Leptospirosis is a zoonotic disease, caused by bacteria of the genus *Leptospira*. There are many different serotypes of disease and prevalence varies with geographic location. Serovars include hardjo-bovis, pomona, canicola, icterohaemmorhagiae, and grippotyphosa. Maintenance hosts, also called reservoir hosts, carry the bacteria and are a source of exposure to other susceptible animals. Maintenance hosts for leptospirosis include cattle, pigs, dogs, raccoons, skunks, and rodents. Animals can be infected by serovars maintained by their own species (host-adapted infection) or by serovars maintained by other species (non-host-adapted infection). Leptospirosis can be transmitted either directly between animals or indirectly, through the environment. Cattle are the maintenance hosts for L. hardo-bovis; disease in cattle with this serovar is less severe but can have a significant economic impact. Cattle infected with other seorvars, especially L. pomona, suffer more severe illness. Clinical signs vary with the herd's degree of resistance or immunity, the infecting serovar, and the age of the animal infected. Host-adapted infections in cattle can occur in animals of any age and mainly affect fertility and the renal system. Infected cattle may shed the organism in their urine for weeks to months. Non-host-adapted infection in cattle is typically due to L. pomona and mainly affects the hemolymphatic, urinary, and reproductive systems. Acute disease is characterized by hemolytic anemia, which causes red urine and jaundice. Reproductive effects include infertility, stillbirths, and abortion 1-3 months after infection. Lactating cows may suffer from mastitis, with decreased production and milk that is thick and yellow.

Campylobacter

Campylobacteriosis, formerly called Vibriosis, is caused by the bacterium *Campylobacter fetus* and is spread by infected bulls when they mate with susceptible cows and heifers. Once infected, a bull remains an asymptomatic carrier of the condition. Transmission is venereal; non-venereal transmission is unlikely to occur. When introduced to a herd the disease spreads rapidly because the cows and heifers have no immunity. Conception rates drop to around 40%. As immunity develops, the disease rate drops but reinfection often occurs as immunity wanes about a year after the initial infection. Conception rates in chronically infected herds are usually between 65 and 75%, with replacement heifers (newly introduced animals) being most severely affected. The infection can prevent implantation of a fertilized egg in the uterine lining, or more commonly, causes death of the developing embryo. When the embryo is lost, the cow goes back into heat and usually can be rebred successfully, since she has now developed immunity. Occasionally the disease results in permanent infertility.

Clostridial Diseases

Clostridial diseases strike cattle suddenly, often causing death before any clinical signs are seen. The bacteria that cause these diseases create very long-lived spores that are found everywhere in the environment and can easily be picked up by grazing cattle or enter the body through a wound. Bacteria may live in the gastrointestinal tract and spores also may be present in the tissues of healthy animals. Not all species of *Clostridium* cause disease but those that do usually are fatal. Examples include:

- *C. septicum* – malignant edema
- *C. chauvoei* – blackleg
- *C. perfringens types A, B, C, and D* – enterotoxemia
- *C. tetani* – tetanus
- *C. botulinum* – botulism

Contributing factors are necessary to allow the bacteria to multiply and cause disease. This may include injury or invasive procedures such as surgery, giving birth (parturition), or puncture wounds. Diet changes, overeating, and acidosis may permit clostridial organisms in the gut to multiply and cause disease. Clinical signs differ depending on the specific organism and may include sudden death in apparently healthy animals, lethargy or depression, high fever, anorexia, localized stiffness or muscle spasms, port wine colored urine, acute lameness and swelling in the hips and shoulders with a crackling sound when the skin is pressed (blackleg), or flaccid paralysis (botulism).

Brucellosis

Brucellosis is an infectious disease that spreads between animal species and between animals and humans. In cattle, the bacterium involved usually is *Brucella abortus*. Brucellosis is highly contagious, spreading very easily between cattle. The primary clinical sign is late-term abortion and the aborted calf, membranes, and fluids all contain large numbers of bacteria.

Make a chart showing physical examination findings for the following diseases in adult cows: bovine viral diarrhea, infectious bovine rhinotracheitis, leptospirosis, Campylobacter – the goal is to help you remember what body system(s) is/are most commonly affected with each disease so your chart may include history findings and clinical signs.

SMALL RUMINANTS

Vaccination Methods

Vaccines cannot replace good management practices. When vaccinating sheep and goats, make sure they are healthy animals, and that the injection site is clean and dry to prevent introducing infection with your injection. Make sure you have adequate handling facilities such as a properly constructed chute or pen. When vaccinating multiple animals using an automatic syringe, verify that the correct dose is being administered. Needles should be changed every 12-20 animals (generally every pen or chute-full) and anytime the needle is dull, burred, or bent. Some facilities will be part of specific disease-control programs (caprine arthritis encephalitis virus (CAE) or ovine progressive pneumonia (OPP)); in that instance, multi-dose syringes may be used but a new needle must be used for each animal. In general, 18 gauge 5/8" needles are used for adult animals and 20 gauge 1/2 to 5/8" needles are used for young animals. Make sure all animals are individually identified (tags, tattoos) and that there is a system for record keeping so you know which animals received which vaccines.

To vaccinate, part the wool if necessary, raise the skin to form a tent and insert the needle into the tent opening so that the needle is almost parallel with the neck. The site of injection is important if the animal you are vaccinating is to be used for food. Vaccines are given so as to minimize carcass and hide degradation due to abscess or scar formation. Vaccines should be given subcutaneously in the neck region or in the ventral aspect of the axillary space. The meat from these regions is of low value and pelt damage in these areas easily can be trimmed with minimal effect on value. Injection over the ribs is not optimal but it can be used if the animal cannot be restrained to allow you to use another location.

How to Vaccinate Sheep and Goats

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Factors to Consider in Developing a Vaccination Strategy

Which vaccines are used depends on:

- History at the individual farm
- Age of the sheep or goats
- Previous disease problems
- Open or closed flock/herd status – are animals coming and going for shows, purchases, breeding?
- Geographic region

- Soil type
- Diet and flock/herd economics
- Withdrawal time (refer to the label!)

To choose vaccines, consider:

- Real and high-likelihood risks
    - Since all ruminants are at risk for *Clostridium perfringens type D,* toxoid against this agent ideally should be used in all sheep flocks and goat herds
    - Show animals have considerable exposure to contagious ecthyma virus (soremouth) and caseous lymphadenitis
    - Open flocks have exposure to foot rot and abortion diseases
- **All animals** should be vaccinated with:
    - CD-T vaccine – *Clostridium perfringens* is more commonly called enterotoxemia or overeating disease. Type C primarily affects lambs and kids during their first few weeks of life. Type D (pulpy kidney disease) affects lambs and kids that are usually over a month of age, particularly those that are creep-fed or finished on concentrate diets. *Clostridium tetani* is the causative agent of tetanus. CD-T toxoid is the vaccine usually used to

protect healthy sheep and goats against these clostridial diseases.

- **Most animals** should be vaccinated against *Campylobacter* and *Chlamydophila* (abortion diseases) and contagious ecthyma (soremouth).
- **Some animals** should be vaccinated against contagious lymphadenitis and rabies and even more rarely, against *E. coli*, bluetongue virus, and *Brucella ovis*.
- Some people recommend use of cattle or equine vaccines in small ruminants but they are not labeled for this use and efficacy has not been well demonstrated.

Diseases in Sheep and Goats

Diseases to be vaccinated against in sheep and goats include:

- Clostridial diseases
- Abortion diseases in sheep
- Contagious ecthyma (soremouth, orf, scabby mouth or pustular dermatitis
- Caseous lymphadenitis (CLA, boils, abscesses or cheesy gland)

Clostridial Diseases

Clostridial organisms of various types are found in the soil, where they can survive for a very long time. Most clostridial organisms also survive naturally in the gastrointestinal tract of healthy animals. Sheep can be infected with various clostridial diseases (see diseases in cattle) but the most common are enterotoxemia types C and D and tetanus. Enterotoxemia type C (hemorrhagic enteritis or bloody scours) is caused by *Clostridium perfringens type C* and affects lambs during their first few weeks of life, causing a bloody infection of the small intestine. It is often related to indigestion and is predisposed by a sudden change in feed, for example an increase in the dam's milk supply or beginning creep feeding as lambs are being weaned. Enterotoxemia type D (overeating disease or pulpy kidney disease) is caused by *Clostridium perfringens type D* and commonly strikes the largest, fastest growing lambs in the flock. It is caused by a sudden change in the feed that causes the organism, which is already present in the lamb's gastrointestinal tract, to proliferate, causing a toxic reaction. It is most common in lambs that are on high concentrate rations but can also occur when lambs are nursing from dams that are heavy milkers. It usually affects lambs over one month of age. Sudden death may be the first sign. Other clinical manifestations include neurologic signs, seizures, and diarrhea. Tetanus is caused by *Clostridium tetani*, a soil inhabitant that is a prolific spore producer. This disease is usually related to tail docking and castration, although any wound can harbor the tetanus organism. Signs of tetanus occur from about 4 days to 3 weeks or longer after infection is established in a wound. The animal may have a stiff gait, lockjaw can develop, and the third eyelid may protrude across the eye. The animal usually will go down with all four legs held out straight and stiff and the head drawn back. Convulsions may occur.

Abortion Diseases

Ewes or does that lose their lambs early in pregnancy may not return to heat because they are seasonal breeders, and so may not be bred back that season. This is a significant loss for the producer both because of decreased lamb crop and because those dams will not lactate that season. Pregnancy also may be lost late in gestation or weak or deformed lambs may be born. For many diseases causing abortion in small ruminants, there is no vaccine in the United States (for example, Q fever, toxoplasmosis, Border disease). In the United States, the most common causes of abortion in ewes are *Chlamydia / Chlamydophila* (enzootic abortion) and *Campylobacter*. Enzootic abortion is transmitted from aborting dams to other females in the flock. Ewe lambs are the most susceptible on farms where the organism is present. Abortion usually is seen late in pregnancy or lambs may be born that die shortly after birth. Campylobacteriosis (formerly called Vibriosis) causes abortion late in pregnancy or birth of stillborn or weak lambs. Infecting organisms are *Campylobacter jejuni* and *Campylobacter fetus*. Ewes are infected orally and the incubation time from ingestion to abortion is just 2 weeks.

Contagious Ecthyma (soremouth, orf, scabby mouth, or pustular dermatitis)

Soremouth is the most common skin disease affecting sheep and goats. It is a highly contagious viral infection that also can produce painful infections in humans. The virus causes scab formation on the skin, usually around the mouth, nostrils, eyes, mammary glands, and vulva. It first appears as tiny red nodules, usually at the junctions of the lips.

Caseous Lymphadenitis (CLA, boils, abscesses, or cheesy gland)

Caseous lymphadenitis is an infectious, contagious disease that primarily infects the lymphatic system, though other organs can be affected. It is caused by *Corynebacterium pseudotuberculosis*. Infection results in abscess formation in the lymph nodes that when cut or ruptured, discharge pus containing the bacteria in the surroundings. When the infection spreads internally, affected animals slowly lose weight and eventually become emaciated.

Vaccines for Disease in Sheep and Goats

Specific vaccines that are available are:

- CD-T (*Clostridium perfringens types C* and *D* and tetanus toxoid)
- Abortion vaccines
- Contagious ecthyma (soremouth, orf)
- Caseous lymphadenitis (CLA)
- Rabies

CD-T (*Clostridium perfringens types C* and *D* and tetanus toxoid)

Protection against type C is needed by nursing lambs and kids on all farms, regardless of management practices. Maternal antibodies will be present in colostrum if the ewe/

doe was vaccinated in the 2-4 weeks prior to parturition. This passive immunity lasts in the lamb/kid for their first 50-60 days of life. Protection against type D is needed in lambs/kids fed grain or lush forage (any high-carbohydrate diet). It is associated with production of a toxin that is acutely fatal in fast-growing lambs. Tetanus toxoid is included in this product. Ewes and does should be vaccinated 8 weeks prior to the first time they give birth, and boostered at 2-4 weeks prior to parturition. Previously vaccinated ewes and does only require the vaccination 2-4 weeks prior to parturition. Offspring from vaccinated dams are vaccinated at weaning and again 3-4 weeks later. Offspring from unvaccinated dams are vaccinated as newborns (may have systemic reaction, can be treated with epinephrine) and are boostered at 3-4 weeks of age and again at weaning. All animals, including males, should be boostered at least annually; some goats may only maintain protective antibody titers for six months after vaccination.

Abortion Vaccines

In general, do not vaccinate if there are no problems on the farm or if animals are determined to be at low risk. Risk is associated with having an open flock, with animal traffic on and off the farm, with free-roaming wildlife, feeding on the ground, or with a history of abortions in the flock. Diagnosis for abortion problems is difficult and for many diseases causing abortion in small ruminants, there is no vaccine in the United States (for example, Q fever, toxoplasmosis, Border disease).

- *Chlamydia / Chlamydophila* (enzootic abortion) vaccine may not be effective against all strains causing abortions and regional variations in protection may exist. The label states that the vaccine should be administered 60 days prior to breeding with a booster in 30 days.

- *Campylobacter* (formerly called *Vibrio)* vaccination induces immunity for only 4-5 months. The label states that the first dose of vaccine should be given 2 weeks prior to breeding and that it should be boostered 2-3 months later. In the face of an "abortion storm," where many abortions are occurring in the flock due to this organism, revaccination of all animals may reduce losses.

Contagious Ecthyma (soremouth, orf)

This is a live virus vaccine that will introduce a mild infection. This vaccine should only be used if this disease is present in the flock. The vaccine is given percutaneously; an area of skin in a wool-less region (inside the thigh or ear, or under the tail) is scarified in the form of an X deeply enough to cause inflammation but not so deeply as to cause bleeding. The vaccine is brushed on. The vaccinated area will scab over and does contain live virus that will be infective even after falling off the sheep. Vaccination under the tail is preferred to that inside the thigh, as vaccination on the medial thigh region may cause irritation and scabbing over the mammary glands and teats. This is a zoonotic disease so people should wear gloves and exercise caution when handling the vaccine or sheep, or picking up scabs. On farms that have a problem with this disorder, each new lamb and kid crop should be vaccinated. Lambs moving into feedlots should be vaccinated at least 14 days before shipment. Do not use this vaccine on farms that do not already have this disorder.

Caseous Lymphadenitis (CLA)

This may be a stand-alone vaccine or combined with CD-T vaccine. Vaccination decreases severity of disease but does not prevent disease. The vaccine should not be used in flocks or herds unless they have been exposed or contain affected individuals.

Rabies

This is a killed vaccine. Several products are available for sheep. No products are specifically labeled for goats but there is a recommendation in some situations that publicly displayed goats will be vaccinated. For example, goats take to a show that will be housed in a pen probably will not be vaccinated for rabies, while goats at a petting zoo that are purposefully brought to that site to interact with people will be vaccinated for rabies. Animals are vaccinated when greater than 3 months of age and then annually.

Make a chart showing physical examination findings for the following diseases in sheep and goats: Clostridium perfringens type D, Campylobacter, contagious ecthyma – the goal is to help you remember what body system(s) is/are most commonly affected with each disease so your chart may include history findings and clinical signs.

SWINE

Vaccination is a common preventive medicine practice on commercial swine farms. Vaccination protocols for swine typically focus upon preventing diseases of the reproductive, respiratory, and gastrointestinal tracts, and preventing multi-systemic disease. Vaccines may be applied to the reproductive herd (sows and boars), replacement females (gilts), or growing pigs, depending on when the disease challenge is expected.

Forms of Vaccination Production

- Commercial (manufactured and sold by pharmaceutical companies)
- Autogenous (typically manufactured by a licensed laboratory from organisms isolated from the farm of concern)
- On Farm – Typically includes other, less controlled, methods that stimulate immunity such as oral feeding of infectious organisms ('biofeedback') or inoculation with serum from viremic animals (serum inoculation)

Routes of administration for swine vaccines typically include IM or oral (per os = PO). Multivalent vaccines (those containing multiple organisms) are commonly created to decrease the stress, labor, and food safety issues associated with multiple injections. Swine farm clientele expect that veterinarians will consider the costs and benefits associated with the vaccination protocols they recommend.

Pork Quality Assurance Vaccination Recommendations

Pork Quality Assurance programs strongly encourage the use of vaccines to prevent the necessity of antibiotic therapy and the potential for post therapeutic residues. They recommend the following when administering vaccines to pigs:

- Use a spot on the neck just behind and below the ear, but in front of the shoulder. Do not use a needle to inject in the ham or loin. There may be some bleeding and bruising of the muscle followed by scarring. This scar can stay in the muscle for the life of the pigs and be a blemish in the cut of meat. This standard applies to sows as well as market hogs. While sows may not be going to market soon, they are at greater risk for blemishes because of the repeated injections they typically receive over their productive life in the form of vaccinations and farrowing medications.
- Use the proper size and length of needle to ensure the medication is deposited in the muscle, not in other tissues.

	GAUGE OF NEEDLE	LENGTH OF NEEDLE (INCHES)
Baby Pigs	18 or 20	½ or ⅝
Nursery Pigs	16 or 18	⅝ or ¾
Finisher Pigs	16	1
Breeding Stock	14, 15 or 16	1 or 1½

Diseases in Swine

Diseases to vaccinate against in swine include:

- Leptospirosis
- Erysipelas
- Porcine parvovirus (PPV)
- Porcine Reproductive and Respiratory Syndrome (PRRS)
- *Mycoplasma hyopneumoniae*
- Influenza

- *Escherichia coli*
- Rotavirus
- Porcine Proliferative Enteritis (PPE)
- Porcine Circovirus Type 2 (PCV2)
- Meningitis

Leptospirosis

As in cattle, leptospirosis is a zoonotic disease, caused by bacteria of the genus *Leptospira*. There are many different serotypes of disease and prevalence varies with geographic location. Worldwide, pigs are the maintenance hosts for pomona, tarassovi, bratislava, and muenchen. Pomona causes important reproductive problems in breeding sows, spreading slowly through the herd. The skunk is a reservoir host. Once the organism is introduced into a herd, the pigs become permanent carriers with infection of the kidneys and intermittent excretion of the organism into the urine. Piglets rarely are infected. The most common manifestation is chronic low-grade disease in sows, with abortions, stillbirths, and birth of weak piglets.

Erysipelas

Swine erysipelas is caused by a bacterium, *Erysipelothrix rhusiopathiae,* that is found on most if not all pig farms. Up to half of the animals on a farm may carry it in their tonsils. It is excreted in saliva, feces, and urine, and so is common in the environment. It is also found in many other species, including birds, and can survive for long periods in the environment. The bacterium alone may cause disease but clinical disease is more common if there is concurrent infection with viral diseases such as porcine reproductive and respiratory syndrome (PRRS) virus and influenza. Disease is relatively uncommon in pigs under

8-12 weeks of age due to protection provided by maternal antibodies from colostrum. The most susceptible animals are growing pigs, non-vaccinated gilts, and young sows. Infected sows may show acute death in apparently healthy animals, fever, abortion, stillbirths, birth of mummified piglets, raised areas in the skin ("diamonds") that turn red and then black, or joint stiffness. Infertility may be a presenting concern on a farm. Infected boars with high fevers have transient decrease in semen quality, reflected as sows not getting pregnant or having smaller litters. Infected growing pigs may show acute death, fever, and the characteristic skin lesion described above.

Porcine Parvovirus (PPV)

PPV is the most common and important cause of infectious infertility in pigs. Porcine parvovirus multiplies normally in the intestine of the pig without causing clinical signs. It is worldwide in its distribution. PPV can persist in the environment for many months and is resistant to most disinfectants. Infected sows show only reproductive signs of disease. Parvovirus is associated with lack of conception, birth of mummified or stillborn pigs, and birth of live pigs with low birth weight. Sporadic disease is seen in individual females that are infected for the first time; for this reason, disease usually is seen in gilts. Once a pig is exposed, it has lifelong immunity. Reproductive problems in a herd appear about every 3-4 years if vaccination is not practiced.

Porcine Reproductive and Respiratory Syndrome (PRRS)

This is a fairly new disease; it has only been recognized in the United States since the mid-1980s and was only identified as being caused by an arterivirus in 1991. The virus has an affinity for macrophages, especially those in the lung. Up to 40% of macrophages are destroyed in a given animal, making it susceptible to other diseases. When introduced into a new herd, 90% of breeding sows will be seropositive within 4-5 months. Grower pigs shed virus for months; adult pigs shed virus for periods of time as short as 2 weeks. Nasal secretions, saliva, feces, and urine may contain virus. The virus can be airborne for up to 2 miles and can be carried between pigs and on fomites (inanimate objects) including boots, equipment, and trucks. The virus also may be carried by flies and mosquitoes. The clinical picture varies tremendously from one herd to another. As a guide, for every three herds that are exposed to PRRS for the first time, one will show no recognizable disease, the second will show mild disease, and the third will show moderate to severe disease. The reasons for this are not clearly understood. Clinical signs in sows include inappetance; fever; abortions; early farrowing with birth of mummified, stillborn, or weak pigs; prolonged return to heat after weaning of piglets; coughing; lack of milk and mastitis; lethargy; and cyanosis (blue discoloration) of the ears. This is the acute phase of the disease. Long-term, reproductive efficiency in herds in which the infection has become enzootic are associated with 10-15% reduction in farrowing rate, increased stillbirths, increased number of abortions, and inappetance in sows at farrowing. Infected piglets may show diarrhea and increase in other respiratory infections. Infected weaning and growing pigs may show other infections secondary to PRRS infection with a variety of clinical signs and mortality rate as high as 12-15%.

Mycoplasma hyopneumoniae

This is one of the most important contributors to respiratory disease in pigs. The organism damages the cilia and epithelia of the airways of the lower respiratory tract, permitting infection with other organisms, for example PRRS virus. Mycoplasma is transmitted via direct contact with infected pigs. Pigs older than 6 weeks are mainly those affected. Clinical signs include a non-productive cough, rough hair coat, and reduced growth rate and feed efficiency. With secondary bacterial infection, signs are more severe and include labored breathing, a harsher cough, fever, and prostration.

Influenza

Influenza viruses are the cause of outbreaks of acute respiratory disease. Influenza A viruses infect a wide range of avian and mammalian species, with the latter group including humans, pigs, horses, and aquatic mammals. Type A viruses are known for their ability to change their antigenic structure and create new strains. The type A viruses are further divided into serotypes, based on the antigenic nature of their surface glycoproteins hemagglutinin (H) and neuraminidase (N). Swine influenza in large herds may become endemic with intermittent bouts of disease and infertility. Different influenza strains may sequentially infect the herd. Immunity to influenza viruses is often short-lived (6 months). Outbreaks are seen throughout the year. Piglets generally are protected by maternal antibodies they receive in colostrum. Sows may show pregnancy loss secondary to fever and coughing. Weaner and grower pigs with acute illness classically are fine one day and then lying prostrate and breathing heavily the next.

Escherichia coli

Diarrhea is the most common and important disease of piglets. In a well-managed herd, there should be fewer than 3% of litters at any time requiring treatment for diarrhea and piglet mortality from diarrhea should be less than 0.5%. At birth, the gastrointestinal tract is microbiologically sterile. Organisms begin to colonize the tract quickly after birth, among them potentially pathogenic strains of *E. coli.* Ingestion of colostrum and later, of milk containing IgA, is vital for creation of immunity within the intestinal tract. If too many bacteria are present or if there are stressors present such as chilling or concurrent infection, piglets will succumb to disease. Periods of greatest risk are before 5 days of age and between 7 and 14 days of age. Weaning is another risk, as loss of sow's milk and the IgA it contains allows the bacteria to attach to the villi of the small intestines. Signs may include acute death, dehydration, and sticky feces around the rectum and tail with an accompanying characteristic sour smell.

Rotavirus

This virus is widespread in pig populations, with virtually 100% seroconversion in adult stock. It is resistant to environmental changes and many disinfectants and so persists for long periods of time in the environment. Piglets are initially protected from maternal antibodies in colostrum but become susceptible to infection by about 3-6 weeks of age. Exposure does not necessarily result in disease; it is estimated that only 10-15% of diarrheas in pigs are due to primary rotavirus infection. The virus destroys the intestinal villi, preventing fluid uptake and causing watery diarrhea.

Porcine Proliferative Enteritis (PPE)

This is a disease characterized histologically by inflammation, ulceration, and hemorrhage in the intestinal tract. The causative organism, *Lawsonia intracellularis*, is a unique obligate intracellular organism related to anaerobic bacteria. Clinical disease is characterized as an acute form common in young adults and a chronic or necrotic form in grower pigs. Carrier animals shed the organism in their feces and susceptible pigs are exposed through the fecal-oral route. Carrier sows may infect nursing pigs as early as 6 days of age. Pigs present with pallor, weakness, and rapid death. Subacute to chronic cases occur more frequently in grower pigs, which show sporadic diarrhea, wasting, and variation in growth rate.

Porcine Circovirus Type 2 (PCV2)

This is a widespread virus and essentially all pig herds are infected. However, very few have PCV2-associated disease which can include a variety of systemic disorders including clinical signs of wasting, pneumonia, enteritis, and reproductive failure. The hallmark of PCV2 infection is depletion or inflammation of lymphoid tissue. In many cases, PCV2 infection requires a trigger such as concurrent infection (PRRS virus, *Mycoplasma hyopneumoniae*) or other stressors.

Meningitis

Hemophilus parasuis and *Streptococcus suis* are two organisms associated with inflammation of the meninges in pigs. Signs of meningitis in piglets and weaned pigs include rapid onset of recumbency, shivering, nystagmus (shaking of the eyeballs), paddling, and convulsions. In older pigs (growers and adults), muscle trembling, nystagmus, and incoordination are more common clinical signs.

Make a chart showing physical examination findings for the following diseases in pigs: leptospirosis, erysipelas, parvovirus, Mycoplasma hyopneumoniae – the goal is to help you remember what body system(s) is/are most commonly affected with each disease so your chart may include history findings and clinical signs.

Vaccines for Disease in Swine

Vaccination for Reproductive Disease

Common vaccinations include:

- Leptospirosis-Erysipelas-Parvovirus combination vaccine
    - Each of these components may be administered as individual vaccinations as well
- Porcine Reproductive and Respiratory Syndrome virus (PRRS) vaccine
    - Modified live virus vaccine typically thought to be most effective

Common uses are:

- Typically administered twice prior to the first breeding of gilts and once before subsequent gestation periods in reproductive herd (sows and boars)

Vaccination for Respiratory Disease

Common vaccinations include:

- *Mycoplasma hyopneumoniae* vaccine
    - Single dose and two dose versions exist
- Swine Influenza virus vaccine
    - Normally include H1N1 and H3N2 components
- Porcine Reproductive and Respiratory Syndrome virus (PRRS) vaccine

Common uses are:

- Routine vaccinations in reproductive herds to maintain respiratory disease stability

- Acclimation of disease-negative replacement females as they enter disease-positive herds
- Growing pigs at weaning or during the nursery phase to prevent significant respiratory disease during the finisher phase

Vaccination for Gastrointestinal Disease

Common vaccinations include:

- *Escherichia coli* vaccine
    - Multiple strains typically included in the vaccine
- Rotavirus vaccine
    - Modified live virus, only one type included in commercial vaccine
- *Lawsonia intracellularis* vaccine
    - A modified live vaccine that requires storage at -70°C and it administered orally following thawing and dilution

Common uses are:

- *Escherichia coli* and Rotavirus vaccines commonly used prior to farrowing to prevent neonatal scours in suckling piglets
- *Lawsonia intracellularis* vaccines administered in late nursery or early finisher (9-12 weeks of age) to prevent ileitis in finisher pigs OR for the acclimation of replacement females into breeding herds

Vaccination for Multi-Systemic Disease

Common vaccinations include:

- Porcine Circovirus Type 2 (PCV2) vaccine
    - Currently the most common vaccine used in swine
    - Considered to be highly effective in preventing a devastating disease syndrome
    - Evidence that it provides effective protection in both single and two dose programs.
- *Hemophilus parasuis* vaccine
    - Typically includes multiple serotypes that provide cross protection for other serotypes
- *Erysipelas rhusiopathiae* vaccine
    - May be delivered IM or PO
- *Streptococcus suis* vaccine
    - Efficacy is questionable
    - Commonly produced as an autogenous vaccine

Common uses are:

- These vaccines are often manufactured in combination type products with respiratory specific vaccines to prevent disease in replacement females or growing pigs.

List your five (5) take-home points – What are things you want to remember from this chapter as you progress through the curriculum and into your career?

5.

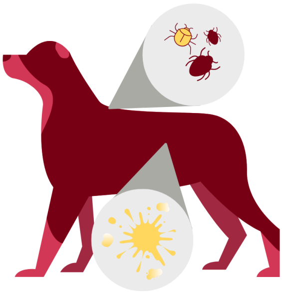
Parasite Control

Learning Objectives

- Describe fecal flotation testing, including fecal egg counts and fecal egg count reduction testing
- List common internal and external parasites of concern in common domestic species
- Describe life cycle of representative parasites as it pertains to control
- Describe drugs and mechanisms used for parasite control in common domestic species
- Define refugia
- Describe pasture management for parasite control

PARASITE INFECTION AND TOOLS FOR DIAGNOSIS

Parasites, either internal (for example, worms) or external (for example, fleas and ticks), draw nutrients away from the host, and can cause disease. This chapter will focus on demonstration of how your understanding of the life cycle of parasites for various species in different environments will help minimize infection or infestation and help with control of the parasite in the environment. The biggest difference appears to be in overall management between large animals and small animals. In large animals, there is concern about resistance of parasites to available deworming medications and great attention is paid to minimizing development of resistant parasites. This may include leaving a small population of worms untreated, so there always are susceptible worms in the overall population and we are not just continually killing off susceptible worms and leaving behind more and more resistant worms. In small animals, where parasites can be a significant public health concern, it is a goal to kill all internal and external parasites. This does not mean there are no concerns about resistance; in 2021, resistance in hookworms, one intestinal parasite of dogs, was described.



Gastrointestinal parasites are the class most commonly addressed. Some common tools used to evaluate presence of gastrointestinal parasites are fecal flotation tests and fecal egg counts. Fecal egg counts are basically quantified fecal flotations. You will also hear fecal flotations called fecal floats. Dr. Erin Burton provides the following differentiation between these two kinds of tests and how they're interpreted: A fecal flotation is a qualitative assessment of the eggs in a sample, while a fecal egg count (FEC) is a quantitative assessment. Fecal flotations are lax on the amount of solution and feces used for each float and so give at best a semi-quantitative assessment of egg burden. FECs use a measured amount of feces and solution, and then plug the number into a formula to get the egg count. FEC usually is done more than once; in order to interpret them they are performed over time and because of that they are the test primarily used to definitively define the degree of drug resistance in an animal or herd. It is also important when evaluating a fecal float or FEC to be aware of how prolific of an egg layer the nematode is. For example, one *Toxocara canis* (roundworm) can produce over 20,000 eggs each day while a whipworm only produces about 1000 per day. Thus, having larger numbers of whipworm eggs on a float or FEC is more indicative of a heavy worm burden than abundant *Toxocara* eggs on float or FEC. Finally, be aware that not all gastrointestinal parasites can be identified by fecal flotation testing. For example, tapeworm eggs generally are released within tapeworm segments, or proglottids, and because the individual eggs are not in the feces and the proglottids are too heavy to float, tapeworm infections generally cannot be diagnosed by fecal flotation testing.

What is a fecal egg count? How will you, as a veterinarian use these results to create a parasite control program?

BEEF CATTLE

Parasites can have potential negative effects on beef cattle that can vary from subclinical immune suppression, irritation, annoyance, appetite suppression, and decreased production, to severe clinical disease and death. The management of parasites is a component of a preventive health program that should also include immunity management (vaccinations), management procedures, handling, and nutritional considerations that reflect an in-depth understanding of not only the beef production system but farm-specific issues and goals.

Internal Parasites

Internal parasites include roundworms (nematodes), tapeworms (cestodes), flukes (trematodes) and protozoans (such as coccidia). Roundworms are considered the most economically important, and many programs revolve around their management. This section regarding internal parasites in beef cattle will focus around roundworms. Understanding the parasite life cycle and the level of parasite pressure is key to the management of internal parasites.

The following is the basic life cycle of internal (gastrointestinal) parasites in cattle:

1. Adult parasites live in the gastrointestinal tract of cattle and lay eggs that are shed in the manure.
2. When a parasite egg is shed on the pasture in the feces, this egg begins development, embryonating into a first stage larva (L1), then molting into a second stage larva (L2), and finally molting again into a third and infective stage larva (L3).
3. During the first two larval stages in the fecal pat, the larva are fairly immobile, feeding off the bacteria and other debris found in the feces.
4. During the third larval stage the larva move out of the fecal pat and onto nearby grass where they are consumed by cattle.
5. L3 larvae maintain an external sheath covering that provides extra protection from environmental conditions allowing survival during winter or drought conditions. This sheath prevents feeding, thus L3 larvae have a limited life span.
6. Egg development is greatly dependent upon

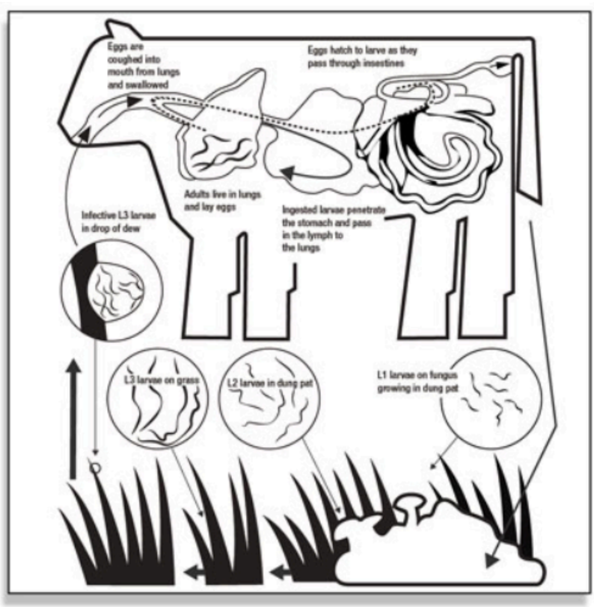
temperature and moisture. Eggs that are passed in the middle of winter will not develop until warm weather returns in the spring. Eggs passed in the middle of a drought or other unfavorable conditions may develop into infective larvae in the feces but without moisture cannot move away from the pat where they can be consumed by a host animal when it eats grass. Eggs that are shed during favorable conditions can develop into infective larvae in just a few days if temperatures are warm and moisture is plentiful.

7. Once consumed by cattle, the infective larvae mature into adults over a period of 3-4 weeks (shorter in younger cattle, longer in adult cattle) and begin to lay eggs, which are shed onto pastures to start the cycle over again.
8. Some larvae can become inhibited or hypobiotic (go into hibernation) in the wall of the abomasum, sometimes referred to as L4 larvae. This process can occur during the winter in the north and in the summer in the south, with these larvae maturing and developing into adult worms when the environment for egg survival is more favorable.

Overall, the controlling of internal parasites has a significant positive return on investment for producers. The main focus of internal parasite control in beef cattle is roundworms. Diagnostics are needed to determine which specific worms are present. For beef cattle this is important because the roundworm life cycle depends on the shedding of the eggs on pasture, larvae development, and the ingestion of the larvae during grazing. Since much of beef cattle production depends on grazing of pastures, the management of roundworms is key. As long as cattle have access to grass, they will have an internal parasite challenge.

Control practices should consider the class (or age) of cattle, nutrition status, stress level, season, and likelihood of parasite contamination of the environment, and involve the use of pasture management options as well as the use of anthelmintic (dewormer) products for treatment.

Life-Cycle of Internal Parasites



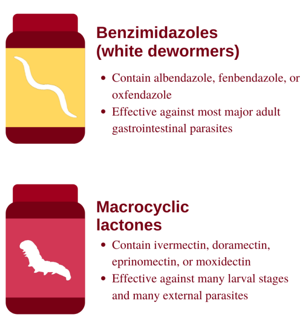
"Lifecycle of a typical roundworm", [*https://www.progressivecattle.com/topics/management/parasite-control-in-stocker-and-grower-cattle*](https://www.progressivecattle.com/topics/management/parasite-control-in-stocker-and-grower-cattle)

1. Infective L3 larvae in a drop of dew enter the cow's mouth when eating grass.
2. Ingested larvae penetrate the stomach and pass in the lymph to the lungs.
3. Adults live in lungs and lay eggs.
4. Eggs are coughed into mouth from lungs and swallowed.

5. Eggs hatch to larvae as they pass through intestines.
6. L1 larvae on fungus grow in dung pat.
7. L2 larvae live in dung pat.
8. L3 larvae move onto grass where they again can be ingested by cows.

Parasite Contamination Susceptibility

PRIORITIZED SUSCEPTIBILITY TO PARASITES	ENVIRONMENTAL PARASITE CONTAMINATION LIKELIHOOD
Calves > Yearlings > Adult bulls > Adult cows	Spring / Early summer > Late summer (dry season) > Winter
Nutritionally challenged > Not nutritionally challenged	Continuously grazed pasture > Rested pasture > Not grazed / Hayed pasture > Recently tilled > Dry lot
Stressed (newly weaned, heat/cold stress, etc) > Not stressed	



Some pasture management activities may include leaving the pasture fallow, grazing other species, and dragging manure pats during the dry season to allow them to dry out.

Anthelmintics used to control internal parasites for beef cattle come in several forms including paste, injectable, drench, pour-on, bolus, and as a feed or mineral additive. Products have varying lengths of activity and costs, but fall into two main classes: benzimidazoles and macrocylic lactones. Benzimidazoles (white dewormers) available commercially contain albendazole, fenbendazole, or oxfendazole. Benzimidazoles are effective against most of the major adult gastrointestinal parasites and many of the larval stages. Products come in various oral formulations and have a short duration of efficacy. Macrocyclic lactones are the avermectins and milbemycins. Products in commercial use contain ivermectin, doramectin, eprinomectin, or moxidectin. The macrocyclic lactones have a potent, broad antiparasitic spectrum at low dose levels. They are active against many larval stages (including hypobiotic larvae) and are active against many external parasites as well. Products are available as oral, subcutaneous, and pour-on formulations for use in cattle. Duration of efficacy varies with the product and may be up to 35 days.

Approaches used to treat parasites in beef cattle are considered strategic deworming. This is the practice of treating cattle at times to not only get the benefit in that animal to prevent economic loss but also reduce environmental contamination for a period of time at least equal to the life cycle of the parasite removed.

Keys to strategic deworming are to place cattle that are not shedding eggs on pastures that are not infected; this is accomplished by deworming prior to spring turnout or fall treatment in the north (following killing frost). The benefit of treating in the fall is that cattle should be free of internal parasites all winter and going into the spring turnout (assuming an effective product was used). Cattle that go onto pasture at spring turnout are free of parasites, thus not shedding eggs, and will be consuming the infective larvae on the pasture if the pasture is contaminated. By consuming the infective larvae and not shedding new ones the cows will be reducing the load on the pasture (acting as vacuum cleaners). After a time the ingested infective larvae will mature and cows will start shedding eggs. Strategic deworming times the treatment so as to reduce the worm burden on the cattle and also decrease the parasite contamination of the pasture during the highest parasite period (spring/early summer).

The timing of these treatments can and should be timed with other management procedures such as summer vaccines for the calves and fall processing of calves and cows. Depending on the geographic location, such as in the south where the weather (moisture) is different, timings may be different, as well as the type of grazing program.

Calves and stockers should be considered within a strategic program while on a grazing program. Times of concern include prior to weaning while nursing the cow and while intensively grazing as a stocker. Calves should not be dewormed while being weaned. Preweaning treatment, prior to the stress of weaning, can reduce the potential negative impact on immune function as well as improve performance. Any time cattle are moving from pasture into a dry lot setting is a good time to deworm as this should clear cattle of parasite load for the time in the dry lot (similar to fall deworming) as there is no green grass to graze.

For the control of other types of internal parasites such as tapeworms (cestodes), flukes (trematodes), and protozoans (such as coccidia), similar concepts are applied. It is important to understand the different life cycles of these different types of parasites as well as the efficacy of products used to treat them.

External Parasites

The major external parasites that affect cattle include flies, grubs, lice, ticks, and mites. These external parasites feed on body tissues such as blood and skin, and in addition they cause irritation and discomfort that result in reduced weight gain and lost production. Parasites that take blood meals have the potential to serve as vectors for the transmission of diseases.

Horn Flies

Horn flies are blood-sucking flies that stay on the shoulders and backs of cattle almost continuously. A horn fly leaves the back of a cow or calf only to lay eggs in fresh manure. They take blood meals from the host 24 hours a day.

Face Flies

Face flies cluster on the faces of cattle and feed on secretions from the mucous membranes of the eyes, nose, and lips. Face flies do not suck blood. They do irritate the surface of the eyeball and may carry pathogens that contribute to pinkeye problems. They spend only a small portion of their life on cattle.

Stable Flies

Stable flies feed primarily on the legs and lower abdomen of cattle and take blood meals two to three times a day depending on the weather. After feeding they move to a resting place to digest the blood meal. Stable flies are associated with substantial economic loss in cattle from the blood loss and pain from feeding. As few as five flies per leg is economically significant in cattle.

Ticks

Ticks cause blood loss and discomfort, and can act as vectors for disease spread. High concentrations of ticks usually occur in brushy pastures and woodlands.

Lice

Lice that affect cattle are either of the biting or sucking type, and cause skin irritation and itching. The entire life cycle of lice is on the host and they are present year round but populations increase in winter months. Lice spread through contact with infested cattle. Infested cattle can experience reduced appetite and anemia, and appear unthrifty.

Mites

In cattle, mites can cause hair loss and a thickening of the skin. Infestation by mites is called mange. Mites are spread by close contact. Severe mange can weaken cattle and make them vulnerable to diseases. Certain types of mites are reportable.

Cattle Grubs (warbles)

Cattle grubs, or warbles, are the larval stage of the heel fly. The larvae migrate from the animal's heel, where the eggs are deposited by the adult fly in early summer, to the back of the animal. The larvae can cause damage to the hide (due to the breathing hole they create) and if treated during the wrong time of the year can cause paralysis due to their location near the spinal column. Cattle should not be treated with a grubicide between November 15 and March 1 if cattle grubs are a concern.

Control of External Parasites

Control of external parasites usually revolves around the use of insecticides. These usually are a pyrethrin or an organophosphate. Strategies or combinations of strategies for delivery include: dust bags, back-rubbers (oilers), animal sprays, pour-ons, and insecticide impregnated ear tags. In addition, the use of injectable products or pour-ons with systemic activity work well to control lice and mites. Larvicides can also be part of control plan for certain types of flies as well as the use of predator wasps and environmental management. The use of dust bags and back-rubbers (oilers) can provide delivery of insecticides and economic fly control if located in an area that cattle are forced to move through such as a gateway or over a mineral feeder.

Delivery of Insecticides

"Insecticide cattle care", http://easywaycattlecare.com/images/walkway-3.jpg

Insecticide sprays and pour-ons are effective for many different external parasites but have the drawback of increased animal handling costs and stress during the fly-season. Insecticide sprays are the only way to manage adult stable flies. Ear tags impregnated with insecticide can be effective in fly control. Maximizing control requires two tags per animal, and timing of application with peak fly numbers often requires a separate handling session of the animals. Ear tags provide good face fly control if applied properly.

Insecticide Ear Tag Fly Control

"Corathon insecticide cattle ear tags", [*https://www.pbsanimalhealth.com/products/corathon-insecticde-cattle-ear-tags*](https://www.pbsanimalhealth.com/products/corathon-insecticde-cattle-ear-tags)

Larvicides prevent fly larvae from developing in to adults and are administered through free choice mineral. To be effective cattle must consume an adequate amount and not be in the proximity of untreated cattle.

Injectable products and pour-ons with systemic activity are mainly the macrocyclic lactones. These are effective against some flies as well as mites and lice. For mites and lice a second treatment may be needed in two to three weeks to kill newly hatched parasites unless using an extended duration product.

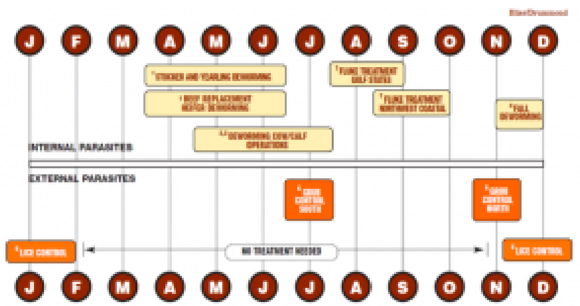
Sanitation or cleaning up of wasted feed or manure that serve as egg-laying sites for certain flies can greatly contribute to the control of certain flies locally. In addition, egg laying sites may be treated with a larvicide.

Environmental management may be a key component to tick control. The reduction of brushy areas and thick wooded areas reduces the habitat for the ticks and reduces exposure.

Certain native parasitic wasps are used as biological control agents of fly populations. Currently, farmers can buy parasitic wasps from commercial insectaries. These wasps emerge into adulthood from the pupal stage, where they develop wings. They fly from the release stations in which they have been held, hung from barn ceilings or other out-of-reach places. The wasps only target flies in their pupal stage. When the wasp finds a pupa in soil or litter, she inserts her stinger and withdraws it, drawing blood and paralyzing the pupa and inserting one egg. The egg hatches after 1 day, and the larva feeds on body fluids and organs for 2-4 weeks. Eventually, the wasp chews its way out of the dead host's puparium and flies away as an adult.

Describe three methods of applying insecticides to cattle for control of external parasites, including pros and cons of each.

Example Strategic Control Program



"Strategic Control: Beef Monograph", [*http://www.midamericaagresearch.net/documents/BeefMonograph.pdf*](http://www.midamericaagresearch.net/documents/BeefMonograph.pdf)

1. Stocker, yearling and replacement heifers dewormed at turnout, four and eight weeks after onset of grazing (0-4-8).
2. Cow/calf deworming six weeks after onset of grazing.
3. If cattle were not dewormed in the fall, adult cows should be dewormed at pasture turnout and again six weeks after onset of grazing.
4. All cattle retained over winter should be dewormed.
5. During lice season, two treatments two to three weeks apart may be necessary.
6. Grub treatment three to four months

after the end of heel fly season, varies south to north. Requires systemic, annual control only.

7. Cattle grazed along the Gulf Coast and Northwest coast should be treated for adult and immature liver flukes.

(Horn-fly control as needed to keep populations below 200 flies per animal.)

There is increasing evidence of antiparasitic resistance in grazing species, such as cattle, small ruminants (sheep and goats), and horses, both globally and within the United States. Antiparasitic resistance is the genetic ability of parasites to survive treatment with an antiparasitic drug that was generally effective against those parasites in the past.

Many factors contribute to antiparasitic resistance, including the biology of the parasite; the immune status of the host animal; treatment practices; drug properties; and certain livestock management practices. To help combat this emerging problem, the FDA's Center for Veterinary Medicine started the Antiparasitic Resistance Management Strategy (ARMS).

DAIRY CATTLE

As in beef cattle, the overarching theme for the prevention strategy of parasitic infection is to reduce the animals' exposure to parasites and their infectious forms. Because multiple animals will be exposed, any strategy will focus on entire groups of animals rather than individuals. So far, this is similar to prevention strategies for any other infectious diseases on farm. However, when thinking about the prevention of parasite infections on farm, the veterinarian must be aware of the infectious form of the parasite (for example, eggs versus larvae) and whether or not other hosts are involved in the life cycle. Then the best parasiticide is selected and management practices, such as grazing schedule, are properly timed to avoid exposure to infectious parasite forms in the environment. In most cases, prevention strategies therefore boil down to good on-farm hygiene and use of well-timed and correctly selected dewormers, as well as pasture management as described for beef cattle. There are different forms of deworming medications for dairy cattle. For simplicity of application, many are pour-ons or feed additives; some are injectables. Oral pastes or any formulation that requires you to handle the animals' heads is rarely used because it is labor-intensive. Any product used in an animal that may be used for milk or meat has a specific withdrawal time. Withdrawal time is defined as the period from when the drug was used until the milk may be put in the bulk tank or the animal sent to slaughter for meat. How long the withdrawal time is and whether you can use a given drug in a lactating cow depends on the product. One thing that people might not be aware of – once a cow has calved for the first time, she is always considered to be a lactating animal, even if she's not being milked (dry period). Always, always, read the label to know what the product will treat for, at what dosage and frequency it should be used, by what route it should be administered, what class of animals it is for, and withdrawal times.

Describe strategic deworming in cattle.

SMALL RUMINANTS

In general, the number of internal parasites in sheep and goats will increase with number of host animals (higher stocking rate); during warm, humid weather; and when pastures are grazed too short. The number of internal parasites will decrease in hot, dry weather; if a non-host animal (cattle or horses) grazes the same pasture; or if the pasture has been rested (no grazing, larvae die off naturally).

Some worms in a population will survive even the most appropriate drug treatments. This is due to genetic selection for resistant worms in a treated population. Modern dewormers are effective, broad in spectrum, cheap, and safe but people have relied more on drugs than on husbandry as a way to control parasites, leading to increased parasite resistance. To minimize development of parasite resistance to dewormers, use treatments specifically and selectively.

Clinical signs of parasitism in sheep and goats include diarrhea, bottle jaw (submandibular edema secondary to hypoproteinemia), anemia, and rough hair coat. Subclinical effects of parasitism include reduced weaning weight, reduced milk production, reduced reproductive performance, reduced growth rate, and increased susceptibility to disease.

"Treating internal parasites correctly", *https://www.scops.org.uk/internal-parasites/treating-correctly/*

Treatment of sheep often includes drenching. The veterinarian should perform diagnostics to determine type of parasite(s) present. You may wish to perform a fecal egg count before and after treatment (fecal egg count reduction test) to determine how effective your treatment was. Weigh the sheep and prepare the dewormer based on weight. Deliver the dewormer over the tongue in the back of the throat with a drench tip or drench gun.

To determine who needs to be dewormed, veterinarians can do a fecal egg count (FEC) to measure number of worm eggs per gram of feces (epg). General class of parasites is identified (for example, strongyle-type) but the specific parasite rarely is identified (it is difficult to differentiate between *Haemonchus*, *Teladorsagia* (formerly *Ostertagia*), and *Trichostrongyles*). One recommendation for goats is to deworm bucks and dry (non-lactating) does if there are more than 2000 epg, lactating does if there are more than 750 epg, and all other animals if there are more than 1000 epg. Not all of the animals in the herd will be carrying parasites to the same extent and schemes exist that permit veterinarians to assess the animal clinically and from that, determine which individuals in the herd should be dewormed. This prevents treating animals unnecessarily, which is better for their health and less expensive for the owner, and helps prevent development of resistant parasites by minimizing use of deworming medications.

Not treating all animals also means you're leaving a certain number of untreated worms in the population; because these worms have not been exposed to dewormer, you're allowing them to persist and maintaining a more genetically diverse worm population. This population of untreated worms (called refugia) can be a valuable thing to consider when facing problems with anthelmintic resistance.

FAMACHA© is a diagnostic test to help small ruminant producers identify animals that require anthelmintic treatment and those that do not require deworming. The tool is a card that matches eyelid color to anemia levels, an indicator of clinical infection with parasites that cause anemia. A good resource about FAMACHA testing and general information about parasite control in small ruminants is the American Consortium for Small Ruminant Parasite Control.

As in cattle, pasture management is another important component of parasite control. To stop the parasite life cycle, remove sheep and goats from pastures for 3-6 months to allow worm larvae in the pasture to die off. Alternate or co-graze pastures with horses or adult cattle. Maintain stocking rates of no more than 6-8 sheep or goats per acre.

General considerations for parasite control include:

- Do not overgraze pastures; the vast majority of infective nematode larvae are on the first 2” of vegetation for a given plant.
- Spread manure in hot, dry conditions to kill worm eggs and larvae that may be in the feces.
- Rotate crops and livestock.
- Ensure a high plane of nutrition for ewes/does and lambs/kids.
- Use body condition score and other clinical signs to monitor flock health.

SWINE

Management and housing techniques used in modern commercial pig production, as well as the prudent use of anti-parasitic products, has dramatically reduced, and in many cases, eliminated the disease and animal welfare issues associated with parasite infections in pigs. Although parasites are no longer a significant challenge to the majority of pigs being produced in North America, they continue to play a role in some types of pig production, primarily in those animals exposed to outdoor environments. Therefore, a solid understanding of their types and prevention are important.

Internal Parasites

Categories of internal parasites include nematodes (roundworms), thorny-headed worms, tapeworms, and protozoa. *Ascarus suum* (a nematode or roundworm) and coccidia (a protozoan) are the most common internal parasites in commercial pig production at this time.

External Parasites

Categories of external parasites include ticks, mites, lice, mosquitoes, and flies. Mosquitoes and flies continue to be common challenges in both indoor and outdoor pig production while ticks, mites, and lice are primarily limited to pigs that are raised outdoors. Mosquitoes and biting flies are known to mechanically spread important diseases between groups and premises.

Prevention of Parasite Infections

Key factors to consider for the prevention of both internal and external parasite infections include:

- Source negative pigs
    - Knowledge of negative parasite status of replacement breeding stock prior to

    - purchase and the prevention of moving positive stock into negative herds

- Minimize dose or eliminate exposure completely
    - Indoor production eliminates access to normal source of infection
    - All in-all out production: regular emptying of facilities between production groups
    - Sanitation: regular cleaning of facilities using appropriate detergent and disinfectant between production groups
    - Eliminate areas where external parasites can breed and develop (e.g. elimination of standing water reservoirs decreases mosquito levels)
- Monitoring program to insure early identification
    - A good monitoring program allows the early detection of a parasite challenge and the early application of intervention strategies.
    - This may include a routine fecal sampling program, observation of clinical signs, and gross signs on routine post mortems or slaughter checks.
- Therapeutic prevention programs

- Strategic preventive therapy programs are commonly used to treat parasite infections so that the challenge to the individual and challenge to herd mates (via shedding) is minimized.

A pork producer calls and wants to know if he has to worry about parasites since he runs a complete confinement, all-in/all-out facility. What are your recommendations to this producer?

HORSES

The internal parasites of greatest importance among North American horses are small strongyles (cyathostomes), large strongyles, ascarids (roundworms), tapeworms, and bots. Strongyles and ascarids are transmitted via a direct fecal-oral route, tapeworms have a more indirect fecal-oral transmission pattern involving the orbatid mite as intermediate host, and bots are transmitted when horses ingest fly eggs deposited on the hairs of their front legs. Small strongyles, ascarids (in young horses under 2 years of age), and tapeworms are the main focus of an equine parasite control program, as they have the greatest potential to cause disease. Bots rarely cause disease and are generally well controlled as a side benefit of the control program used to control strongyles and ascarids.

Ascarids (*Parascaris equorum*) are a significant health risk for foals, weanlings, and yearlings, but not for adult horses due to development of age-related immunity. Adult horses within a given herd can vary greatly in their susceptibility to parasite infestation, especially with respect to small strongyles. A small percentage of horses in the herd tend to harbor the majority of worms, and these horses are targeted for more frequent deworming.

Factors contributing to gastrointestinal parasitism in the horse are similar to those in other species: animal age; stocking density; geography and climate; presence and abundance of intermediate hosts; whether the animals are on pasture or dry lot; and pasture/paddock management practices.

Light parasite burdens are not associated with clinical disease, but heavy burdens can result in disease and death. Clinical signs of heavy parasitism include weight loss, stunted growth in juvenile horses, anemia and hypoproteinemia, colic (abdominal pain), acute or chronic diarrhea, and pulmonary injury. Young horses and immunodeficient geriatric horses are most susceptible to heavy parasite burdens and disease, but all horses are susceptible under the right conditions and in the absence of an effective parasite control program.

The goals of an equine parasite control program are to:

- Minimize the risk of parasite-related disease.
- Limit the extent of parasite shedding into the environment.
- Preserve the effectiveness of anti-parasitic medications.

As with vaccination programs, there is no such thing as a “one-size-fits-all” parasite control program that is appropriate for use in all horses!

Anti-Parasitic Medications

Over the past 30 years, widespread frequent use of over-the-counter oral anthelmintic products has resulted in excellent control of parasite-related disease across the population, but also accelerated the development of drug resistance among parasites. It was not uncommon to see that every horse on a farm was getting dewormed every 8 weeks, and often more frequently than that! In other words, too rigorous and indiscriminate an approach was taken. Resistance issues are of great concern because there are no new parasite control products in the drug production pipeline.

Current recommendations strive to avoid development of further resistance problems while still providing adequate protection from parasite-related disease. Compared to historical approaches, we now recommend a more strategic and targeted approach that results in much less frequent deworming for the majority of horses.

Horses are dewormed using over-the-counter commercial oral paste products that are dosed on the basis of body weight. Available medications include the macrocyclic lactones (ivermectin and moxidectin), pyrantel pamoate and tartrate, benzimidazoles (fenbendazole and oxibendazole), and praziquantel (available only in combination with ivermectin or moxidectin). To date, most parasite resistance is related to the benzimidazole and pyrantel products, but some resistance to the avermectins has also begun to appear recently. The parasite species most likely to exhibit resistance are small strongyles and ascarids.

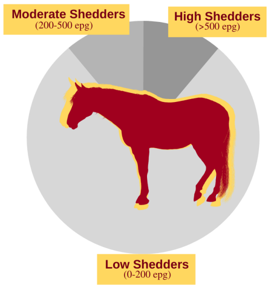
A variety of herbal and organic deworming products are available and widely promoted among horse owners and managers, but there is no scientific evidence that these products are effective. They have not undergone formal testing for safety and efficacy, and are not approved or licensed as drugs by the FDA. Because non-drug products are allowed much more leniency in labeling, manufacturers can make almost any claim they want without having to substantiate that claim.

Design of Parasite Control Programs

In adult horses, decision-making about which horses to deworm, and with what products, is guided by serial quantitative fecal egg count (FEC) surveillance. Determination of the number of strongyle eggs per gram (epg) of manure helps owners and veterinarians to (i) estimate individual parasite burdens; (ii) identify the horses with moderate or heavy parasite burdens that will benefit from deworming; (iii) identify the specific horses within the herd that serve as the major long-term parasite reservoirs and require more frequent deworming; and (iv) determine which specific deworming products are effective against parasites on that farm.

On the basis of FEC, horses are categorized as low shedders (0-200 epg), moderate shedders (200-500 epg), or high shedders (> 500 epg). In a well managed herd it is common for 70-90% of adult horses to fall in the low-shedding category; these horses require as few as 2 deworming treatments per year (spring and fall). Management of moderate shedders varies by region, but these horses typically require at least one additional deworming treatment during the parasite transmission season. In Minnesota, for example, these horses generally receive one additional treatment for strongyles between April and October, with the timing dictated by the egg reappearance period (ERP) for the dewormer used in spring. Heavy shedders require treatment throughout the spring/summer parasite season, though never any earlier than the expected ERP for the deworming products used.

Fecal egg count reduction tests (FECRT) are used to evaluate the efficacy of specific deworming agents against both strongyles and ascarids. This entails running FEC tests immediately prior to worming and then 14 days after worming, and then calculating the percent reduction in fecal egg counts due to treatment. Specific cut-offs for suspicion of resistance vary between medications and parasites, but in general a dewormer should be dropping egg counts by 90-95% or more if the parasite is susceptible to its killing effects.



Under this type of program, adult horses with innate resistance to parasitism that carry low worm burdens are dewormed only 1-2 times per year. This ensures that many of the worms in the population are able to avoid the frequent exposure to deworming medications that selects for development of drug resistance. By contrast, horses with high worm burdens that are at greater risk for disease and contribute most to environmental contamination are selected for more frequent dosing. This applies some selection pressure for development of resistance, but is counterbalanced by the larger population of worms that remain genetically susceptible (refugia). The higher the proportion of worms in refugia, the more slowly resistance develops!

Foals, weanlings, and yearlings are approached differently due to their high level of susceptibility to parasitism in general, and ascarids in particular. Current recommendations are to treat them a minimum of 4 times in the first year of life, with the first treatment at 2-3 months of age using a benzimidazole (for example, fenbendazole). A second deworming is recommended just prior to weaning at approximately 6 months of age, prior to which an FEC is performed to determine whether worm burdens consist primarily of ascarids or of strongyles. The third and fourth treatments are administered at approximately 9 and 12 months of age, and should target primarily strongyles. One of those treatments should also include praziquantel to address tapeworms. Recently dewormed weanlings should be turned out into the cleanest pastures with the lowest worm/egg burdens.

Fecal egg counts are *not* useful for diagnosis of tapeworm or bot infestation, so most horses are simply treated annually for these in late fall on the assumption that a significant infestation exists. Praziquantel is the only medication licensed for treatment of tapeworms, while bots are treated with ivermectin or moxidectin. Timing this treatment for late in the fall serves to "clear out" the existing population of bots and tapeworms at a time when immediate reinfection is not possible because the flies and mites responsible for transmission are no longer active. Horses will begin to re-accumulate those parasites the following spring when flies and mites appear to resume transmission.

Environmental Management

As in other species, periodic administration of anthelmintic drugs is only one element of an effective control program and environmental sanitation and management are also important. The most effective approach is removal of manure from paddocks and pastures; twice-weekly manure collection is recommended. Dragging or harrowing paddocks and pastures to break up manure pats is much less effective, and only recommended for geographic regions in which spread manure will dry rapidly. Composting of manure and soiled bedding generates enough heat to kill parasite larvae and eggs. Non-composted manure should never be spread on pastures as this will serve to increase the level of parasite contamination. Reducing animal numbers, reducing stocking density, and avoiding overgrazing will reduce parasite exposure, as will rotating pastures and grazing other types of livestock on rested pastures. New horses should have an FEC on arrival, and be dewormed if warranted, before being turned out with resident horses.

SMALL ANIMALS

This is an excerpt from a book for pet owners (Root Kustritz MV (ed), The University of Minnesota Guide to Dog and Cat Wellness, ASIN: B00GCC0YN8).

Most puppies and kittens are born carrying some internal parasites, even if they are born into excellent breeding facilities. Your veterinarian can check the puppy or kitten's feces for evidence of the parasites, but many infected puppies and kittens will test negative. Your veterinarian may recommend routine worming for your puppy or kitten several times when they are young, to ensure they are not carrying internal parasites. Adult dogs also may carry these parasites. If worm eggs in the feces hatch outside, the young worms may live in your lawn and infect humans, especially children, and other animals. Because of this, all feces should be picked up and disposed of immediately.

Intestinal parasites are treated with specific anti-parasitic drugs. *Note from Dr. Root for Preventive Medicine course – classes of wormers commonly used are those described for beef cattle (benzimidazoles and macrocyclic lactones) with some specific wormers for other classes used for things like tapeworms. Each type of worm is treated with a specific drug so it is important that the specific type of parasite present in your animal is identified. Over-the-counter wormers generally are not as effective as those available from your veterinarian. Some medications must be dosed more than once to destroy both juvenile and adult worms.

Heartworm is a form of internal parasite that infests the circulatory system. Young worms are injected by infected mosquitoes into the dog or cat. These young worms eventually lodge in the heart as adults where they mate and produce young worms that circulate in your dog or cat, infecting mosquitoes that feed on other animals and continuing the life cycle. Your dog or cat can contract heartworm anywhere they encounter mosquitoes, including indoors. The adult heartworms cause severe and potentially fatal damage to the heart, lungs, and other vital organs. Clinical signs of heartworm disease include coughing, fatigue, loss of appetite, and possibly episodes of fainting. Many infected dogs and cats show no signs of disease. Your veterinarian will test your dog yearly for this disorder;

cats should be tested as well. Treatment is difficult so prevention is preferred. There is no treatment available for cats, so prevention is critical. Fortunately, cats are more resistant to heartworm disease than are dogs, so incidence of heartworm disease is lower in cats than in dogs. Your dog should be tested yearly and preventative medications given monthly. Heartworm prevention can be instituted in puppies as early as 6-8 weeks of age. Be aware that many heartworm medications also protect your pet against intestinal parasites described earlier.

Regarding heartworm in dogs, which is preferred, prevention or treatment? Explain your answer and describe the basic protocol for your choice.

Common Intestinal Parasites of Dogs and Cats

COMMON NAME	APPEARANCE	CLINICAL SIGNS	HOW TRANSMITTED
Roundworms	3-12″ long, spaghetti-like	Usually do not cause clinical signs; may see worms passed in feces, young animals may show poor weight gain. Most common in dogs and cats less than 6 months of age.	Eggs in feces, across the placenta or while nursing from the dam
Hookworms	Very small, thread-like	May see anemia, digested or frank blood in feces.	Eggs or young worms in feces, on the ground, nursing from the dam, penetration of larvae through skin

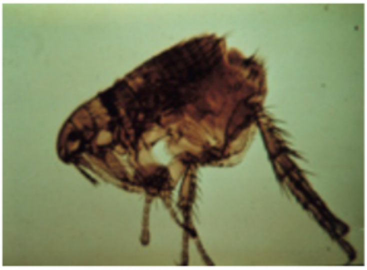
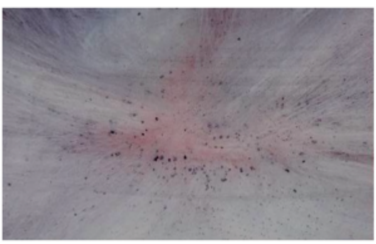
Whipworms	Very small, thread-like	Usually do not cause clinical signs; may occasionally be associated with diarrhea.	Eggs in feces, on the ground
Tapeworms	Very long and flat, made up of segments that look like grains of rice caught in the hair around the anus	May cause weight loss.	Eating rabbits, rodents, or eating fleas containing the worm.

External parasites of most concern are ticks and fleas. Fleas feed on blood and can transmit disease, including tapeworms. Fleas are primarily an environmental concern; 95% of the flea population (eggs, larvae and pupae) live in the environment and only 5% (adult) live on animals. Outside areas exposed to sunlight in summer or extreme cold in winter are unlikely to harbor fleas. Inside the home, flea populations will be concentrated where the animal spends the most time resting or sleeping. Fleas are the most common external parasite in small animals; cats are twice as likely as dogs to have fleas when examined by veterinarians. Successful flea control requires treatment of the animal and the environment. There are excellent flea control products available. Not all are safe for use in puppies and kittens.

Ticks can transmit disease to dogs including Lyme disease, anaplasmosis, ehrlichiosis, and Rocky Mountain Spotted Fever. Safe and effective tick products are available but there is no tick preventative that is 100% effective; dogs and outside cats should be checked and ticks removed by hand at least once daily in the warmer months.

Describe tick control for dogs and explain why it is optimal for dog health to minimize tick bites.

Fleas and Ticks in Small Animals

 *Flea (Ctenocephalides canis) enlarged, (photo courtesy of Drs. Sheila Torres and Laura Molgaard)*	 *Flea near actual size, (photo courtesy of Dr. Sheila Torres)*
 *Flea dirt on the skin at the base of the hairs (photo courtesy of Dr. Sheila Torres)*	 *Common dog tick (wood tick; Dermacentor variabilis) enlarged, (photo courtesy of Dr. Bert Stromberg)*
 *Deer tick (Ixodes scapularis) enlarged, (photo courtesy of Dr. Bert Stromberg)*	

List your five (5) take-home points – What are things you want to remember from this chapter as you progress through the curriculum and into your career?

EXTRA RESOURCES

- Flea products: https://todaysveterinarypractice.com/practical-parasitologythe-flea-infested-pet-overview-current-products/
- Managing fleas on the pet and in the environment: https://todaysveterinarypractice.com/practical-parasitologythe-flea-infested-pethow-manage-pet-environment/
- Fly control products and approvals: http://entomology.unl.edu/livestock
- Applicability of the Antiparasitic Resistance Management Strategy (ARMS) to cattle: https://www.fda.gov/animal-veterinary/safety-health/antiparasitic-resistance
- American Consortium for Small Ruminant

Parasite Control: www.acsrpc.org

- Internal parasite categories in swine: https://thepigsite.com/disease-guide/endoparasites-internal-parasites-worms-nematodes
- External parasite categories in swine: https://thepigsite.com/disease-guide/ectoparasites
- Fleas in small animals: https://www.banfield.com/state-of-pet-health/skin-allergies/overview

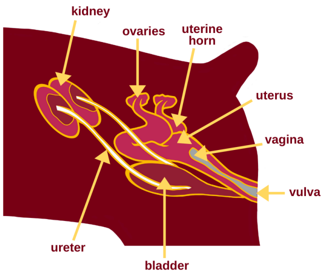
6.

Reproduction Control

Learning Objectives

- Describe basics of normal reproductive physiology in the male and female dog and cat
- Explain the difference between contraception and sterilization and describe medical and surgical techniques for each
- Describe social, behavioral, and medical pros and cons for gonadectomy in male and female dogs and cats

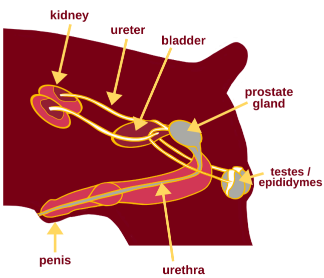
REPRODUCTIVE PHYSIOLOGY OF THE FEMALE



The ovaries contain thousands of follicles, each of which contains an egg or ovum. As each estrous cycle begins, a cohort of follicles is selected to begin development. Development is promoted by release of hormones from the hypothalamus (gonadotropin releasing hormone [GnRH]) and pituitary (follicle stimulating hormone [FSH] and luteinizing hormone [LH]). As the follicle develops, it secretes estrogen, which causes the physical and behavioral signs of early heat, or proestrus. Estrogen concentrations fall about 9 days after the onset of proestrus; at this time, the bitch will stand to be bred (standing heat or estrus) and a surge of LH is released, causing ovulation. This is spontaneous ovulation. Queens are induced ovulators. In this species, copulation is the most common trigger for release of GnRH and subsequent ovulation. In either spontaneous or induced ovulators, the eggs are released from the follicles into the uterine tube, where fertilization occurs.

The egg is surrounded by a thick capsule, the zona pellucida, and by a layer of cells from the follicle. Spermatozoa introduced into the reproductive tract of the bitch undergo capacitation, a process involving the acrosome reaction on the head of the spermatozoon and achievement of hypermotility. Capacitated spermatozoa digest the layer of cells surrounding the egg and invade the zona pellucida. As soon as one spermatozoon gets to the inner layer of the zona pellucida, entry of other spermatozoa is blocked by an electrochemical reaction so only one spermatozoon fertilizes each egg. Cell division begins immediately. The developing embryos move into the uterus within days but do not implant in the uterine wall and develop placentas until about 12 days after the LH surge in cats and about 16-18 days after the LH surge in dogs.

REPRODUCTIVE PHYSIOLOGY OF THE MALE



Testes of male dogs should be descended into the scrotum by 8-14 weeks of age and must be descended by 6 months of age for the dog to be considered normal. Testes usually are descended at birth in male cats but may not be palpable until 6-8 weeks of age. The testes contain spermatogonia, which will divide to form spermatozoa under the influence of the hormone testosterone. Testosterone secretion from testicular Leydig (interstitial) cells is stimulated by GnRH and LH release from the hypothalamus and pituitary, respectively.

Spermatozoa are manufactured in the testis but are neither motile nor capable of fertilization until after they pass through the adjoining tissue, the epididymis. Spermatozoa ejaculated at the time of semen collection come from the epididymis.

REPRODUCTION CONTROL

Contraception

Any procedure that prevents reproduction for a time but is reversible such that the individual may be capable of reproduction in the future.

Sterilization

Any procedure that makes an individual permanently incapable of reproduction.

Research into non-surgical methods for sterilization of dogs and cats is ongoing and no products are available at this time.

Surgical Sterilization

Ovariectomy (surgical removal of the ovaries), hysterectomy (surgical removal of the uterus, also called ‘ovary-sparing spay’), ovariohysterectomy (surgical removal of the ovaries and uterus) and tubal ligation (tying off the uterine tubes) are the techniques described in the literature for sterilization of bitches and queens. Tubal ligation is not commonly used for contraception of bitches or queens anywhere in the world.

Ovariectomy is commonly used in Europe and appears to offer the same benefits and concerns as does ovariohysterectomy (OHE or spay). Ovariectomy is reported to be less time-consuming and less invasive then OHE. In one study of 264 dogs, 126 of which had undergone ovariectomy and 138 of which had undergone OHE, no significant differences were reported in incidence of urogenital problems during a follow-up period of 8-11 years after surgery. Urinary incontinence was a reported finding in both groups; difference in incidence between the groups was not statistically significant. Ovary-sparing spay requires complete removal of the uterus to the level of the cervix and is not quicker or less-invasive than OHE. In the United States, OHE still is the most common surgical sterilization method.

In male dogs and cats, castration (surgical removal of both testes) and vasectomy (tying off the spermatic cord) are reported sterilization techniques. Castration is the most common surgical sterilization method.

Optimal Age for Surgical Sterilization of Dogs and Cats

Optimal age at which to perform OHE or castration of dogs and cats is not defined by the veterinary literature. In the United States, most veterinarians recommend cats and dogs be spayed or neutered when about 6 months of age, prior to puberty, which is defined as acquisition of normal breeding behavior and semen quality in males and first estrus in females. In other countries, veterinarians recommend that dogs and cats be spayed after their first estrus, or do not recommend elective surgical sterilization be performed at any age. Indeed, in some countries, elective gonadectomy is considered unethical and is either strongly discouraged or illegal. For this discussion, it is assumed that the veterinarian is comfortable with the ethics of elective gonadectomy and practices in a country in which such surgery is considered acceptable by professional associations and the society at large.

Dogs and cats can be considered as part of a larger population of animals or as individuals. Recommendation for age at which to perform elective gonadectomy must take this into account. Animals at humane organizations should be evaluated as part of the larger population as those animals are not yet associated with a responsible owner or guardian. Dogs and cats with an owner or guardian may be considered either as part of a larger population or as an individual.

Sterilization of Dogs and Cats With No Owner or Guardian

In the United States, a serious problem with pet overpopulation exists, such that millions of unowned dogs and cats are euthanized yearly. Some of these are feral animals, some are abandoned and brought to the humane association as a stray, and many are relinquished. Intact animals are much more likely to be relinquished than are spayed or neutered animals and animals that are adopted out from the humane association while still intact may either be returned or may repopulate that shelter with their offspring. While most intact animals are adopted out with a spay-neuter contract, compliance with such contracts has been demonstrated to be less than 60%. There is a significant lack of knowledge among pet owners regarding normal reproductive physiology among dog and cats owners; studies have demonstrated that up to 57% of bitch owners were unaware that bitches cycle at least twice yearly, up to 83% of queen owners were unaware that queens are polyestrous from spring to early fall, and up to 61% of dog and cat owners were unsure or believed that their animal would somehow be “better” after having had at least one litter. In one survey of dog- and cat-owning households, 56% of 154 canine litters and 68% of 317 feline litters were unplanned, with the majority of those owners reporting that they did not know the female had been in heat. While everyone would like to believe that better education of pet owners would lead to more responsible pet ownership, and while increasing education is a worthy goal that should be pursued, gonadectomy of dogs and cats prior to adoption is one weapon in the fight against overpopulation that should be employed at this time. Multiple studies have been published demonstrating safety of gonadectomy in puppies and kittens as young as 7 weeks of age. To that end, I recommend that all male and female dogs and cats should be spayed or castrated prior to adoption from humane organizations.

Sterilization of Dogs and Cats With an Owner or Guardian

Pros and cons of spay/castration can include behavioral and medical concerns. Here are some definitions you may find useful:

Incidence = the number of new cases in a population over a period of time

Morbidity = extent of illness among those having the condition

Mortality = death due to the condition

- **Male Cats –** The normal behavior of most intact male cats is incompatible with their living as

house pets. Breeding behavior in cats is aggressive and intact male cats show that behavior readily. Urine from intact male cats is used for territorial marking and has a very distinct, strong odor. Incidence of obesity after castration is high, and is due to decreased metabolic rate in cats after gonadectomy. There are virtually no other health conditions reported to be increased or decreased in association with gonadectomy in male cats. Because of this, I recommend that any male cat not intended for breeding be castrated.

- **Female Cats –** Benefits of OHE in female cats include decreased incidence of mammary neoplasia, ovarian or uterine tumors, and pyometra. Of these, the most significant is mammary neoplasia. Mammary neoplasia is the third most common tumor of female cats, with a reported incidence of 2.5%. Incidence is increased with number of estrous cycles in the cat's life and is increased in the Siamese and domestic Japanese breeds. Greater than 90% of cases are malignant adenocarcinoma.

Detriments of OHE in female cats include possible complications of surgery, obesity, increased incidence of feline lower urinary tract disease (FLUTD), and increased incidence of diabetes mellitus. Reported incidence of post-surgical complications in cats is 2.6%, with most reported complications mild and self-resolving. Incidence of obesity after OHE is high, and is due to decreased metabolic rate in cats after gonadectomy. Obesity can be controlled by use of a proper feeding regimen. Finally, increased incidence of FLUTD and diabetes mellitus has been reported after OHE in queens, with the Burmese breed especially prone to development of diabetes mellitus. Incidence of these two conditions is 0.6% and 0.5%, respectively.

Because the incidence and morbidity of mammary neoplasia are much higher than are the incidences of FLUTD and diabetes mellitus, and because morbidity associated with obesity can be controlled by the owner or guardian of the cat, I believe that female cats not intended for breeding should be spayed as early in their life as possible.

- **Male Dogs –** Benefits of castration in male dogs include decreased incidence of testicular neoplasia and non-neoplastic prostate disease, and possible increased lifespan. Testicular neoplasia is a common tumor of aged, intact male dogs, with a reported incidence of 0.9%. Morbidity generally is low. Benign prostatic hypertrophy (BPH) is a very common disorder of male dogs, with reported incidence of 75-80% in dogs aged 6 years or more. Again, morbidity generally is low. Finally, several studies have documented increased lifespan in castrated male dogs compared to intact males. This may be due to greater care by owners after the "investment" of surgery has been made in that animal, or may be due to a decrease in sexually dimorphic behaviors that put the animal at increased risk, such as roaming.

Detriments of castration in male dogs include complications of surgery; increased incidence of prostatic neoplasia, transitional cell carcinoma, osteosarcoma, lymphosarcoma, and hemangiosarcoma; increased incidence of anterior cruciate ligament (ACL) injury and hip dysplasia; obesity; and possible increased incidence of diabetes mellitus.

Some reports also suggests increased incidence of behavioral disorders, such as fear of storms. Reported incidence of post-surgical complications in dogs is 6.1%, with most reported complications mild and self-resolving. Prostatic neoplasia, transitional cell carcinoma, osteosarcoma, and hemangiosarcoma generally are low in incidence but high in morbidity and mortality. No breed predisposition has been identified for prostatic neoplasia, but does exist for the other cancers noted. Incidence of ACL injury in dogs is relatively high, at 1.8%, and morbidity may be high, although this is generally considered to be a curable condition with surgery. Again, some breeds, most notably large and giant breeds, are predisposed to ACL injury. Obesity is high in incidence but morbidity can be controlled by the owner or guardian.

Appropriate recommendation for castration of male dogs is less readily evident than is that for male cats. While a given male dog can produce many more offspring than can a given bitch, suggesting that castration is necessary for population control, the significant morbidity associated with castration as a possible predisposing cause of the conditions described above suggests that castration is not recommended when considering the animal as an individual. I believe this recommendation must be made on a case-by-case basis, evaluating the breed of the dog, his intended working life or activity level, and the owner’s wishes regarding use of that animal for breeding. Many owners choose castration for male dogs to control normal male reproductive behaviors that we have deemed to be inappropriate, such as mounting.

- **Female Dogs –** Benefits of OHE in bitches include decreased incidence of mammary neoplasia, with greatest benefit if spayed before the first heat; decreased incidence of ovarian or uterine neoplasia and pyometra; and possible increased lifespan. Mammary neoplasia is the most common tumor of female dogs,with reported incidence of 3.4%. It is the most common malignant tumor in female dogs, with 50.9% of mammary tumors reported to be ma

lignant; metastases are found in about 75% of cases of mammary carcinoma with the lung the most common site of metastasis. Exact cause-and-effect relationship has not been defined, although a hormonal basis for malignant transformation of mammary cells and progression of neoplasia is hypothesized based on the decreasing benefit of OHE with increasing number of estrous cycles in the dog's life prior to surgery. The other very common disorder in female dogs when aged is pyometra, reported to occur in 15.2% of dogs by 4 years of age and in 23-24% of dogs by 10 years of age. Morbidity is high, although OHE at the time of clinical presentation is curative; reported mortality ranges from 0-17% in dogs.

Detriments of OHE in female dogs include complications of surgery; increased incidence of transitional cell carcinoma, osteosarcoma, lymphosarcoma, cutaneous mast cell tumors, and hemangiosarcoma; increased incidence of ACL injury and hip dysplasia; obesity and diabetes mellitus; a possible increase in aggression in at least one breed and reactivity in one breed; and increased incidence of urethral sphincter mechanism incompetence (estrogen-responsive urinary incontinence). Reported incidence of post-surgical complications in dogs is 6.1%, with most reported complications mild and self-resolving. As in male dogs, incidence of tumors reportedly associated with gonadectomy is low but morbidity with these tumor types is high. Breed predispositions exist for many tumor types. Incidence of obesity is high after OHE but morbidity can be controlled by the owner. Incidence of ACL injury in dogs is relatively high, at 1.8%, and morbidity may be high, although this is generally considered to be a curable condition with surgery. Again, some breeds, most notably large and giant breeds, are predisposed to ACL injury. Aggression after OHE has been reported in English Springer Spaniels; there is some suggestion that this effect may be more likely in bitches that demonstrated aggressive tendencies prior to surgery. Urethral sphincter mechanism incompetence is a problem of spayed female dogs, especially those weighing more than 20 kg. Morbidity is low and this is a disease easily controlled with medical therapy in most female dogs. Evidence exists suggesting incidence can be decreased by spaying bitches when greater than 3-5 months of age.

Appropriate recommendation for OHE of female dogs is less readily evident than is that for female cats. Certainly mammary neoplasia and pyometra are of high incidence and high morbidity, and are greatly decreased in incidence by OHE. However, possible predisposition to very high morbidity tumor types or ACL injury must be evaluated. As with male dogs, I believe this recommendation must be made on a case-by-case basis, evaluating the breed of the dog, her intended working life or activity level, and the owner's wishes regarding use of that animal for breeding.

Much information and misinformation about this topic is available to the owners, guardians, and breeders of dogs and cats. It behooves us, as veterinarians, to be familiar with the current veterinary literature and to base our recommendations on science, rather than on anecdote or tradition.

Benefits and Detriments of Spay / Castration Surgery in Dogs and Cats

Bold indicates high incidence, *Italic* indicates high morbidity or mortality

	MALE CAT	FEMALE CAT	MA
Undesirable physical or behavioral manifestations of reproduction			
Ovarian / ***Uterine disease (pyometra)***			
Mammary cancer			
Benign prostatic hypertrophy			
Testicular cancer			

Risks of anesthesia / surgery				
Bone cancer				
Genitourinary cancer				
Anterior cruciate ligament injury				
Urinary incontinence				

Obesity	↑	↑	↑

For male and female dogs and cats, describe (don't just list), the pros and cons of ovariohysterectomy or castration, including overpopulation and medical concerns.

Non-Surgical Reproductive Control

What about non-surgical sterilants? Are there contraceptives available for dogs that would control reproduction without completely removing the possibility of fertility in that animal later in life?

Pharmacologic Reproductive Control

Drug therapy affects normal hormone secretion, decreasing estrous cycling. Examples include:

- **Progesterone –** Megestrol acetate (Ovaban™). This is the only drug that was ever FDA-approved for estrus suppression for breeding dogs in the United States. It is not available as a veterinary product but can be dispensed through human pharmacies. Ovaban can be given either during anestrus (0.25 mg/lb once daily per os x 30 days) to prolong time until the next proestrus begins, or within the first 3 days of proestrus (1.0 mg/lb once daily per os x 8 days) at which point the bitch will go out of heat in 5-6 days and will not ovulate at that cycle. If used properly, megestrol acetate should not cause uterine disease or impact fertility in bitches. Possible side-effects of treatment with any form of progesterone in dogs include weight gain, predisposition to mammary neoplasia and uterine disease, and induction of diabetes mellitus. These same side-effects are seen in queens with administration of progesterone, as is mammary hypertrophy. Current research describes use of progesterone within silastic implants, reported to suppress estrus for up to 2 years in bitches with no side-effects.
- **Androgens –** The only androgen that was FDA-

approved for use in female dogs (Cheque™) was never approved for use in breeding animals and is no longer available from the manufacturer. The active ingredient, mibolerone, is available through compounding pharmacies. Other androgens described for estrus suppression are forms of testosterone, which are effective in a dose-dependent manner and have been reported to be only 66% effective at suppressing estrus in Beagle bitches. Possible side-effects include vaginitis, hypertrophy of the clitoris, and liver disease. Androgens cannot safely be used for estrus suppression in queens, in which they are hepatotoxic and thyrotoxic.

- **GnRH agonists –** These drugs mimic the action of GnRH, causing release of FSH and LH. Initially this will cause estrus but continued treatment with the drug will shut down the system, with no further estrous cycling. These drugs have been demonstrated to prevent estrus in bitches for up to 27 months and have not been associated with decreased fertility. Similarly, in males initially administration of these drugs will cause increased release of LH and testosterone but will eventually shut down the system, decreasing testosterone secretion and spermatogenesis. GnRH agonists have been demonstrated to suppress fertility for up to 27 months in dogs with subsequent return to normal fertility. These drugs are not approved for use in dogs or cats in the United States. In queens, GnRH can be used to induce ovulation (GnRH; 25 mcg/cat IM). Luteinized follicles will be maintained an average of 40 to 50 days, giving the owner a respite from estrous cycling in the queen. Ovulation induction by physical means also has been described but in the author's experience is less effective than is pharmacologic induction of ovulation.

- **Estrogen –** Estrogen compounds can be used to induce azoospermia (lack of spermatozoa in the ejaculate) in dogs. However, toxic effects of estrogen include induction of squamous metaplasia in the prostate and pancytopenia. I do not recommend the use of estrogens in male dogs.

Immunologic Reproductive Control

Immunologic approaches to contraception work by vaccinating the animal against one of the tissues or hormones described above. When an animal is vaccinated against a tissue, for example, it will create antibodies against that tissue that will either destroy the tissue or prevent its normal function. There is no commercially available contraceptive vaccine for dogs or cats at this time. Compounds that are being investigated include:

- **Zona pellucida –** Vaccinated bitches and queens may or may not continue to cycle and time until re-vaccination is required varies much between individuals. This technique may or may not be reversible; ovarian pathology described after immunization of bitches against porcine zona pellucida proteins include ovarian atrophy and polycystic disease.
- **GnRH –** This is a compound against which animals do not develop antibodies readily. Immune response in tested animals has been

> variable, however, this vaccine may be the best candidate for commercial availability in the near future.

The search for the elusive "spay vaccine" has been ongoing for decades. Recently, a concerted effort has been made to gather like-minded scientists and to ensure sharing of ideas and materials. These collaborative efforts by the Alliance for Contraception in Cats and Dogs and the Found Animals Foundation have served to increase the number of research studies performed in field of dog and cat contraception and sterilization. Current concepts under investigation include immunocontraception, targeted cytotoxins, and gene silencing. No such products are commercially available as of this writing. Products approved for use in other species show great promise in dogs and cats and it is hoped that some sort of injectable reproductive control agent will be available within the next 5-10 years.

Sclerosing Agents for Reproductive Control

Sclerosing agents are drugs or compounds that are injected into the testes or epididymes to cause localized inflammation and destroy or scar testicular or epididymal tissue, preventing formation and movement of spermatozoa. Testicular tissue does not regenerate so if that tissue and the spermatogonia within it are destroyed, sterility may be achieved. Many compounds have been investigated.

In 2002, the FDA approved one compound, Neutersol™, for use in puppies aged 3-10 months with testicular width between 10 and 27 mm. This compound was most recently available under the brand name Zeuterin™; as of this writing, no product is commercially available in the United States. The compound (zinc gluconate with arginine) is injected directly into each testis, with dose dependent on testicular width. Sedation may be required but most dogs are reported to tolerate the injection well. Immediate side-effects include transient swelling of the testes or scrotum, and vomiting. Zeuterin™ cannot be used in cryptorchid dogs and should not be used in dogs with scrotal irritation or malformation of the testes or epididymes. In a field study of 224 dogs treated with Neutersol™, 223 were considered to be completely sterilized by 6-12 months after injection, based on inability to collect normal semen from these males. Testosterone secretion was decreased but not to as great an extent as with castration. Studies are ongoing for evaluation of safety of the product, efficacy as a contraceptive or sterilant, and effect of decreased testosterone concentrations on prostate disease and on behavior.

What is the primary cell type within the testis that must be destroyed to ensure no more spermatozoa can be formed? What cell type within the testis must be destroyed to completely eradicate testosterone secretion?

Non-Surgical Sterilization Techniques Currently Under Investigation

	DEFINITION	EXAMPLE
Immunocontraception	Induction of humoral (antibody) and cellular immunity to destroy proteins or tissues specific to reproduction	“Vaccination” against zona pellucida (outer layer of ova) to prevent conception by inducing antibodies that block sperm-binding sites
Targeted Cytotoxins	Attachment of toxins to carriers that will bind to and destroy cells specific to reproductive function ; analogous to chemotherapy for cancer treatment	Exotoxin A from *Pseudomonas aeruginosa* bound to a ligand that binds to the receptor for FSH, selectively destroying cells that require FSH to function, such as granulosa cells lining ovarian follicles

Gene Silencing	Introduction of short strands of RNA that block transcription of homologous segments of DNA and effectively abolish expression of that gene	Use of interfering RNA to block production of kisspeptin in neurons, subsequently altering section of GnRH and FSH

List your five (5) take-home points – What are things you want to remember from this chapter as you progress through the curriculum and into your career?

EXTRA RESOURCES

- Non-Surgical Reproductive Control: Dr Bob Weedon – pdf presentation

- Alliance for Contraception in Cats and Dogs: (www.acc-d.org)
- Found Animals Foundation: (http://www.michelsonprizeandgrants.org/)

7.

Care of the Young

Learning Objectives

- Describe variability in need for colostrum by species
- Describe ways to maximize and assess colostrum quality
- List significant milestones in development for small animals and foals
- Discuss management of the dam and facilities to optimize health of newborns
- Describe common procedures performed in neonatal foals, calves, and piglets

COLOSTRUM NEED BY SPECIES

Specific actions may be taken to promote health in young animals. Amount of veterinary intervention varies by species. You will note that there are no notes for small animal; that is because there is little routine prenatal care provided and after giving birth, the bitch and queen care for their puppies and kittens with virtually no veterinary intervention associated with preventive healthcare. Notes for this course will review preventive healthcare in foals, calves, and piglets.

One overarching theme when discussing care of any young animal is the need for them to ingest colostrum. Colostrum is the primary route by which most young animals get maternal antibodies (passive transfer) to protect them from disease before they have a functional immune system. How much antibody transfer occurs is dependent on placentation in that species. Remember that there are six possible layers in placentas. Three are always present (fetal endothelium, fetal connective tissue, and fetal epithelium, also known as the chorion). The chorion abuts the uterine tissue of the dam, with varying degrees of penetration into that tissue. In an epitheliochorial placenta, the chorion abuts the dam's epithelium (6 layers). This is the type of placenta in cattle, horses, and pigs. In some species, cells from the chorion fuse with maternal epithelial cells, creating intermittent or continuous areas with 5 layers. This used to be called a syndesmochorial placenta. Now it is understood that this is a variant of the epitheliochorial placenta, sometimes called a synepitheliochorial placenta. This is seen in sheep and goats and may be seen in cattle. In an endotheliochorial placenta, the chorion abuts the dam's endothelium (4 layers). This is the type of placenta in dogs and cats. In a hemochorial placenta, the chorion is bathed in the dam's blood (3 layers). This is the type of placenta in primates and rodents. The big picture is that animals with thicker placentas have reduced access to maternal proteins through the placenta, including antibodies, and are therefore more prone to failure of passive transfer, making them dependent on colostrum to a larger extent than other species. Failure of passive transfer (lack of antibodies needed to protect newborn animals against infectious disease) can occur either because a newborn animal didn't get antibodies through the placenta while *in utero* or because they did not get colostrum, the antibody-rich first milk, immediately after birth.

CARE OF SMALL ANIMALS

Veterinarians do not provide routine veterinary care for puppies and kittens immediately after birth as they do in other species. The chart below provides you with information regarding normal developmental milestones in puppies and kittens. Extensive information about physical examination and common disorders of puppies and kittens is available in the resources folder for this module of the course.

Timing of Significant Events in Pediatric Development of Puppies and Kittens

EVENT	AGE AT OCCURRENCE
Umbilical cord dries and falls off	2 to 3 days
Eyelids open	5 to 14 days
External ear canals open	6 to 14 days
Extensor dominance	5 days
Capable of crawling	7 to 14 days
Capable of walking, urinating and defecating spontaneously	14 to 21 days
Hematocrit / RBC number stabilize near that of adult	8 weeks
Renal function nears that of adult	8 weeks
Hepatic function nears that of adult	4 to 5 months

CARE OF FOALS

The level of care and degree of intervention for any neonate will vary with the management type and philosophy, and to some extent with the value of the individual offspring. In this section we'll look at fairly typical care of neonatal foals. Good management of the foal starts prior to birth, with care of the dam integral to optimizing postnatal foal health, and continues with common management procedures and veterinary examination of the neonate.

Management of the Pregnant Mare to Optimize Foal Health

Maximizing Colostral Quality

Even though they become immunocompetent during gestation, while cocooned in the uterus foals are generally not exposed to environmental and common disease-causing pathogens that they will be exposed to after birth. Due to their type of placentation, antibodies from the mare are not transferred prior to birth so the foal is born agammaglobulinemic and naïve regarding protection against potential pathogens they will encounter once born. Their initial circulating antibodies are absorbed from the mare's colostrum so it is important that the antibody content of colostrum is high in quantity and quality – that is to say that it is directed against organisms the foal is likely to encounter. Two strategies are generally employed to ensure this:

1. If the mare is to be moved to a different farm for foaling (this often happens either to have her at a location with more supervision/experience in foaling mares or to have her at the farm where she will be re-bred for the next season), this

move should occur at least 4-6 weeks prior to birth. This allows the mare to be exposed to the local microflora and to make use of gut-associated lymphoid tissue (GALT) to push antibodies against local flora into colostrum and later to create IgA in milk for continued protection against invasion.

2. Vaccinate the mare 4-8 weeks prior to parturition to boost colostral antibodies.

This is a time to use vaccines that will give a systemic (IgG) response in the mare versus a local (IgA) response because we want the serum IgG available for transfer into the colostrum.

Typical vaccines used include those against:

- Tetanus
- Rabies
- Western and Eastern Equine Encephalitis (WEE/EEE)
- West Nile Virus
- Herpes Virus 1 and 4 – or just use EHV-1 and hope for cross-protection
- Influenza

Additional vaccines occasionally used depending on locale/farm conditions and likely pathogen exposure may include:

- Botulism
- Rotavirus

- *Streptococcus equi*

When giving large numbers of vaccines to a mare it is often considered good practice to give no more than four antigens at one time and to have a 2-4 week break before giving the next group, until the administration of all those desired has been completed. To accomplish this, the vaccines against diseases of lower risk and the vaccines resulting in the most robust antibody response are given earlier, and the "weaker" antigens are given later, usually about 4 weeks prior to foaling. Of those listed above, both tetanus and rabies vaccines are known to give a robust response and thus can be moved to the earlier time. Note that a mare in her first pregnancy may need an initial series of vaccines she has not had previously; in subsequent pregnancies it is most often just a single booster.

Measuring Colostral Quality

As foaling is imminent or immediately following birth of the foal, many larger farms will measure the quality of the colostrum. This is done by measuring specific gravity using a colostrometer or by measuring total solids using a sugar refractometer as a proxy for IgG concentration (Note: regular clinical refractometers used for plasma protein or urine specific gravity DO NOT work). Foals from mares with poor quality colostrum may be targeted for early supplementation from a frozen colostrum bank. Mares with excellent quality colostrum have some stripped out (250-300 ml) and frozen to deposit in the bank.

Mare Anti-RBC Antibody Screening

On larger farms and particularly for mares that have previously had a foal with neonatal isoerythrolysis (antibody-associated break down of red blood cells by the foal shortly after birth and colostrum ingestion), a blood sample is taken from the mare in the last two weeks of gestation to screen for antibodies directed against red cell antigens. Like other animals, horses have blood types and if the mare has antibodies against red cell antigens her foal has inherited (from the sire) it can result is severe red cell lysis once the foal has suckled. These antibodies are concentrated in colostrum and absorbed by the foal. In cases where a mare comes up positive the foal is NOT permitted to suckle her initially but is given colostrum from a safe source. The mare is milked out and the colostrum discarded. This is repeated and the foal not permitted to suck until about 24 hours of life (when the colostrum is gone and the foal's gut has closed to antibody absorption).

Anthelmintic (dewormer) Administration

On or about the day of parturition the mare is given an anthelmintic (usually ivermectin) to reduce passage of parasites to the foal. A particular parasite targeted by this is *Strongyloides westeri*, which is transmitted through the milk.

How does management of the pregnant mare optimize foal health? Give five specific examples, including two examples of how to increase concentration of antibodies in colostrum.

Management and Care of the Newborn Foal

If pregnancy and delivery were normal, the farm staff will observe the foal for normal behaviors and "milestones". If everything is going well, you, as a veterinarian, will probably see the foal for the first time when it is 12-18 hours old. If things were abnormal at birth or are not progressing as usual, you can expect a call earlier, and in the case of a high risk pregnancy, may be in attendance at birth.

Normal parameters for farm personnel to watch for are:

- Following birth the foal should be vigorous, have good muscle tone, and attain sternal recumbency within 2 minutes (i.e. not stay in lateral).
- A suckle reflex should be present in 10-15 minutes.
- The foal should attempt to stand in 15-30 minutes and achieve standing within 1 hour.
- The foal should nurse the mare's udder within 2 hours – Note that it is normal for it to try a few other places before it locates the udder!
- Normal behavior is for the foal to nurse about 7 times an hour for about 90 seconds/bout. They should gain about 2-3 lbs/day in weight.
- The foal should pass meconium (first poop, sticky dark tan/orangy stuff) within 4 hours.
- The foal should first urinate in about 4 hours and then keep on doing so. The urine should be pale, not distinctly yellow.

What the farm personnel will/should do:

- Dip the umbilical stump to help prevent ascending infections
    - Generally done with dilute chlorhexidine (0.5% = 1 in 4 dilution) or dilute iodine

- Usually repeated several times in the first 24 hours
- Use a syringe case or soaked gauze – they need to dip the umbilical remnant, not the entire ventral abdomen

- Weigh the foal
- Save the placenta for veterinarian to examine
  - Plastic bag inside a clean 5 gallon feed pail with lid
    - This avoids the common pathological artifact *lesionae doggus chewus*
- On many farms it is usual to give the foal an enema either prophylactically or if no meconium has passed in a few hours. Usually warm soapy water or a commercial "Fleet" enema is used.

Important Newborn Foal Milestones

Some of the vital milestones are summarized as the **1-2-3 rule**:

- The foal should be standing within 1 hour
- The foal should have suckled from

the mare within 2 hours

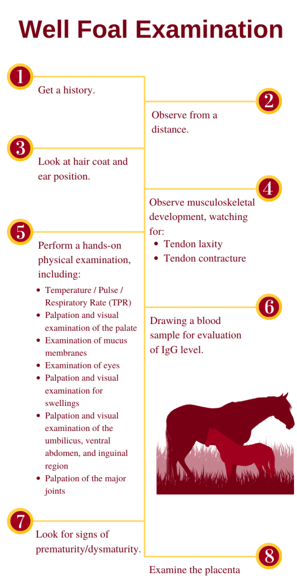
- The mare should have passed the placenta within 3 hours

Assuming all this happens and there are no other issues, then the first time the foal is seen by a veterinarian is for the well foal examination.

Well Foal Examination

Usually occurs at 12-18 hours of age (but may be out to 24-36 hours on a distant farm), and the veterinarian will:

1. Get a history including length of pregnancy, time and length of delivery, and the parameters listed previously (time to stand/ nurse/pass meconium)
2. Observe from a distance for normal behavior and respiratory effort and character



    - Normal foals are active between naps and have slightly jerky movements. Reduced activity and somnolence are signs of a problem as is a distended udder in the mare – usually an indicator that the foal is not nursing.

3. Look at hair coat and ear position (silky coat and/or floppy ears are a sign of prematurity/ dysmaturity).
4. Observe musculoskeletal development, particularly of the limbs, watching for:
    - Tendon laxity – fetlocks near/on the ground, toes tipped up, carpus hyperextended
        - Tendon laxity is another sign of prematurity/ dysmaturity
    - Tendon contracture – club foot, upright fetlocks, flexed carpi
    - Limb deviations in the mediolateral plane when viewed from in front or behind
        - Valgus and varus
5. Perform a hands-on physical examination particularly including:
    - Temperature / Pulse / Respiratory Rate (TPR)
        - It is normal to auscult a

heart murmur for 1-2 days following birth; murmurs or arrhythmias present beyond 4 days after birth need investigating

- Palpation and visual examination of the palate (for cleft palate – additional sign may be milk coming from the nostrils)
- Examination of mucus membranes for normal color and refill and no petechiation (petechiation is a sign of sepsis)
- Examination of eyes for cataract, corneal ulcers or entropion (rolled in eyelashes rubbing on cornea)
    - Foals don't have a reliable menace response (blink as you poke toward their eye) until about 2 weeks of age, so they have to learn to be scared of getting poked in the eye by stuff
- Palpation and visual examination for swellings over the ribs and "clicks" indicative of fracture (birth in the horse is a fairly violent event)
- Palpation and visual examination of the umbilicus, ventral abdomen, and inguinal region for evidence of swelling or herniation

    - Palpation of the major joints (carpus, stifles, fetlocks) for effusion
        - Joint effusion is usually related to infection in the joint, secondary to septicemia; this would be early to pick it up

6. Drawing a blood sample for evaluation of IgG level (to assess adequacy of passive transfer of colostral antibodies – VITALLY IMPORTANT).
    - This is usually performed as a stall side test using a rapid ELISA kit
        - Foals with less than adequate levels (<800 mg/dL) get supplemental IgG, usually in the form of IV plasma, because sepsis is a leading cause of foal mortality and foals without adequate IgG levels are much more likely to become septic.

7. Look for signs of prematurity/dysmaturity.
    - Foals with these signs that are otherwise doing okay should have carpi and tarsi radiographed to check for cuboidal bone ossification (the small bones that make up the carpus and tarsus), and have activity restricted if these are incompletely

formed to avoid crush injuries.

8. Examine the placenta
    - Is it complete?
        - Bits left in the mare promote uterine infection with resultant endotoxemia and laminitis – a very bad deal.
    - Are there abnormalities that indicate the foal may deserve a more thorough examination, closer observation or even some prophylactic treatment?
        - Placentitis, evidence of premature placental separation, reduced placental size.

Expected Vitals for Newborn Foals

AGE (hours)	HEART RATE (/min)	RESPIRATORY RATE (/min)	TEMPERATURE (°F)
0-2	120-150	60-80	99-100.5
2-36	90-120	20-40	99-101.5
48+	60-80	20-40	99-101.5

Other Things People May Do to Neonatal Foals Prophylactically

- Prophylactic antibiotics
    - On farms that have particular problems with septicemia or other neonatal bacterial infections, foals may be placed on antibiotics for the first 3-5 days of life. There is evidence in some studies of a significant reduction in serious infections when this is done.
- Hyperimmune plasma
    - Plasma from donor animals specifically vaccinated to provide high

antibody titers against certain diseases is commercially available (e.g. against clostridial organisms) and is used as an IV infusion, usually in the first day of life, on farms that have particular problems.

    - Some may also be administered by stomach tube to provide high levels in the gastrointestinal tract to prevent toxin absorption or bacterial adhesion (depending on whether you give an antitoxin-based antibody or one against the bacteria itself)

- Blood sample for complete blood count (CBC)/chemistry
    - People who have had sick foals previously may have a blood sample submitted for a CBC and serum chemistry panel as another early indicator of any possible infection (the earlier you can detect and treat the better it usually goes).
    - If the foal is being insured, a CBC may be part of the insurance company requirement prior to issuing a policy.

Physical Exercise for Newborn Foals

Foals have a fairly large surface area to volume ratio and not much in the way of insulating adipose tissue, so they depend on food intake and movement to generate heat. Provided the foal is normal and the weather and footing reasonable they can start life outside right away; obviously, that is the way they were designed. However, since we often modify the breeding season for economic reasons so birth is close to January 1st, conditions are often less than ideal. In particularly cold weather the mare and foal are usually housed inside, ideally with turnout a couple of times a day in an indoor arena or at least hand walking.

Foals with abnormalities of the musculoskeletal system (identified by management or on the veterinary examination) are more restricted:

- Premature and dysmature foals with incompletely ossified cuboidal bones are kept in a stall and often non-weight-bearing (i.e. lying down) as much as possible to avoid crush injury until ossification is complete (monitored by serial radiographs).
- Foals with tendon laxity are given controlled exercise, usually turnout in a small area so they don't try to get up too much speed until the tendons strengthen.
- Foals with tendon contracture have fairly heavy bandages or even casts put on their legs which actually encourage tendons to relax (you restrict something on a foal and it tends to respond by getting floppy), with some very controlled exercise to encourage stretching, and pain control (e.g. a non-steroidal anti-inflammatory like ketoprofen).

Other treatments for these can include frequent foot trims, corrective shoeing (glue on at this age), and medical and surgical options for those that are more severe or are not responding to conservative management.

Make a physical examination chart or table for your use when doing well foal examinations.

CARE OF CALVES

Disease in dairy calves is not uncommon, with incidence of pre-weaning mortality reported as 5.6% and incidence of post-weaning mortality reported as 1.9%. Common causes for pre-weaning mortality include scours (gastrointestinal disease), respiratory disorders, and calving problems. The most common cause of post-weaning mortality is respiratory disease.

Calfhood disease is associated with short-term losses (labor to manage calves, drugs, calf mortality) and long-term losses (decreased rate of gain, increased risk of death before achieving goals as an adult such as increased risk of culling before first calving or increased age at first calving). Specific goals are set by the Dairy Calf and Heifer Association; these standards give farmers and their veterinarians goals to shoot for in disease management. For example, the goal for a given farm for pre-weaning mortality is less than 3%.

Key Management Areas for Pre-Weaned Dairy and Beef Calves and Specific Management Strategies

Late Gestation

In the last trimester, nutrition, immunity, and environment/housing of cows must be managed. Be aware that dairy cows are bred and calve year-round and that beef cows are bred and calve seasonally, with calving seasons in spring and fall. Late gestation nutrition includes feeding a diet balanced for energy, protein, vitamins, and minerals. Food must be palatable and may be available free choice. Free choice fresh water must be available. Body condition score should be at or just above average (3.0 to 3.5 on a 5-point scale for dairy cows, 5 to 6 on a 10-point scale for beef cows). Poor nutrition is associated with lower birth weight of calves; difficulty calving, especially in fat cows; lower production of colostrum and milk; slower calf growth; and overall lower calf survival. Cows are often vaccinated late in gestation to ensure high antibody concentrations in colostrum to protect the calf. In the time just prior to calving, dairy cows should be housed on clean, dry bedding and should not be overcrowded. Control heat in the summer (shade, fans, sprinklers) and provide protection from wind and precipitation in the winter. Beef cows are tough but do require a wind break, access to bedding, and access to feed.

Calving Environment

The calving area must be well-bedded and draft-free. It is important to keep it as clean and dry as possible by frequently removing dirty bedding and adding clean bedding. The calving area must be well away from pens for sick animals in the facility. Animals should be handled in a calm manner. Try to keep the cow from standing in mud, which is made up of manure, urine, and dirt. Her udder and the ground will be the first things to which the calf is exposed and both should be as clean as possible. An example of a pasture rotation system used in beef cattle to ensure calves are born on clean, parasite-free pasture is the Sandhills Calving System – The Sandhills Calving System uses larger, contiguous, pastures for calving, rather than high animal-density calving lots. Cows are turned into the first calving pasture (Pasture 1) as soon as the first calves are born. Calving continues in Pasture 1 for two weeks. After two weeks the cows that have not yet calved are moved to Pasture 2. Existing cow-calf pairs remain in Pasture 1. After a week of calving in Pasture 2, cows that have not calved are moved to Pasture 3 and cow-calf pairs born in Pasture 2 remain in Pasture 2. Each subsequent week cows that have not yet calved are moved to a new pasture and pairs remain in their pasture of birth. The result is cow-calf pairs distributed over multiple pastures; each containing calves within one week of age of each other. Cow-calf pairs from different pastures may be comingled after the youngest calf is four weeks of age and all calves are considered low-risk for neonatal diarrhea.

Care of the Newborn Calf

For beef calves, calving should be monitored and assisted if needed. The calf's umbilicus should be disinfected with 7% tincture of iodine. The calf is assessed to ensure good vigor and a protected area with or without a heat lamp and other supportive care is provided if needed. The calf is individually identified with an ear tag and will remain with the cow until weaning. For dairy calves, calving should be monitored and assisted if needed. The calf's umbilicus is disinfected with 7% tincture of iodine. The calf is immediately removed from the cow (within 30-60 minutes of birth) and is raised separately from her.

Immediately post-partum, the calf is dried in a warming box, with a heat lamp, or in a warm room if the calf is born during cold winter months. Calf blankets may be used and the calf is individually identified with an ear tag.

Colostrum

Cows have an epithelichorial placenta with six complete layers (three each from the fetus and dam). There is virtually no movement of antibodies across this placenta so all calves are born without protective circulating antibodies. Colostrum, the first milk secreted after parturition, is rich in immunoglobulins (IgG, IgA, IgM), cytokines, and nutrients. Colostral antibodies are absorbed across the gut early in the calf's life and so help the calf develop circulating concentrations of antibodies that provide temporary immune protection until the calf's immune system develops. Blood can be drawn from calves between 24 hours and 7 days of age to determine if they have had sufficient antibody transfer; normal values are greater than 10 mg/mL of serum IgG and/or greater than 5.2 gm/dL of serum total protein. Dairy calves are presented with colostrum by the farmer in the first days of life. Beef calves get colostrum directly from the dam; if the cow is not a good mother or the calf if not nursing for some other reason, the calf may need to be fostered onto another cow or handfed to ensure it receives colostrum. It is reported that up to 14% of dairy calves in the United States have insufficient transfer of antibodies ("failure of passive transfer") and that 31% of deaths in the first 3 weeks of life are associated with failure of passive transfer.

Specifics of colostrum management include:

- *Evaluation of quality* – The goal is to have greater than 50 gm/L of IgG in colostrum. Factors that impact colostrum quality include late gestation (dry cow) vaccinations, dry cow nutrition, avoiding stress in dry cows (heat, crowding), and ensuring the dry period is of adequate length (not shorter than 21 days). Antibody concentration is measured on a colostrometer or Brix (sugar) refractometer (22% total solids = 50 gm/L IgG).

- *Ensure calves are receiving the right quantity* – The goal is to feed 150-200 gm of IgG. This usually is done by providing 10% of the calf's body weight (usually 3-4 liters or 4 quarts) within 6 hours of birth. Dairy calves can be fed using a nippled bottle or an esophageal tube feeder.
- *Ensure time to first feeding is as quick as possible* – The gut loses ability to absorb large proteins like antibodies by 24 hours of life so the goal is to provide colostrum orally within the first 1-2 hours of life if possible.

Beef calves are left to nurse off of the cow and to receive colostrum with less oversight. Someone should verify that the cow has colostrum (thicker and yellower than regular milk), that the cow's teats are patent, that the calf is up and trying to nurse, and that the dam is allowing the calf to nurse. If a dairy or beef cow has no colostrum, calves can be fed frozen colostrum from storage, or colostrum replacement products. As in foals, blood can be drawn from calves within the first week of life to determine if they have received adequate colostrum.

Pre-Weaning Nutrition

See Nutrition-Herbivores chapter.

Housing and Sanitation

The goal when housing dairy calves prior to weaning is to avoid contact of that calf with older animals or their environment, including air, water, bedding, feed, and pasture used by older animals. Calves also should not directly contact each other. The housing may be individual calf hutches or other individual enclosures. If producers do group dairy calves prior to weaning, then introduction to the group should be delayed until the calf is 12-14 days old, and group sizes should be kept as small as possible (< 8 calves/group) in order to reduce disease risk. The enclosure should be draft-free but well ventilated and bedded with abundant clean, dry bedding. Enclosures should be well cleaned and sanitized between uses. The setup should be such that calves can be managed and moved with minimal stress and decreased risk of injury. Calves are not in solitary confinement when in calf hutches; a study published in Applied Animal Behavior Science in 2015 demonstrated that calves that had gentle interactions with handlers up to three minutes per day as they received their normal feeding and care gained more weight in the first two weeks of life. Research has shown some benefits of allowing pre-weaned calves to socialize (i.e. have a buddy). Pair housing (groups of 2 calves) is a viable compromise to allow socialization between pre-weaned calves while still minimizing the increased disease risk that occurs if we group pre-weaned calves. Since early weight gain is associated with increased milk production as an adult, this has behavioral benefits for the calves and benefits for the producer as well.

Health Procedures

Which procedures are performed depends on the farm, with the program determined by the farmer and veterinarian. Examples include ear tag application and dipping the umbilicus as described above, testing serum protein concentrations to assess for failure of passive transfer, tests for specific diseases, vaccination, dehorning, and castration.

Disease Detection and Treatment

This again varies by farm. Early detection and treatment of disease improves success and may help prevent spread of disease in the facility. Veterinarians may be involved in helping develop protocols and in training farm staff.

Describe a rotating pasture system (like the Sandhills Calving System) and explain how this system increases health of calves born.

CARE OF PIGLETS

The following notes are largely excerpted from: http://extension.missouri.edu/p/G2500

The most critical period in the life cycle of a pig is from birth to weaning. On the average, about 1-2 piglets per litter are lost during this period, with an average pre-weaning mortality of 12%. As number of piglets per litter increases, birth weights of individual piglets decreases. Piglets that weigh less than 2.2-2.4 pounds (1 kg) at birth have more than a 50% chance of dying before weaning. Other common causes of mortality are crushing, starvation, and dehydration due to diarrhea.

Weaning large litters of thrifty, heavyweight pigs is a key