

Equine Health and Production Management



**In the direction of knowledge empowerment of
equine owners.....**



ICAR-National Research Centre on Equines, Hissar



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Preface

The history of our association with horses is more than 6,000 years old, when mechanization in the world was not even a distant dream. With the use of this animal, the culture, tradition and religion was spread across the countries. The horse has been used for various activities since ages, where donkeys and mules are the means of livelihood of poorest-of-the-poor, the horse is a symbol of the prestige of wealthy persons and the army. It is possible that mechanization in the present era has reduced the number of equines but in the hilly areas where other means of transport are inaccessible, role of the equines is still important. NRCE has brought out a booklet "Equine Health and Production Management" with an aim to provide general and brief information to equine lovers, veterinarians, animal health officials, students, industry professionals and other stakeholders. This booklet will enhance their knowledge in various aspects of equines with regard to breeds, management, nutrition, diseases, artificial insemination, pregnancy diagnosis, etc. Besides these, the information about diagnostic services, artificial insemination services, provision of semen for production of superior quality mules, horses and donkeys and the technologies developed by the Centre is also provided for the overall development of animals in the country.

I congratulate the editors and thank the faculty of NRCE who have provided the valuable information for this compilation. I hope it will serve as a ready reckoner to help the farmers and other stakeholders in raising an economical and profitable equine husbandry.

With best wishes

Bhupendra Nath Tripathi,
Director



EQUINE BREEDING

Breeds

The horse is very important among the equine species because their contribution to human civilization has been commendable. In modern times, horses also do integral work in the Indian Army, the security forces, the police and various socio-cultural programs. There has been a considerable decrease in the number of Indian horses since 1952. Many horse breeds have reached the brink of extinction. There are six major breeds of horses in India such as Marwari, Kathiawadi, Spiti, Zanskari, Manipuri, and Bhutia. Apart from these, minor or non-descript breeds also exist in India. The brief description of major Indian breeds is given below:

Indigenous breeds of horses in India

Marwari Horse



Origin

- ♦ Marwar region of Rajasthan - the natural habitat of the breed

concave face between ears and smooth towards the nostrils.
♦ Average height: 14-15 hands (140-150 centimetre)

Characteristics

- ♦ The predominant body colour is brown where as other body colours are roan, chestnut, white and black with white patches.
- ♦ Large ears intend to touch each other when active and can be rotated to 180°, large forehead,

Special features and uses

- ♦ Generally active, beautiful, known for race, endurance and uncertain temperament.
- ♦ Commonly used in sports, ceremonial activities, safari and riding purposes.

Kathiawari Horse



Origin

- ◆ Kathiawar region of Gujarat

Characteristics

- ◆ The most prominent body colour in Kathiawari horses is chestnut followed by bay (body chestnut, foreleg up to knee and fetlock are black, Reshwali black, hairs of tail and neck are black) grey (complete white colour) and dun (light chestnut).
- ◆ Concave profile, long neck, short leg and squared quarters. Face is dry and short, triangular from pale to

forehead and small muzzle, big nostrils, edge of nostril is thin, small, fine and curved upright ears on 90 degrees axis that can rotate at 180 degrees, broad forehead and large expressive sensitive eyes. Tail is long, not bushy, curved well and touching to the ground, foot round and broad.

- ◆ Average height: 13-15 hands (130-150 centimetre)

Special features and uses

- ◆ Known for fast race and endurance.
- ◆ Commonly used in sports, safari, security and riding purposes.



Zanskari Pony



Origin

- ♦ Zaskar valley of Leh&Ladhak area of Jammu & Kashmir

Characteristics

- ♦ The predominant body colour is grey followed by black and copper.
- ♦ Strong and compact body, wide forehead, very active, predominant eyes, heavy & long tail and uniform gait. The body hairs are

fine, long and glossy.

- ♦ Average height: 11-13 hands (120 to 140 centimetre)

Special features and uses

- ♦ These ponies are prone to live in cold conditions and known for their endurance
- ♦ Load carriage capacity in hilly area, riding and used to play polo.
- ♦ Average height: 11-13 hands (120 to 140 centimetre)



Manipuri pony



Origin

- ◆ Manipur and Assam states of North-East region

Characteristics

- ◆ The breed is available in 14 different colours viz; bay, black, grey, mora white, leiponwhite, sinai white, stocking, liver chestnut, roan, light grey, reddish brown and dark bay.
- ◆ These ponies are small in size with compact body, very active, long forehead extended nostril, wither with a good shoulder, short back, well developed quarters and strong limbs. Mane is generally coarse and upright. It has small pointed ears, eyes are alert and slightly slant. The area between

the nostrils is flat not crispy. Withers are not prominent. Face is concave and tail is well set and commensurate with height.

- ◆ Average height: 11-13 hands (110-130 centimetre)

Special features and uses

- ◆ Strong and hardy breed and has very good adaptability to extreme geo-climatic conditions, intelligent and extremely tough and have tremendous endurance.
- ◆ Load carriage capacity in hilly area and suitable for riding and polo game. Polo was started first time in India with these ponies.
- ◆ Closely associated with the socio-economic life of the people of hilly region and used to travel, transport and hunting purposes.



Bhutia Horse



Origin

- ◆ Low altitude of Himalayan region of India and Bhutan, Sikkim and the district of Darjeeling in northern India.

Characteristics

- ◆ The usual coat colours are bay and grey.
- ◆ Small in size with compact body, wide forehead, small and strong

neck, and long hairs on mane, long tail, strong legs, very active with wide and extended nostrils.

- ◆ Average height: 13-13.2 hands (130-132 centimetre)

Special features and uses

- ◆ Known for load carriage capacity and riding purposes in hilly areas.
- ◆ Capable of surviving in cold and hilly areas.

Spiti pony



Origin

- ♦ Spiti valley and adjoining areas of Kullu and Kinnaur divisions of Himachal Pradesh.

Characteristics

- ♦ The predominant body colour is grey (complete white) followed by black, black flay bone (white body with black patches), brown and bay.
- ♦ Hardy and surefooted, strong well

developed body with fairly strong bones. The legs are thick and covered with long coarse hairs.

- ♦ Average height : 12 hands (120 centimetre)

Special features and uses

- ♦ These ponies are prone to live in cold conditions and known for their endurance. They are used for riding and as pack animals.
- ♦ Known for load carriage capacity in hilly areas.



Kachchi-Sindhi Horse



Origin

- ♦ Kachchh district of Gujarat and Jaisalmer and Barmer districts of Rajasthan.

short pastern bone length, broader hoof for better grip and docile temperament.

- ♦ Average height: 14.2-15.4 hands (142.2-152.4 centimetre)

Characteristics

- ♦ The predominant coat color is bay.
- ♦ Roman nose appearance of face, ears curved at tips but not touching each other, short back,

Special features and uses

- ♦ Performs with great speed and stamina covering long distance.
- ♦ Excellent drought and heat tolerance capacity in arid & semi arid region.



Artificial insemination in Equines

Artificial insemination (AI) technique involves collection of semen usually from a superior male and transfer of that semen into a sexually receptive female at a suitable time to facilitate successful fertilization. This technique is widely used in equines worldwide for rapid genetic improvement. AI is usually performed either with fresh semen, chilled or frozen semen. Equine owners may consider this method of breeding, as most of the advantages of AI includes:

Advantages of artificial insemination

- ◆ Faster genetic improvement can be achieved through AI for using superior genetic material and with introduction of new genetic material.
- ◆ Number of mares covered per stallion increases in a season, thus making valuable stallions available to the ordinary mare owner. Risk of injury during transport or breeding is almost nil with AI.
- ◆ Mares suffering from skeletal abnormalities or weaknesses, laminitis etc or with nervous temperament can be bred using AI to overcome limitations for use of natural service.
- ◆ Mares with increased immunological response to spermatozoa and that show some degree of endometritis post-coital, can be benefitted with smaller doses of spermatozoa used in AI than would normally be ejaculated at natural service.
- ◆ It encourages routine examination of mare's reproductive tract.
- ◆ Avoiding direct contact between the mare and the stallion removes risk of injury and disease transmission.
- ◆ Semen collection and its evaluation prior to AI allows quick detection of problems for immediate remedial measures.
- ◆ Addition of antibiotics to semen extenders reduces chances of venereal disease transmission compared to natural service.
- ◆ Reproductive potential of sub-fertile stallions can be enhanced by treatment of semen for concentration, addition of supportive and protective factors for spermatozoa.
- ◆ Extension of stallion's breeding season is possible by using frozen semen during non-breeding season.
- ◆ Comparatively reduces the cost of semen transportation, with no geographical barrier and avoids hazardous movement of horse/mare.
- ◆ Provides assistance for preservation of rare breeds by reintroduction of stored semen from such breeds i.e. ex situ conservation.





Pregnancy Diagnosis

After natural/artificial insemination, pregnancy testing is important. Equine owner can get the pregnancy test done by the rectal palpation examination/ultrasonography/serum-based hormonal assay test. In view of the advantages and disadvantages of each technology, the farmers can choose any of the techniques given below.

1. Rectal Examination (palpation)

- ◆ Old, economical and well established method for pregnancy diagnosis in mares
- ◆ Diagnose the pregnancy as early as 18th day of conception and more precisely by 25th to 30th day.

2. Ultrasonography

- ◆ Visualization of the conceptus is possible from day 14 of pregnancy.
- ◆ Not used very frequently under field conditions as ultrasound scanner is costly and require expertise.

3. Hormonal assay for pregnancy diagnosis

- ◆ eCG based ELISA for pregnancy diagnosis is simple and economical as it does not involve the transport of the animal and avoids extra stress.
- ◆ Effective in diagnosing the pregnancy between days 35 and 125 of gestation.



Stallions available for cryopreservation of semen and AI

NRCE provides services to the farmers for artificial insemination. The description of quality horses and donkeys available for semen cryopreservation and artificial insemination is given below to get the benefit for production of the best quality horses, mules and donkeys.

Description of Marwari Horses



Rithik

Birth: 19-04-2008

Height: 152 cm

Color: Skewbald



Karan

Birth: 09-07-2008

Height: 150 cm

Color: Grey



Mohit

Birth: 04-09-2010

Height: 155 cm

Color: Black



New Toofan

Birth: February 2010

Height: 155 cm

Color: Dark Bay

Description of Zanskari Horses



Z-1

Birth: 20-02-2007

Height: 134 cm

Color: Bay



Z-4

Birth: August 2007

Height: 126 cm

Color: Bay



Z-18

Birth: 25.07.2012

Height: 127 cm

Color: Black



Description of Manipuri Horses



MNP-1

Birth: December 2008

Height: 126 cm

Color: Bay



MNP-3

Birth: December 2005

Height: 119 cm

Color: Bay



MNP-4

Birth: December 2006

Height: 122 cm

Color: Chestnut



MNP-16

Birth: 21-06-2006

Height: 129 cm

Color: Chestnut



Description of Donkeys



M-11

Birth: 14.05.2005

Height: 142 cm

Color: Black



M-22

Birth: 28.07.2006

Height: 125 cm

Color: Black



M-25

Birth: 23.08.2009

Height: 130 cm

Color: Black



M-28

Birth: 26.02.2012

Height: 130 cm

Color: Black



EQUINE CARE AND MANAGEMENT

Adoption of good equine care and management practices is directly related for maintaining the overall health and fertility of equines. Better management is a key role for better reproduction and good health of horses. equine owners can follow the following points given categorywise on horse ears and management for overall physical development of their animals.

General management practices

- ◆ Horse owners must be well acquainted with the nature and habits of their equines for better care and safety.
- ◆ Keep the sick horse separate away from the healthy stock.
- ◆ Follow the vaccination and deforming schedule to prevent the horses from various diseases.
- ◆ Always keep the newly purchased horses in quarantine for a period of 30-45 days before mixing with the existing stock.
- ◆ Avoid the barbed wire or thorny bushes boundary of grazing pasture or stables. Never wrap a lead rope around your hand. Never tie a horse with a rope around his neck. If he pulls back he could strangle himself.
- ◆ Tie the rings at shoulder height to the horses.
- ◆ Try to groom the horses daily both before and after being ridden. Daily grooming gives a chance to detect and monitor any injuring or other health problems such as cuts, skin infection, allergic reaction, thrush, etc. Grooming also helps in increasing the blood circulation and keeping the hair clean.
- ◆ Regular exercise is must to keep the horses healthy. Warm up exercise is must to improve performance and also to reduce the risk of injury.

- ◆ After exercise let the horse dry and a thorough grooming should be performed. After some rest provide grain and water in small quantities.
- ◆ Take care of hooves, as proper hoof care prevents various diseases and infections.
- ◆ Thrush develops in horses while remain standing in mud and urine. Thrush is a major cause of lameness, thus, keep the stables clean.
- ◆ Horses should be shod from time to time. Try to trim the hooves after every six weeks.

Care of mares during gestation and foaling

- ◆ Increase the quantity of feed and fodder of pregnant mares during late gestation. Average gestation period in horse mare and donkey mare is 335 and 365 days, respectively.
- ◆ Vaccinate mares against tetanus, abortion (EHV-1), rabies and influenza during gestation to control the diseases. Vaccinate the pregnant mares for tetanus one month before foaling. Don't give any medicine to mares against parasitic infestation during the last month of gestation.
- ◆ Keep the pregnant mare housed in stable during winter. Also plant sufficient number of shady trees near stables to protect them from heat stress in summer.



- ◆ Keep the pregnant mare in a well ventilated stable as she approaches near foaling. Foaling in mares generally takes place during night, so there should be arrangement of light in foaling box. Foaling should be under the guidance of experienced and trained person. Wash the vagina, udder and teats of the mare properly after foaling.
- ◆ Never use pregnant mares for riding and other heavy work before 5-6 weeks of foaling.
- ◆ Ensure the availability of following things with you at the time of foaling:
 - Mobile number of a veterinarian
 - A watch, note book and pen/pencil to note down the foaling time
 - A clean towel to clean the newly born foal
 - A new blade and disinfectant viz., betadine lotion to dip and clean the umbilical cord
 - A bucket of lukewarm water and soap
 - New surgical gloves to work with clean hands
- ◆ Ensure the expulsion of placenta within 3 hours of foaling or inform the veterinarian
- ◆ Remove the fetal membrane from the head of foal as soon as possible.
- thread and apply betadine lotion to prevent infection.
- ◆ Feed colostrum to newly born foal soon after the foaling. Take the foal near the mare's teat and put some drops of colostrum in foal's mouth so that he/she may develop the taste of colostrum and finally start taking milk/colostrum from the teat. Provide the grains to foals for feeding after 6-7 months.
- ◆ After consuming colostrum, foals generally defecate or pass meconium. If it does not pass meconium, do enema with lukewarm water and liquid paraffin. Meconium also passes after feeding liquid paraffin.
- ◆ Save the new born foal from chilled air and bad weather and keep them at warm place. Keep the foal in clean & well ventilated place and cover the floor with bedding material.
- ◆ Tie head collar to foal for 3-4 hours daily from 2-3 days onwards. Grooming and cleaning of hooves are essential for good health.
- ◆ Record the date of birth, sex, body weight, body markings and details of the parents of foal in a register serial wise.
- ◆ Separate foal from its mothers between 4-6 months of age.

Care of newly born foal

- ◆ Remove mucus from nostrils and mouth of the newly born foal to facilitate normal breathing.
- ◆ Generally, umbilical cord breaks itself. Apply betadine lotion at the site. If umbilical cord is intact, then cut it from 3-4 inches away from the body by new blade. Tie it with clean

Stable management

- ◆ Protect horses from extreme weather: Your horse also require special consideration during, summer, winter and rains thus stable should be made at a safe place with well ventilation.
- ◆ Keep the bulb and light arrangements



in stable at a proper height and away from the reach of horses.

- ◆ Floor of stable should not be slippery. The slope of floor should be in such a manner that water should not stagnate at any place and cleaning can be performed regularly. In case of katcha floor, the upper layer of the soil must be removed once or twice in year.
- ◆ Use dust free dry grass and rice straw as bedding material. Horse feels comfortable if bedding is provided.

It absorbs urine and makes dung removal easy. Remember wet and dirty bedding should be removed immediately.

- ◆ Arrange neat and clean water and grains in stable and troughs should be cleaned time to time.
- ◆ Horse is a social animal thus never make stables at lonely place. Avoid using peg, nail or any pointed thing in it. Corner of the stable should be round to save the horse from any injury.

Stable Size (in feet)

Equine categories/room	Stable Size	Height	Door width
Horse	12x12	8.9	4
Pony	10x10	8	4
Stallion	14x14	9	4
Mare	12x12	9	4
Mule	10x10	8-9	4
Breeding house	24x24	15	9
Foaling line	16x16	9	4
Yearling	10x10	9	4

Note: Keep the height of the stable 7-8 feet



EQUINE FEEDING

Horses are non-ruminants herbivores animal. Therefore, they should be nurtured carefully, fed correct and balanced nutrition. Horses should fed grain and fodder several times a day, in many parts. Stallions should be raised according to physical growth and age. Following are some of the important consideration related to horse nutrition:

- ◆ Feed the horse according to the class and requirement. Horses require different amounts of nutrients according to their lifestyle. The horse owner must be sure that each horse receives a total diet to meet its needs.
- ◆ The ration of a horse should be balanced and half of the ration should contain good quality forage.
- ◆ Ration should be fed on the basis of weight rather not volume and adjusted according to growth, production and pregnancy of the animals.
- ◆ Abrupt change in ration may culminate to colic. Changes in types of feed should be made gradually in 7 to 10 days for small changes and up to three weeks for radical changes.
- ◆ Include high quality forages and grain mixture to equine ration. Green fodder can cater the need of vitamins for the equines. Mules and donkeys seldom over-eat, but horses need restricted feeding to prevent colic, laminitis and equine metabolic syndrome.
- ◆ To prevent colic, provide horse the fibrous feed and less concentrate mixture.
- ◆ Moreover, high percentage of concentrate mixture in ration may cause laminitis. Total concentrate mixture should be fed in 2-3 divided feeds. The nutrient deficiency in equines can be avoided by feeding various types of grains as mixture.
- ◆ Never feed dirty, decayed, fungal and stale ration to horses to avoid risk of disease.
- ◆ If horses are fed in a group, use individual feeders spread far apart, put out extra feeders, and make provisions for timid horses (low in the pecking order) to ensure that they have the opportunity to eat adequately.
- ◆ Add legumes to the ration of young growing foals, pregnant mares and weak horses.
- ◆ Feed half the quantity of dry fodder during night time.
- ◆ Horses need routine dental care. Sharp teeth can cause problems with eating and also performance.
- ◆ Changes in consistency, color, odor or composition of feces may indicate a digestive disorder. Coprophagia may be an indication of vitamin or mineral deficiency, to supplement adequate quantity of vitamin and mineral in ration.



Feed Requirement of Foals (Per animal per day)					
Classification	Concentrates (Kg)	Dry fodder (Kg)	Green fodder (Kg)	Salt (gms)	Mineral mixture(gms)
Nursing foals (4 months)	Increase 0.5 kg per month till weaning	No need	Mother's share	Increase 15grs per month till weaning	Increase 10grs per month till weaning
Weaning foal	2.5	Manger should not be empty of dry roughage	2	50	25
Yearling (12 Months)	2.8		5	60	30
Long Yearling (18 months)	3.2		10	65	35
Two year old (24 Months)	3.6		10	75	40
*Concentrate mixture should have 18% CP or above					

Feed Requirement of Adult Horses (Per animal per day)					
Classification	Concentrates (Kg)	Dry fodder (Kg)	Green fodder (Kg)	Salt (g)	Mineral mixture (g)
Maintenance	2	Manger should not be empty of dry roughage	5-10	40	20
Mares late gestation	4		5-10	80	40
Mares early lactation	4		5-10	80-120	40-60
Mares late lactation	4		5	80	40
Concentrate mixture should have 16% CP					

Feed Requirement of Working horses (Per animal per day)					
Classification	Concentrates (Kg)	Dry fodder (Kg)	Green fodder (Kg)	Salt (g)	Mineral mixture(g)
Light work	2	Manger should not be empty of dry roughage	5-10	40	20
Moderate work	4-6		5-10	80-120	40-60
Heavy work	4-6		5-10	80-120	40-60
Intense work	6-7		5-10	120-140	60-70
*Concentrate mixture should have 16% CP					

Feed Requirement of breeding and non breeding stallions (Per animal per day)					
Classification	Concentrates (Kg)	Dry fodder (Kg)	Green fodder (Kg)	Salt (g)	Mineral mixture(g)
Non breeding	2	Manger should not be empty of dry roughage	5-10	40	20
Breeding	3-6		5-10	60-120	30-60
*Concentrate mixture should have 16% CP					



EQUINE HEALTH MANAGEMENT

General Points for consideration:

Observe the animal for behavior, appetite, body condition or weight, hair coat, eyes, nose, legs, feet, drinking water and other vital signs to know whether animal is normal or suffering from any disease and contact the veterinarian accordingly.

Behavior

Healthy equines are bright and alert. Occasionally they roll and shake of the dust off, but if a horse or donkey rolls & often looks at the side, it might be having signs of colic & relate with other signs.

Appetite

Notice the animal for feed & water intake. Ill health causes the animal to either refuse the feed or decrease the feed intake. It may be due to teeth problem or infectious disease, if rectal temperature is elevated.

Body condition: Body condition of the animal can be seen through the weight of the animal. Too thin or too fat indicates health problem.

Hair coat

A dull hair coat presents the signs of poor nutrition, parasites or any disease condition.

Eyes and Nose

Notice for unusual discharge from eyes and nose or a dull glazed or cloudy appearance of eyes.

Gums

The horse gums should be moist, pink in color.

Vital Signs

For an early indication of a problem, observe the animal for vital signs: heart rate, respiration rate, capillary refill time, intestinal sounds.



IMPORTANT EQUINE DISEASES

Infectious diseases

It is of immense importance to take good care of equine health besides management and reproduction. Therefore, it is very important that the owners should be given information about various equine diseases, so that they can identify diseases in time and can prevent or cure them with the help of veterinarians.

(i) Glanders



Nasal Glanders



Skin Glanders

Glanders is a fatal infectious and notifiable disease which primarily affects horses, donkeys and mules. It is caused by the bacterium *Burkholderia mallei*. Apart from equines humans may also get infection through direct and prolonged contact with glanderous horses. Carnivores may also contract disease by eating infected meat.

Symptoms

- ♦ Chronic course in horses or an acute form in mules and donkeys. Most prominent clinical signs include nasal, cutaneous/farcy, pulmonary and asymptomatic carriers.
- ♦ Cutaneous glanders or Farcy is characterized by multiple edematous, ulcerative nodules of hind limbs and abdomen. Gradually nodular abscesses become ulcerated and ooze typical yellow-green gelatinous pus.
- ♦ The nasal form of glanders is a local infection of the nasal cavity and characterized by yellowish-green unilateral or bilateral nasal discharge, or ulcers on the nasal mucosa.
- ♦ Pulmonary/Respiratory form of glanders is associated with development of round, firm, greyish, encapsulated nodules throughout the lung tissues.
- ♦ Asymptomatic carrier: Chronically and subclinically infected horses do not show any typical clinical signs. These carrier animals are responsible for spreading infection to susceptible equines. Identification of these animals is of great importance for eradication and containment of glanders.



Diagnosis

The disease is commonly diagnosed by complement fixation test (CFT) and ELISA. It can also be diagnosed by bacterial culture & PCR/RT-PCR tests.

Treatment

Treatment is not recommended in

equines. However, expensive/ endangered animals like zebra/tiger may be treated with combination of antibiotics with regular monitoring.

Control

Control of glanders can be achieved by testing and culling policy. Effective vaccine is not available.

Precautions

- ◆ Monitor the health of horses in the premises daily by observing for clinical signs
- ◆ Identify and isolate the animal suspected for glanders.
- ◆ Call the veterinarian and arrange to send the specific samples of diseased as well as other equines in the premises to NRCE laboratory for diagnosis.
- ◆ Surveillance programmes about glanders to be carried during the disease occurrence.
- ◆ Keep away the visitors from the premises
Do not mix diseased and healthy animals.
- ◆ Use separate feeding and watering trough, utensils for diseased and healthy animals.
- ◆ Dispose off the left over feed and other belongings of the diseased animals properly either incinerating or burying.
- ◆ Handle diseased and healthy animals separately. If not possible, handle healthy animal first and then affected animal.
- ◆ Do not handle the diseased animal if having wounds, scratches and abrasions on hands.
- ◆ Bury the dead animal deep underground at the designated place.
- ◆ Wash the hands properly with disinfectants after attending the animals.
- ◆ Use personal protective equipment for handling the affected animals.
- ◆ Do not open the carcasses for necropsy in case of death due to glanders
- ◆ Disinfect the premises with suitable disinfectants.
- ◆ Decontaminate the materials with proper disinfectants.
- ◆ Do not reuse bedding and other belongings of infected animal.

(ii) Strangles



Mucus from the abscess of lymph glands

Strangles is an infectious and contagious disease of Equids caused by gram-positive bacterium; *Streptococcus equi*. The disease is characterized by abscessation of the lymphoid tissues of the upper respiratory tract.

Symptoms

- ◆ High fever, anorexia, serous or mucopurulent nasal discharge, submandibular lymphadenopathy, abscess of lymph nodes, difficulty in swallowing, inspiratory respiratory noise and extended head & neck.
- ◆ In older animals, catarrhal form of the disease occurs with mucoid nasal discharge, cough and mild fever.
- ◆ Metastatic strangles (bastard strangles) is characterized by abscessation in other lymph nodes of the body.

Diagnosis is confirmed by the bacterial culture of abscesses or nasal swab samples.

Treatment

- ◆ Provide warm, dry and dust-free environment.
- ◆ Apply warm compresses to sites of lymphadenopathy to facilitate maturation of abscesses.
- ◆ Facilitate drainage of mature abscesses and flush the ruptured abscesses with dilute (3%–5%) povidone-iodine solution for several days until discharge ceases.
- ◆ Administer NSAIDs to reduce pain and fever.
- ◆ Tracheotomy may be required in horses with retropharyngeal abscessation and pharyngeal compression.
- ◆ Administer antibiotics usually procaine penicillin after consulting a veterinarian.

Control

- ◆ Separate the clinically affected animals from rest of the herd.
- ◆ Clean and disinfect the contaminated equipments.
- ◆ Provide protective clothing to caretakers, farriers and trainers.
- ◆ Additions to the herd should be carefully scrutinized for evidence of disease or shedding (nasopharyngeal culture) and quarantine newly introduced animals for 14–21 days. The animals showing two negative nasal swab cultures for the organism during the quarantine period may be included in the herd.



(iii) Tetanus

Tetanus, also known as lockjaw, occurs in horses unprotected by vaccination. The disease is caused by the toxins produced by an anaerobic spore forming bacterium, *Clostridium tetani* present in the digestive tract of many animals and in soil when it enters the body through wounds.

Symptoms

- ◆ Stiffness, difficulty in moving and eating, protrusion of the third



Body stiffness in tetanus-infected animal

eyelid (membrana nictitans), lock jaw, sweating, stiff tail.

- ◆ Stiffness and extension of head, neck, back and leg muscles, sawhorse pose.
- ◆ Loud sound, bright light or touch can exacerbate the signs.
- ◆ In advanced cases, the horse collapses with spasms, convulsions and may die due to respiratory failure.

Treatment

- ◆ Place the horse in a quiet and dark place.

Keep feeding and watering devices high enough to allow use without lowering the head.

- ◆ Use slings for horses having difficulty in standing or rising.
- ◆ Administer large doses of antibiotics, usually penicillin in conjunction with tetanus antitoxin intravenously/intramuscularly.
- ◆ Administer tranquilizers in hyperaesthetic horses.

Prevention

- ◆ Vaccinate the horses and ponies with 'tetanus toxoid'.
- ◆ Vaccinate the foal at four month of age.
- ◆ Feed colostrum to newly born as it provides protection to some extent.
- ◆ Clean and disinfect the wounds thoroughly.

(iv) Equine herpesvirus

- ◆ Equine herpesvirus 1 (EHV-1) is a virus of the family Herpesviridae that causes abortion, respiratory disease and occasionally neonatal mortality in horses.

Symptoms

- ◆ Incubation period 2-10 days, Course 2-5 days.
- ◆ Fever, coughing, clear nasal discharge, oedema of limbs. Abortion primarily in third trimester of gestation.
- ◆ Retained Placenta.
- ◆ Neurological signs include coordination, posterior paralysis, recumbency.



Abortion of a EHV-1 infected animal

Diagnosis

- ◆ Collect the blood samples on the day of abortion and after 21 days of abortion for diagnosis by serological tests (ELISA), virus neutralization and PCR test.

Treatment and control

- ◆ No specific treatment available.
- ◆ Good nursing care and keep hygiene in the paddock.
- ◆ Segregate the aborted fetus and dam immediately call upon a veterinarian for further guidance, get blood sample tested in the recognised laboratory of NRCE.
- ◆ Symptomatic treatment may be given on the advice of veterinarian. Antibiotics to prevent infections with secondary bacterial infections may be used.
- ◆ Vaccinate pregnant mares in 5th, 7th, 9th months of gestation.

(v) Equine influenza

- ◆ Equine influenza is a highly contagious respiratory viral disease of equines characterized by high morbidity and occasional mortality. It is caused by influenza A virus

(strains equine-11 H7N7 and equine-2 H3N8 endemic to horse species. Transmission of EIV mainly occurs through close contact with infected animals. The virus is shed in the nasal and ocular discharges as well as in other excretions (saliva, urine and



Nasal discharge from equine influenza infected animal

feces). The spread of infection by aerosol droplets is a most likely factor in quick spread of the virus by winds for considerable distance.

Symptoms

- ◆ High fever, loss of appetite and weakness.
- ◆ Oculo-nasal discharges.
- ◆ Dry and hacking cough.
- ◆ Pneumonia may occur as secondary complication.

Diagnosis

- ◆ Clinical symptoms
- ◆ Diagnosis by Haemagglutination Inhibition (HI), virus isolation and PCR assays.

Treatment and control

- ◆ Rest and supportive care.
- ◆ Provide antihistamines, non-steroidal anti-inflammatory drugs



in fever.

- ◆ Administer antibiotics in case of complications like pneumonia or consistent fever for 3-4 days.
- ◆ Prevention of equine influenza outbreaks is achieved by vaccination and hygiene procedures.
- ◆ Dispose off the manure and bedding properly from stalls housing sick animals. Clean and disinfect the stalls, water buckets, grooming tools, pitchforks, and other items.
- ◆ Follow precautions to prevent the virus from spreading to susceptible or potentially susceptible wild populations. A national standstill on movement of horses if implemented for 6-8 weeks can help in minimizing and control of spread of infection to a greater extent.

(I) Rabies

Rabies is a fatal and zoonotic viral disease caused by genus *Lyssavirus*. The bite of an infected animal transmits the virus. Virus replicates locally in muscle tissues, and then travels up peripheral nerves into the spinal cord and brain. The time between bite and clinical signs is usually 2-9 weeks or can be longer than 6 months depending on the site of the bite.

Symptoms

- ◆ Behavioral changes, blindness, ataxia and incoordination, fever, hypersalivation, paresis to paralysis and difficult swallowing, colic and obscure lameness.
- ◆ In furious form, animal may become hyperexcitable, fearful or enraged, hyperesthetic.
- ◆ In dumb form mental depression, inappetence, head pressing, circling, flaccid tongue and tail.

Diagnosis

- ◆ No definitive antemortem test in animals. Blood test is not specific.
- ◆ CSF fluid analysis can be performed for yellow color, mononuclear pleocytosis and increased protein.
- ◆ Disease confirmation by demonstration of negri bodies in brain tissues on histopathology on post-mortem examination.

Treatment and control

- ◆ No curative treatment.
- ◆ Euthanasia is recommended in cases with clinical signs of disease.
- ◆ Vaccination is highly effective. Inactivated vaccines induce a strong serologic response. All horses should be annually vaccinated by a veterinarian. Boost pregnant mares prior to breeding or foaling. Foals born to vaccinated mares should receive a first vaccine dose not earlier than six months of age and a second dose four to six weeks later followed by annual vaccination. Foals of unvaccinated mares should receive a first vaccine dose at three or four months of age and should be revaccinated annually.



(vii) Trypanosomosis (Surra)

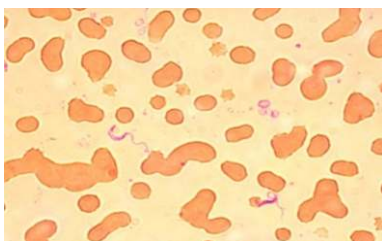
- ◆ Trypanosomosis is caused by *Trypanosoma evansi*. The hosts principally affected are equids, camels, buffaloes and cattle. The disease occurs in tropical and sub tropical regions of Asia, Africa, Central America and South America.

Symptoms

- ◆ Weight loss, lethargy, anemia, progressive paresis.
- ◆ Recurrent episodes of pyrexia associated with transient parasitemia.
- ◆ Enlarged lymph nodes, petechiae of serous membranes, dependent oedema, urticaria and alopecia, exudation or necrosis of the coronary bands.

Diagnosis

- ◆ Agent identification by wet blood films examination, haematocrit centrifugation.
- ◆ Antigen-ELISA, animal inoculation, PCR assay, DNA probes.
- ◆ Serological tests: ELISA, Card agglutination test, Latex agglutination test, IFAT.



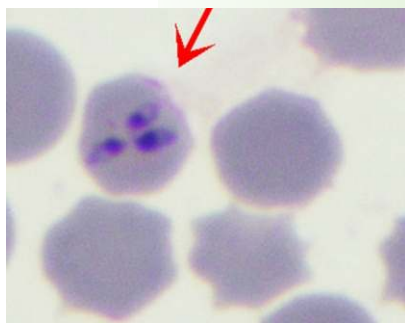
Trypanosoma evansi in blood smear examination

Treatment and control

- ◆ Chemotherapy with curative dose of quinapyramine sulfate or diminazene aceturate or Isometamidium chloride as per recommendation of a veterinarian.
- ◆ Control the flies' population in stable.
- ◆ In endemic areas, the preventive dose of quinapyramine chloride may be given in serologically positive animals before the onset of rainy season.

(viii) Equine babesiosis/ piroplasmosis

Equine babesiosis/piroplasmosis is caused by intra-erythrocytic protozoa *Theileriaequi* and/ or *Babesia caballi*. The disease is transmitted from infected horse to healthy horse by bite of infected ticks. The disease is endemic in native equines. Clinical signs appear under stress conditions.



Theileria equi in blood smear examination

Symptoms

- ◆ Fever (mostly of an intermittent



nature), progressive anemia, anorexia, decreased working capacity, swelling of eyes, icterus, etc.

- ◆ Bilirubinuria and haemoglobinuria are usually seen during last stage of the disease condition.

Diagnosis:

- ◆ Microscopic examination of stained blood smear, ELISA and PCR techniques are used for diagnosis of this disease.

Treatment and control:

- ◆ No effective drug is available for treatment of this disease. Imidocarb, dimenazene aceturate, oxytetracycline drugs may be used to treat infected equines. These drugs do not completely clear the infection from the body, but subsides the symptoms of the disease.
- ◆ Spray insecticides in equines stables/premises to control ticks after consultation with veterinary doctor.





Metabolic diseases

(i) Equine colic

Colic is the general term for abdominal pain in the horse. The severity of cases of colic can range from mild to potentially fatal. It is a common cause of death in horses and ponies. It is very important to treat cases of colic as potentially serious.

Types of colic

- ♦ **Impaction, blockage or stoppage**
Caused by food blocking the alimentary canal, sometimes occur after a deworming course when worms could not be expelled and block the gut.
- ♦ **Flatulent/Gas/Tympanic colic**
Caused by trapped gas resulting in distension of the gut wall and cause abdominal pain.
- ♦ **Spasmodic colic**
Spasms caused by an irritated and overactive gut wall.
- ♦ **Artery blockage**
Blood supply to a part of intestine is interrupted by the worms particularly *Strongylus vulgaris* larvae.
- ♦ **Twisted Gut**
Twisted gut causes obstruction in the blood flow resulting in intense abdominal pain.
- ♦ **Enteritis/colitis**
Caused by inflammation of the small or large intestines.
- ♦ **Sand colic**
Due to eating sand or grazing on sandy soils.

Symptoms

- ♦ Anxiety or depression, pawing at the ground, looking at the flank, rolling, lack of defecation, anorexia, excessive sweating, high pulse rate (over 50 beats per minute), lack of normal gut noises, frequent urination.
- ♦ Sweating, sporadic gut pain, loud gut sounds, restless and anxious, frequent attempts to roll in spasmodic colic.
- ♦ No defecation, chronic pain in abdomen, dark mucous membranes, reluctance to eat, extended periods of laying down, impacted colon, drop in temperature (as disease progresses) in impaction.

Diagnosis

History

Symptoms, fecal consistency and frequency; recent changes in management, feeding or exercise; Medical history including deworming and past episodes of abdominal pain, breeding history and pregnancy status.

Physical examination

If the horse is in extreme pain, insert a nasogastric tube to relieve gas before the examination.

- ♦ Observe the horse's behavior.
- ♦ Examination of vital signs (temperature, heart rate, respiratory rate, mucus membrane color, refill time and gut sounds).



Laboratory procedures:

- ◆ Blood evaluation, abdominocentesis, abdominal radiography, endoscopy, ultrasonography and diagnosis of fecal material.

Treatment

The decision on treatment is based on the horse's history, clinical signs, physical examination, and evaluation of laboratory data.

- ◆ Analgesics to control the abdominal pain.
- ◆ Laxatives in impactive colic.
- ◆ A nasogastric tube to relieve the gas pressure in the gut or to administer fluids (electrolytes or mineral oil) directly into the stomach.
- ◆ IV fluids if the horse is dehydrated or in shock.
- ◆ Surgery in case of a twist in a loop of bowel.

Prevention

- ◆ Give access to plenty of fresh and clean water.
- ◆ In cold climates, regular checks to avoid ice buildup in the water buckets, or install water heaters.
- ◆ Enough access to roughage, such as pasture or hay.
- ◆ Regular dental check-up to ensure proper grinding of food.
- ◆ Slowly introduce the horse to lush pastures.

(ii) Laminitis

Laminitis is a painful condition of horse due to inflammation of laminae

(a delicate tissue in the hoof) resulting in lameness if not treated in time. As laminitis progresses, coffin bone rotates and perforates through the sole of the hoof and digital phalanx also rotates. Obesity, excessive grain or pasture, hormonal deficiencies, trauma and stress are predisposing factors.



Laminitis affected hooves

Symptoms

- ◆ Foot tenderness progressing to inability to walk, increased digital pulses and increased temperature in the hooves.
- ◆ Anxiety, trembling, sweating.
- ◆ "Founder rings" (growth rings that are wider at the heel than the toe) in founders.
- ◆ Recumbency and rotation of the hoof in severe cases.

Treatment

- ◆ Manage disease with minimizing the horse movement and bedding the stall with shavings, straw or sand.
- ◆ Cooling of the hooves in the developmental stages of laminitis for 24–72 hours.
- ◆ Provide anti-inflammatory



/analgesics, vasodilators and anti blood clotting drugs.

- ♦ Trimming and shoeing to re-establish the spatial orientation of digital phalanx within the hoof capsule.
- ♦ Deep digital flexor tenotomy performed in cases of chronic rotation.
- ♦ Consider acute laminitis as a medical emergency because phalangeal displacement can occur rapidly.
- ♦ Despite prompt therapy, the prognosis is guarded until complete recovery.

(iii) Exertional rhabdomyolysis (Azoturia, tying up)

Exertional myopathy in horses is a syndrome of muscle fatigue, pain or cramping associated with exercise. Exertional rhabdomyolysis can be either sporadic, with single or very infrequent episodes of exercise-induced muscle necrosis, or chronic, with repeated episodes of rhabdomyolysis.

Symptoms

- ♦ Clinical signs are seen shortly after onset of exercise.
- ♦ Excessive sweating, tachypnea, tachycardia, pain, muscle fasciculations, reluctance to move.
- ♦ Recumbency and myoglobinuria (red colored urine) in severe cases.

Diagnosis

- ♦ History and clinical findings (muscle cramping and stiffness after exercise).
- ♦ Abnormal increase in serum creatine kinase, lactate dehydrogenase and aspartate aminotransferase (AST) enzymes.

Treatment and control

- ♦ Stop exercise immediately and move the horse to a well-bedded stall with access to fresh water.
- ♦ Reduce feed intake when animal is not working.
- ♦ Use sedatives/tranquilizers and oily laxatives judiciously.
- ♦ Vitamin B complex and selenium are frequently used as supportive therapy.
- ♦ Management changes that may decrease excitement, like minimizing stall confinement.
- ♦ Provide a high-fat and low-starch diet.



Vaccination schedule

Disease	Vaccine	Dose	Route	Schedule
Equine Influenza	Influenza vaccine(Calvenze-03-Boehringer)	2 ml	I/M	Twice in a year (interval of 4 weeks) afterwards yearly.
Equine herpes Infection	<ul style="list-style-type: none"> • Pneumabort-K + 1B Vaccine • Equiherpabort vaccine (NRCE) 	2 ml	I/M	During 5 th , 7 th & 9 th month of pregnancy.
Tetanus	Tetanus Toxoid AT Serum	1 ml	I/M	Twice in a year (interval of 4 to 8 weeks) afterwards yearly.
Rabies	Rabies vaccine		I/M	<p>First vaccine: at 3 to 4 months of age. After that vaccinate yearly.</p> <p>Vaccinate pregnant mares before parturition.</p> <p>Vaccinate new born at 6 months of age and then afterwards yearly.</p>

Note:

1. Vaccinate the animals according to the advice of a trained veterinarian.
2. Be sure to read the instructions written by the company concerned before vaccination.
3. Shake the vial well before applying the vaccine.
4. Give dewormer to the animal before immunization for better results.
5. Never vaccinate diseased animals.

For detail information please:-

- ◆ Toll Free Help Line Number NRCE Hisar: 1800 180 1233
- ◆ NRCE, subcampus, Bikaner 1800 180 6225
- ◆ NRCE Website: www.nrce.nic.in
- ◆ NRCE Infoequine mobile app (googleplaystore).



Contractual services provided by NRCE

NRCE is a National Referral Centre of Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare (Govt. of India) to conduct testing for health certification and to provide consultancy and diagnostic services for various equine diseases to the stake-holders. Testing of samples received from state and regional disease diagnostic labs, regional animal quarantine and certification stations, polo associations, Equestrian Federation of India, field veterinarians and equine owners is a regular and routine activity for various diseases.

(i). Bio-sample required

Appropriate bio-sample for each testing in good condition is to be supplied at NRCE during working hours. The samples must be accompanied by a covering letter, giving details of samples correspondence Address, phone, fax and e-mail, indicating clearly the test to be undertaken.

- For serological test (ELISA, VNT, CFT, Coggins Test IFAT, HI, STA)- serum
- For PCR, RT-PCR- blood in EDTA
- For agent identification - infected biological material in sterilized center

(ii). Bio-sample submission application format :

To

The Director
ICAR-National Research Centre on Equines
Sirsa Road, Hisar-125001 (Haryana)

Subject: Submission of samples/ biologicals for testing.

Sir,

I am submitting the samples as per the enclosed list, along with Certificate from the Veterinarian collecting the sample, for their testing as per the test requested:

Sr. No.	Animal Detail (Name, ID, Age, sex, breed, color)	Owner Details (Name, Address, Email and Phone)	Test Requested	Payment Details

Your faithfully
Signature

(Name of the Owner/Veterinarian)

Date:

- Enclosed: 1. Certificate from the Veterinary Officer
2. Demand Draft/ Payment details



(iii) Bio-sample testing fee

The rates of disease testing contractual services provided by NRCE for various diseases is furnished below:

Contractual Services	Diseases	Rates per test (Rs.)
	Equine Infectious Anemia	Coggins Test -500.00
		ELISA Test – 500.00
	Equine Rhinopneumonitis (EHV-1)	VNT Test -2000.00
		CFT Test-600.00
	EHV-1/EHV-4 differentiation	ELISA Test -1000.00
		PCR Test -1000.00
	Equine Viral Arteritis	VNT Test -2000.00
	Equine Influenza	HI Test -500.00
		VNT Test -2000.00
		RT-PCR Test -1000.00
		ELISA Test – 1000.00
	Japanese Encephalitis	HI Test -500.00
		VNT Test -2000.00
		RT-PCR Test -1000.00
	West Nile Fever	HI Test -500.00
		VNT Test -2000.00
		RT-PCR Test -1000.00
	African Horse Sickness	ELISA Test – 1000.00
	Glanders	CFT Test-600.00
	Salmonella Abortusequi infection	STA Test- 500.00
	Brucellosis	STA/ Plate Test-500.00
	Equine Piroplosmosis/Theileriaequi/ Babesiababli (Each test)	ELISA Test for T. equi – 500.00
		c-ELISA Test-2000.00 (Each Test)
		PCR Test- 1000.00 (Each Test)
		IFAT Test -7000.00 (Each Test)
	Rotavirus	ELISA Test-500.00
		RT-PCR Test-1000.00
	Surra (Trypanosomaevansi)	ELISA Test -500.00
		Isolation/Identification Test - 1000.00
		PCR Test- 1000.00
	Dourine	CFT Test – 1000.00
	Contagious Equine Metritis (CEM)	Isolation/Identification Test-1500.00
	Other Bacteriological agents	Isolation/Identification Test-1500.00
	Bacterial Antimicrobial Sensitivity	Disc diffusion Test- 1000.00
	Serum sample based pregnancy testing	ELISA Test – 200.00
Surveillance & Monitoring	(same diseases) as mentioned above Free of cost- -Indigenous equine farmers Supported by letter from State Govt. Veterinary officer, -Collected by NRCE	
Disease Investigation	As per case Free of cost Supported by letter from State Govt. Veterinary officer / request from farmer -Collected by NRCE	

(iv) Mode of payment of bio-sample testing fee

The bio-sample testing fee is to be paid in form of demand draft in favour of **“ICAR Unit, NRCE” payable at 'Hisar'**. OR NEFT/RTGS/IMPS to following account. Bank Details: STATE BANK OF INDIA, NGM Hisar, Account Number: 10440797032, IFCS Code- SBIN00057100 and Branch Contact No. 01662-276159



TECHNOLOGIES AVAILABLE FOR STAKEHOLDERS

National Research Centre on Equines, Hisar is actively involved in research on equine health and production since its inception. Many diagnostics kits, vaccines and packages of practices have been developed for use by stakeholders.

Updated Equine Influenza Vaccine



It is an inactivated aluminium hydroxide adjuvanted vaccine for equine influenza (horse flue). The virus in the vaccine is an indigenous equine influenza virus {A/eq/Katra-Jammu/06/08 (H3N8)} belonging to Clade 2 of Florida sublineage, a recommended OIE strain.

- ♦ The vaccine is intended for immunization of horses, mules and donkeys.
- ♦ Dosage: 1ml Intramuscular
- ♦ Vaccination schedule: First vaccination in animals above 6 months of age followed by a booster vaccine after 4-5 weeks and repeated annually or after monitoring the titres by Haemagglutination inhibition

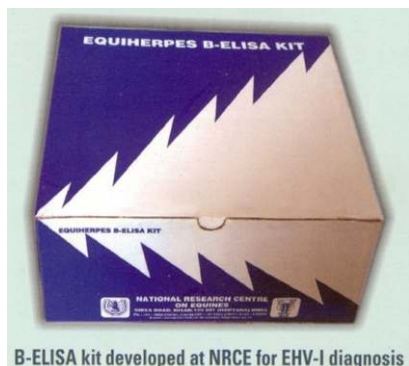
assay (HI titres below 64- repeat vaccine).

Equine herpes virus-1 vaccine (Equiherpabort)



- ♦ The equiherpabort vaccines is a formalin inactivated vaccine prepared from an indigenous EHV-1 (strain hisar-90-7), grown in Vero cell culture.
- ♦ The vaccine is intended for all equine species.
- ♦ Dosage schedule: 2 ml intramuscular at 5 months of pregnancy followed by two boosters at 7th and 9th month of pregnancy.
- ♦ This vaccine provides very good protective immunity against abortions due to EHV-1.

Equi Herpes B-ELISA Kit



- ◆ Equiherpes B-ELISA Kit is an alternative to virus neutralization test and gives result in 6 hr.
- ◆ This kit is able to diagnose EHV-1 recent infection in paired samples.
- ◆ The test is useful for assessment of herd immunity in equine breeding farms where vaccination is undertaken against EHV-1.

Rota virus kit

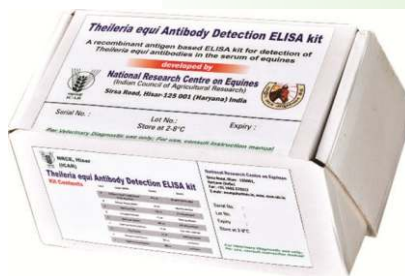
- ◆ A monoclonal antibody-based sandwich enzyme immunoassay for detection of rotavirus in different animals and human stool samples.
- ◆ The assay is simple to perform, highly sensitive and specific assay for detection of rotavirus from equine stool samples
- ◆ The assay has 100% sensitivity and a specificity of 96% in comparison to virus isolation.

EHV1/4 ELISA kit



- ◆ A recombinant protein based ELISA kit for differentiation and diagnosis of EHV-1 and EHV-4 infections.
- ◆ EHV-1 and EHV-4 are together responsible 'Equine Rhinopneumonitis', an OIE listed disease of equines. EHV-1 in addition is foremost cause of abortions, neurological disorders and perinatal foal mortality. Disease is endemic in India.

Recombinant antigen based ELISA kit for Theileria equi diagnosis



- ◆ This kit is used for the diagnosis of equine piroplasmosis.



It is a recombinant antigen (EMA-2) based plate ELISA for detection of antibodies against Theileriaequi infection in equine.

- ♦ The test sensitivity and specificity are comparable to OIE recommended ELISA.
- Stability of kit reagents : More than six months at 4°C

EIA ELISA kit



- ♦ It is a recombinant antigen (p26) based ELISA for diagnosis of equine infectious anaemia.
- ♦ The test detect antibody specific to EIA virus.
- ♦ Test capacity: 45 samples per plate
- ♦ Stability of kit reagents : One year at 4°C

ELISA Kit for diagnosis of Glanders



Pregmare kit for pregnancy diagnosis in mares

- ♦ This is an early pregnancy kit



based on detection of PMSG or eCG by ELISA which can be used for pregnancy diagnosis between 35 to 120 days of gestation in mares covered by horse stallions.

- ♦ Ready to use ELISA plate is provided with eCG standards for quantification of eCG in serum sample of pregnant mare.
- ♦ This ELISA kit is rapid, sensitive, specific and animal friendly.
- ♦ Stability of kit reagents: More than six months at 4°C.

Recombinant Hcp1 based ELISA

Very specific & sensitive
Homogenous protein purification
Cost effective- Rs.100/sample
Easy to adopt & interpretation of results



Painting by: Dr. Anju Manuja

