



newsletter



September 2004

A Quarterly Publication

Volume 9, Issue 3

From the Director:

As a laboratory user you are likely familiar with the contributions that AZVDL faculty make to veterinary diagnostic investigations in Arizona. What you may not realize is that faculty are also involved in other pursuits such as research, publishing articles, and teaching in the department curriculum. Here are a few examples:

Dr. Bob Glock and Master's graduate student Matt McDaniel are beginning a research project to identify the incidence rate of Arizona calves persistently infected with bovine viral diarrhea virus (BVDV). These persistently infected (PI) animals are often clinically normal yet continue to shed virus for life and represent a source of infection to the remainder of the herd. Infection can result in substantial economic loss due to reproductive failure, increased susceptibility to infection, unthriftiness, diarrhea, and in some instances, death. Dr. Glock and Matt will be using ear punches from approximately 3,000 beef calves from southern Arizona ranches and a similar number of Arizona dairy calves to test for PI status using immunohistochemistry. It is their hypothesis that BVDV infection in general and PI calves in particular are not a problem in southern Arizona beef herds due to range conditions which spread animals out over a large area. If this is found to be true, it could make Arizona calves more valuable to feedlots who recognize the economic losses associated with presence of PI animals in their pens.

Dr. Carlos Reggiardo and junior pre-vet student Estehela Gonzales are currently in the midst of a project to validate a *Mycobacterium paratuberculosis* (Johne's disease) PCR test for a private company. The PCR test is performed on feces and is compared to the serum ELISA we currently run. They are also participating in the USDA National Johne's disease check test that compares the PCR to ELISA culture. Preliminary results suggest that the PCR test uncovers 50% more infected animals than the standard ELISA. Final results will be tallied in the fall. The fecal PCR could prove a valuable tool in eliminating Johne's disease from Arizona dairies.

Dr. Sharon Dial and Dr. Lisa Shubitz in conjunction with investigators from the Valley Fever Center for Excellence have just received a \$4.5 M, National Institute of Health Program Grant. Dr. Dial will direct the imaging core that uses immunohistochemistry, *in situ* hybridization and morphometry to study novel antigens of *Coccidioides immitis* for possible vaccine development. This is a multi-departmental project with investigators from both the human and veterinary fields. The project promises to bring us closer to the ultimate goal of an effective vaccine for control of Valley Fever.

Dr. Ted Noon, toxicology coordinator for the AZVDL, investigated an episode of blister beetle poisoning in Cochise county this summer. To get the word to as many horse owners and equine veterinarians as possible, Dr. Noon wrote an informative article about blister beetle intoxication in horses. You can read the article on the Arizona Department of Agriculture web site: www.agriculture.state.az.us/ASD/BlisterBeetle.htm. In addition to his diagnostic duties, Dr. Noon is teaching "Diseases of Livestock" this fall in the department curriculum and will teach "Wildlife Diseases" in the spring semester.

Dr. Peder Cuneo, extension veterinarian, has been working hard over the last year toward the development of the Arizona Livestock Incident Response Team (ALIRT). This is an emergency response network funded by the legislature to provide rapid response to unusual or catastrophic livestock death losses in Arizona. When fully in place, it will link the office of the State Veterinarian, the AZVDL, contract veterinarians, wildlife agencies, producers and extension agents throughout Arizona. Training for contract veterinarians who will be first responders will take place at the AZVDL and include a review of sample collection, necropsy technique, other diagnostic methodologies and foreign animal diseases. Educational programs to describe the program to producers and extension agents will also be a part of the program. Training should begin this fall.

Greg Bradley, Director

Featured article:

SELENIUM DEFICIENCY IN ARIZONA RANGE CATTLE

Selenium is one of 15 essential trace minerals or micronutrients required by animals and humans. It is naturally present in varying amounts in soils and is taken up by range forage plants at levels that usually reflect soil content or availability of the element. It is required nutritionally only in “trace” amounts (i.e. less than 0.1 % of feed dry matter) and either deficient or excessive intakes can be detrimental to livestock. Intakes of trace elements that are considered “adequate” to meet nutritional requirements of livestock fall within a fairly narrow range between deficiency and toxicity. To prevent signs of selenium deficiency, the National Research Council recommends that beef cattle rations contain 0.1ppm (parts-per-million) selenium. Because of wide variations in soil levels, cattle consuming native forages are at risk of selenium deficiency in many regions of the United States. In Arizona, analysis of soils, range forages, and blood samples from range cattle suggest that deficiencies of selenium are common in east-central Arizona and in the southern border regions.

Functions of selenium: Selenium is an essential component of antioxidant enzyme systems in the body that protect cells and their internal components from oxidative damage from oxidizing substances formed during normal cellular metabolic processes. Oxidative damage to cells and their components, if not controlled, can lead to tissue damage and impaired function that vary in severity depending on a number of factors. Vitamin E and several other antioxidant enzyme systems are involved as well but we have not found vitamin E deficiency to be common in Arizona cattle grazing natural range forages. Vitamin E, however, has been found to be deficient in some cattle in feedlots.

Effects of selenium deficiency:

In calves, severe selenium deficiency can cause muscle degeneration (nutritional myopathy or White Muscle Disease) that can lead to death. In less severely or “sub clinically” deficient calves, impairment of the immune system has been reported resulting in poor response to vaccination and greater susceptibility to infectious causes of pneumonia and scours.

In cows, some effects of chronic, sub-optimal selenium intakes that have been reported are: decreased conception rates, retained placentas, abortions, mastitis, weak, stillborn, or lethargic calves, and occasional downer cows following calving. Keep in mind that some reproductive effects can be subtle (i.e. “sub clinical”) and may not be readily observed unless cattle are observed routinely and good records are kept. At the UA V-V Ranch in east-central Arizona, provision of a loose salt-mineral mix containing 90 ppm selenium along with recommended levels of other trace minerals and calcium and phosphorus was shown to improve early breeding season (January-April) conception rates in treated cows compared to un-supplemented control cows.

Diagnosis of selenium deficiency:

Direct assessment of selenium status: Selenium status of cattle can be evaluated most conveniently by analyzing whole blood samples (submitted in a purple-top EDTA tube) from approximately 10 cows in a herd. Whole blood is best because it reflects long-term intakes and selenium that is active in antioxidant enzyme systems as well as current dietary intake. Serum samples are less desirable because selenium levels in serum reflect only current status and are more difficult to interpret, particularly in cows in mid to late pregnancy.

Indirect assessment of selenium status: This can be done by analysis of forage samples and is an acceptable option but multiple composite samples of the moderately palatable, more abundant forage species from several areas of the range should be tested. Forage analysis is also a good option when determining the status of copper, another nutritionally important trace element. Blood or serum levels of copper are not diagnostically useful. We normally analyze forage for a number of other nutritionally relevant trace minerals including selenium and copper.

Continued on Page 7

DIAGNOSTIC UPDATE

The following are selected samples of cases submitted to the AzVDL during the months of June, July, and August

BOVINE

Two heifers died unexpectedly in a pasture in the Thatcher, Arizona area. The owner surveyed the pasture and found piles of discarded oleander clippings. Multiple fragments of oleander leaves were identified in the rumen contents at necropsy and a diagnosis of **oleander poisoning** was made.

Abortion due to *Neospora* sp. infection was diagnosed in an aborted Holstein fetus. The fetus had characteristic lesions of granulomatous encephalitis, multifocal myocarditis and skeletal myositis.

Pericardial tamponade due to a **ruptured pulmonary artery** was the cause of death in a two-and-one-half-month old Red Angus bull calf. At necropsy the pericardial sac was filled with clotted blood. The heart chambers were constricted. The main pulmonary outflow tract was dilated and contained an 8 cm long intimal tear and a 2mm diameter, full thickness perforation of the vessel wall. This likely represented a congenital weakness in the wall of the pulmonary artery.

Bloat was diagnosed in an Angus heifer. It was found dead on permanent pasture. The pasture consisted of Bermuda and fescue. At necropsy the carcass was extremely bloated and decomposition was advanced. A "bloat line" was evident in the esophageal mucosa. Other gross changes were typical of bloat as well. Numerous grass seeds were found in abomasal ingesta and ruminal pH was subnormal for an animal grazing forage-type pasture. It was suggested that excessive consumption of Bermuda seed heads may have caused ruminal acidosis, impairing ruminal motility and function leading to gas accumulation and bloating.

Bovine respiratory syncytial virus infection (BRSV) was diagnosed in 3 five-month-old Hol-

stein calves. All calves were noted to have great difficulty breathing and the anteroventral areas of the lungs were discolored purplish. Affected areas were consolidated and sank in fixative. Microscopic changes were typical and fluorescent antibody stained imprints of lung tissue were positive for BRSV.

EXOTICS

A severe, **chronic pancreatitis** with loss of most of the parenchyma was found in the necropsy of an adult male guinea pig.

A sixteen-year-old male llama was euthanized because of a large **fibrosarcoma of the left paranasal sinus**. The tumor had completely filled the sinus, eroding the bone and invading the oral cavity and surfacing in the face just below the left eye.

SMALL RUMINANTS

A two-year-old Nigerian dwarf goat was observed to be eating normally in the morning and was then observed to be "acting strange". It was dead within a few hours. The necropsy findings indicated **severe acute bronchopneumonia with fibrinous pleuritis**. *Mannheimia haemolytica* bacteria was isolated from lung tissue. These organisms frequently cause rather rapidly fatal and unexpected pneumonia in small ruminants of various types.

EQUINE

Purulent meningitis was diagnosed in a six-year-old gelding that was euthanized after an illness of two days duration. Rabies was suspected. Clinical signs were listed as "neurological/wobbly, down-unable to rise, heavy breathing". In necropsy the meningeal areas of the brain exuded thick greenish to cream colored exudate. Rabies testing was negative.

AVIAN

An **ovarian adenocarcinoma** was the cause of death of an adult chicken. This type of lesion is observed fairly

Diagnostic Update

frequently in older birds.

Pro ventricular dilatation syndrome was diagnosed in a five-year-old female Sun conure that developed neurologic signs prior to death. The bird was “depressed” and was “head to chest”. Pre-mortem blood work was non-diagnostic. At necropsy, the pro ventriculus was dilated, packed full of ingesta, and had an abnormally thin wall. Microscopic lesions were typical.

Internal laying was diagnosed in a one-year-old Rosy leg hen. The bird was found dead in its nest box. Internal lesions were compatible with yolk peritonitis due to internal laying.

Crop impaction was diagnosed in a Silver Duckwing chicken that became ill and died after an illness of one-day duration. The bird was also “pale, lethargic, drinking but not eating”. Internally, the crop contents consisted of mixed grains including considerable numbers of large whole kernel corn. One large kernel of corn had obstructed the esophageal opening of the crop, restricting the outflow of ingesta.

Hemangioma with splenic rupture and resultant severe intra abdominal hemorrhage was diagnosed in a six-year-old Lilac crown amazon. The owner reported that the bird had “swallowing problems and died that night”. Internally there was considerable abdominal hemorrhage and there was tumorous splenic enlargement. Microscopically, the splenic mass was typical of cavernous hemangiosarcoma.

Avian tuberculosis was diagnosed in an adult female Quaker parrot. The following history was reported: the bird died after an illness of three days duration. The bird was found weak at the bottom of the cage. Internally there were numerous granuloma-like lesions scattered throughout the parenchyma of liver and lungs. Microscopic findings, including acid-fast staining of sections, were typical of avian tuberculosis.

Mycotic pneumonia was the cause of death in a six-

month-old African grey parrot that became acutely anemic and died. The apical ½ of the left lung was firm; plum colored and had a white, firm central core. Histologically, there was massive necrosis of lung tissue and colonization with fungal hyphae.

Multifocal myocardial necrosis with or without non-suppurative inflammation has been the most constant lesion encountered in wild or captive birds dying of **West Nile Virus** infection. We have seen a wide range of lesions in confirmed cases of the infection, from inflammatory and necrotic changes affecting multiple organs (very rare) to a complete absence of diagnostic lesions (most cases). The real-time PCR test on tissue samples has proven to be the most sensitive confirmatory test, and is the only test we use in non-surveillance cases. Antigen tests (“RAMP”, IHC) are still used for surveillance cases because they are more cost-effective for epidemiological purposes.

Intra abdominal hemorrhage originating in a necrotic **hepatoma** was the cause of death of a female white-shouldered Mynah. The bird was found dead with a distended abdomen. The tumor was roughly two inches in diameter with several areas of necrosis.

FELINE

Systemic mastocytosis was diagnosed in a thirteen-year-old female domestic short haired feline dying after a short episode of respiratory distress. On necropsy, there were numerous areas of gastric hemorrhagic ulceration and subcutaneous hemorrhages in the head and neck. Large multifocal aggregates of mast cells were found throughout liver and spleen on histologic examination.

Calicivirus was isolated from the lung of a rescued, five-week-old domestic medium haired kitten suffering from acute interstitial pneumonia and pulmonary edema.

Multiple **metastatic carcinomas** were found in the lungs, brain, pancreas, kidneys and lymph nodes of a sixteen-year-old DSH female. An adenocarcinoma of the mammary gland had been removed eight months

Diagnostic Update

previously.

CANINE

A bilateral **renal lymphoma** was the necropsy finding in a five-year-old male Shepherd mix with a one-week history of lethargy. There were multiple large, confluent nodular tumors throughout both kidneys, which were enlarged to roughly twice the normal size. The tumors were soft, pale, with a fatty appearance.

Asphyxia produced by choking on cooked hamburger was the cause of death of a nine-year-old female Shar Pei. A large piece of hamburger (3" by 1.5") was tightly lodged in the pharynx, obstructing the entrance of the larynx and blocking the airway.

An acute **purulent bronchopneumonia** and **septicemia** was diagnosed in a six-month-old Bassett hound with a history of chronic bronchitis since its purchase from a pet store. Many cases of chronic bronchitis in dogs are believed to be due to a failure to resolve acute episodes of bronchitis, such as those of infectious tracheobronchitis. Bacterial pneumonia is a common complication.

An acute intra-abdominal hemorrhage produced by the rupture of a **renal hemangiosarcoma** was the cause of death of a ten-year-old female Maltese. The tumor originated in the pelvis of the left kidney and was approximately double the size of the kidney.

An adult pug was submitted with a history of becoming quieter than normal and being found dead the next morning. The history included administration of vaccines on the day before the animal became ill. The cause of death was extensive **chronic adrenalitis** with necrosis and atrophy of adrenal cortex. These lesions very likely resulted in severe adrenal insufficiency. This condition, sometimes called Addison's disease, is often expected to be a slowly progressive clinical entity, but sudden death due to stress or sudden decompensation may result in rapid death of the animal.

A fourteen year-old dog experienced seizures with some diarrhea and elevated body temperature. The only significant finding in this animal was **severe diffuse meningitis** with primarily mononuclear inflammatory cells. Heavy populations of Group G *Streptococcus* sp. were isolated.

A thirteen year-old Borzoi dog died quite suddenly after vomiting. She did exhibit some paralysis. The apparent cause of death was multifocal to diffuse **bronchopneumonia** with heavy populations of *E. coli* present. There were also hemorrhagic lesions in some other organs suggesting septicemia. The right lung had a small bronchogenic carcinoma located on the pleural surface invading a short distance into the parenchyma. One might speculate that the carcinoma may have been a predisposing factor in the development of the pneumonia.

A thirteen-year-old female Schnauzer died suddenly. The dog had a thin hair coat, thin skin, a pot-bellied appearance, and no identifiable thyroid tissue. Coronary vessels of the heart contained multifocal, raised, yellow intimal plaques. Histologically, the plaques were characteristic atherosclerotic lesions with one vessel lumen occluded by a fibrin thrombus. Heart attack or **acute myocardial infarction** is unusual in dogs primarily due to the rarity of atherosclerosis in the species. However, atherosclerosis secondary to hypothyroidism is one exception to this rule.

Splenic torsion was diagnosed in a three-year-old male Belgian Malinois. The dog developed an acute onset of lethargy and ataxia. There was a leukocytosis and an anemia. Internally, the abdomen was full of thin sanguinous fluid, the spleen was large, swollen, and congested with blood and there was a counter clockwise torsion of the spleen and its mesentery. Microscopically the spleen was congested, hemorrhagic, and necrotic.

Intestinal obstruction due to a foreign body was diagnosed in a four-year-old male Pit bull that died after an illness of approximately two-months duration. Internally there was a small intestinal obstruction caused by a three to four centimeter diameter rubber "chewy" that

Diagnostic Update

had lodged approximately six inches distal to the pylorus. The submitting veterinarian noted that there were elevations of the serum BUN, phosphorus, and ALT values with a normal creatinine. It was suggested that if there was protracted vomiting then a dehydration-related artifact in these values might have occurred. Alternatively, it was suggested that if the foreign body was in the stomach at the time the serum values were measured and there was significant gastric hemorrhage, then elevations of the BUN and phosphorous might have occurred as a result of absorption of blood-origin protein and phosphorus.

Canine parvovirus was diagnosed in two unrelated cases, one a six-month-old neutered Pit bull mix, the other, a nine-week-old male Yorkie. The pit bull had a "questionable" vaccination history and a negative parvovirus CITE test. PCR testing of pooled spleen and intestine was positive for canine parvovirus and gross and microscopic changes were typical in both.

WILDLIFE

West Nile Virus infection was diagnosed in three squirrels that were found dead in Navajo County. Lesions consisted of enlarged, hemorrhagic lymph nodes that were suggestive of plague or tularemia. Test results for these diseases were negative. All animals had encephalitis and myocarditis and West Nile virus infection was diagnosed by PCR testing.

We received a nine-month-old collared peccary (javelina) with a history of several animals in a captive herd having severe diarrhea. The only findings on necropsy included sand and a 3 cm phytobezoar in the stomach and watery contents in the small intestine. There was also some suppurative bronchopneumonia observed histologically. Numerous **Group D Salmonella** sp. organisms were isolated from lung. There have been incidences of *Salmonella* isolation from javelina in urban environments as well as free-ranging animals.

Chronic, disseminated **Aspergillosis** caused by *A. fumigatus* was the cause of death of an adult raven. The bird died within hours of admission to a wildlife rehabilitation center in central Arizona.

We received a two-year-old rabbit with a history of head tilt and final recumbency. There was extensive **suppurative otitis** with extension to the brain, producing meningi-

tis. *Pasteurella multocida* was isolated. This is a common cause of otic lesions in rabbits.

WEST NILE VIRUS DIAGNOSIS IN BIRDS

We have had inquiries regarding the numbers of various species of birds that have been identified as infected with West Nile Virus.

Positive diagnoses for West Nile Virus include 27 sparrows, 7 kestrels, 7 canaries, 6 owls, 4 finches, 3 jays, 3 crows, 2 herons, 2 ravens, 2 scarlet grasskeets, and one each amazon, cactus wren, cockatiel, lorikeet, merlin, lory, quail, scrub jay, sun conure and wren, plus one unknown for a total of 76 birds. Species are identified as designated by the submitting party. Fifty-three birds came from Maricopa County and ten came from Pima County. There were lesser numbers from Yavapai, Coconino, Navajo, Mohave, La Paz, Cochise, Graham, and Gila Counties.

NOTES FROM THE TOX LAB

As this newsletter was being prepared, we have been informed by two equine veterinarians that there have been several cases of photosensitization in paint horses in the Phoenix/New River area. This problem has occurred in the past in Arizona horses. As additional details become available, we will update our ANIMAL HEALTH ALERT regarding this disease. The Alert can be found on our web site at www.microvet.arizona.edu/AzVDL/infoalerts/Alert1.htm.

T. H. Noon, DVM
Toxicology and Nutritional Testing Section

Featured article: continued from page 2

Caution: loose salt-mineral mixes should not be offered suddenly to water or salt-deprived cattle. Over consumption may occur and will lead to salt poisoning and death of the animals. Salt-deprived animals should be given plain white hard salt blocks prior to the provision of loose salt mixes so that they become salt-sufficient. Adequate water in reasonably close proximity to the supplement should be available at all times. Cattle in remote, difficult-to-reach areas of the range should have plain white salt blocks available as well so that they do not become salt deprived if the loose salt-mineral mix is depleted and not re-supplied for some time. So-called mineralized salt blocks, also known as “brown blocks” or “camouflage blocks” that contain added trace minerals normally do not contain sufficient selenium to meet the needs of selenium-deficient cattle. Supplements containing “organic,” “complexed,” or “chelated” selenium are also available and are claimed to be more effective but are often more expensive. All supplements should be formulated to provide adult cows a maximum daily intake of about 3 mg (milligrams) selenium. To our knowledge, there is currently no Arizona feed company capable of manufacturing blocks of custom mineral supplements to a satisfactory hardness.

2. A second, more expensive, but effective option that has recently become available is sustained-release ruminal boluses (CoSecure® boluses). These have been evaluated in cattle on the UA V-V Ranch and were effective in raising blood selenium levels in cows and their calves, with some variation by year and breed. The boluses that were evaluated last about 6 months in the cow’s rumen as they slowly dissolve and release selenium, copper, and cobalt and so need to be administered twice a year. An obvious disadvantage of boluses is the necessity for handling cattle in a squeeze chute individually twice a year in order to administer the boluses orally. In some types of operations, however, this option is well worth considering. Another disadvantage is the salt requirement of cattle is not met when this method is used unless salt is provided separately.

3. The third, least desirable option for long-term supplementation is administration of selenium by injection. Again, this is effective but must be repeated periodically, as elevation of blood selenium levels will only last 30-60 days. Obvious disadvantages besides the cost of these products are the labor and facilities required for repeated injections and the possibility of injection-site blemishes in cattle that are marketed.

Recommendations:

1. Selenium supplementation should be customized to meet, but not exceed, the selenium requirements of cattle.

2. We recommend that any salt-mineral supplements containing customized mineral levels be routinely batch-tested to determine their actual selenium content.
3. Selenium status of cattle should be monitored by follow-up blood testing in a minimum of about 60-90 days after routine supplement consumption by cattle has begun.
4. The intake of mineral supplements by cattle should be monitored closely. Records should be kept of consumption.
5. Laboratory testing is available through the AzVDL Toxicology and Nutritional Testing Section (520-621-2356, extension 17). AzVDL or Veterinary Extension personnel (520-621-2356, extension 19) can assist producers in monitoring a supplementation program. Feel free to call for information.

*Ted H. Noon, DVM
AzVDL Toxicology & Nutritional Testing Section*

*Howard Frederick, PhD
Adjunct Professor, Department of Veterinary Science and Microbiology*

*S. Peder Cuneo, DVM, MS
UA Extension Veterinarian*

© Telsol, Ltd.. P.O. Box HH7, Leeds, United Kingdom LS82YE. Manufacturer of CoSecure. Mention of a proprietary product does not constitute a guarantee or warranty of the product by the University of Arizona Agricultural Experiment Station or the authors and does not imply its approval to the exclusion of other products that may also be suitable.

The University of Arizona
Dept. of Veterinary Science and Microbiology
Arizona Veterinary Diagnostic Laboratory
2831 N. Freeway
Tucson, AZ 85705-5021

NON-PROFIT ORG.
U.S. POSTAGE PAID
TUCSON, ARIZONA
PERMIT NO. 190

Director: Greg Bradley DVM, Diplomate ACVP

Diagnosticians:

Robert D. Glock DVM, PhD, Diplomate ACVP
Sharon M. Dial DVM, PhD, Diplomate ACVP
Ted H. Noon DVM
Carlos Reggiardo DVM, PhD, Diplomate ACVM

Extension Veterinarian:

Peder Cuneo DVM, MS, Diplomate ABVP

Administrative Staff:

Barbara Pickard, Administrative Associate
Aurora Astorga, Computer Database Specialist
Elaine Nakashian, Quality Control Manager
Cindy Martinez, Daria Borntreger, Emma Timmerman
Megan Sieveke

Necropsy: James Hicks, Animal Technician Senior
Ryan Knoper, Student Laboratory Assistant

Toxicology/Nutritional Testing:

Barbara Rickert, Research Specialist

Histology: Marsha Hernandez, Histotechnologist
Shannon Shula, Histotechnologist

Immunohistochemistry:

Matt McDaniel, Research Lab Assistant

Microbiology: Brooke Mourreale, Research Technician

Virology: Mark Shupe, MS, Senior Research Specialist
Belinda Lockett, Research Technician
Kathy Boland, Research Technician

Molecular Procedures:

Nancy McCullough, Research Specialist
Lori Nelson, Research Technician

Adjunct Faculty:

Howard Frederick, PhD, PAS

Diagnostic Services offered at AzVDL:

Pathology: gross necropsy, histopathology, cytology, immunohistochemistry or other diagnostic tools used to determine the cause of disease

Microbiology: the use of microbiological techniques to identify bacteria, viruses, parasites, and other infectious agents, and their relationships to animal diseases

Toxicology: The study of poisons, their identification, chemical properties, biologic effects, and the disease conditions they cause

Nutritional Testing: chemical analysis of feed, forage, and body tissue samples for nutritionally relevant levels of nutrients

Serology: analysis of serum to monitor animals' prior exposure to diseases

Molecular Diagnostics: PCR testing for common diseases of companion animals

This newsletter can be accessed electronically via <http://microvet.arizona.edu/AzVDL/index.htm>

The University of Arizona College of Agriculture and Life Sciences is an equal opportunity employer authorized to provide research, educational information and other services only to individuals and institutions that function without regard to sex, race, religion, color, national origin, age, Vietnam Era Veteran's status, or disability.