

PRODUCTION AND MANAGEMENT OF CAMELS

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PREFACE

The camel, without exaggeration, is the most ignored among the domestic ruminants in Pakistan. This is as much true in terms of lack of efforts to improve its care and productivity as it is in terms of lack of any planned research on it. Had it been an unproductive and a useless animal, its population would have gradually diminished, but it is the other way round. Its population is steadily growing. On papers, its population is being shown as stagnating, but most probably it is not so. On the international scene, there seems now a growing awakening in respect of the camel. At places, it has been termed as a 'food security animal'.

In Pakistan too, some teaching institutions have taken an initiative and have incorporated "Camel Production" in their teaching courses. No doubt, it is a very timely step.

Scientists from Germany, England, India, Australia and UAE have published books on camel. These are, of course, good books but as usual their prices are prohibitive for our students, extension workers and even for teachers. Moreover, these books contain a little information about camels in Pakistan. Therefore, an easy-to-understand book on 'Production and Management of Camels' using a question-answer format, has been compiled. This should provide ready-made answers to so many questions simmering in the minds of students, teachers, researchers and extension specialists. It embodies about 400 questions along with their answers.

The book discusses the distribution of camels in different continents/countries, breeds and types of camels with cross reference to other species, nutritional physiology and reproductive management, the way camels adapt to hot arid environment, milk and meat production and work performance, practical management and training of camels, marketing, health care and some diseases, including valuable information on several other aspects. Camel breeds and camel raising practices in Pakistan have been adequately discussed.

We feel great pleasure in acknowledging the hard work done by so many researchers/authors/editors, whose published information has been used, mostly as such, in compiling the book under reference. Their efforts have been amply acknowledged in the text/tables/figures etc. It was beyond our means to individually contact them in this regard.

We are highly thankful to Akhter Saeed MD for providing us useful literature from abroad. We are equally thankful to Dr. Ghulam Muhammad, Chairman CMS, UAF, for his cooperation in providing pertinent literature. Ch Sikander Hayat and Nawaz Ahmed Sipra also deserve our heart-felt appreciation for helping us out of many problems pertinent to the publication of this book.

No book has ever been claimed to be perfect in all respects and so is this one. The readers are requested to convey in writing their suggestions about omissions/shortcomings noticed in this book. Their suggestions would not go unnoticed.

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FOREWORD

For a long time the camel has been the victim of disregard and deliberate neglect of scientists and development workers. However, the last about two decades have witnessed a resurgence of interest in this species. Most of the work to exploit the productive potential of the camel has been undertaken by those who come from such countries that do not even possess camels. I think this should be more than enough to make us realize our responsibility towards a multipurpose domestic animal species, of which this country has a sizeable population. We need to investigate its peculiarities and exploit its potential especially in terms of milk and meat production and to explore the possibility of increased export of live camels to several Middle East countries. Presently some of these countries are importing camels from Australia.

To strengthen the possibility of implementing such plans, we must be equipped with recent knowledge about various aspects of camels. In this connection and as an animal scientist myself, I feel pleasure to mention that a book with the title 'Production and Management of Camels' has been brought out by experienced teachers/researchers, which should suffice to meet the needs as mentioned above. The contents of this book make me believe that it should be as much helpful for students, teachers and research workers as for extension specialists.

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PART – III

Part – III includes:

- ▶ *Diseases*
- ▶ *Specimen Objective Questions*
- ▶ *Glossary*
- ▶ *Annexure*
- ▶ *References*
- ▶ *Subject Index*

DISEASES

Q. Give a list of diseases that commonly occur in camels.

Among others following is the list of diseases that commonly affect camels: Camel pox, contagious ecthyma, camel papillomatosis, pasteurellosis, trypanosomiasis, pneumonia, influenza, gastrointestinal disorders, sarcoptic mange, tick infestation, fly infestation, dermatomycosis, ocular problems, rabies, facial paralysis, wry neck syndrome, stiff neck, plant poisoning, saddle sores, wounds and abscesses.

Q. Discuss, in general, about the occurrence of diseases in camel.

Despite a general reputation of camel for hardiness and resistance, which largely is true for adult camels, very young camels are susceptible to several problems leading to high morbidity and mortality. Passive immunity to many diseases is not transmitted to young camels via the placenta of the dam and therefore has to be acquired after birth. Colostrum does, however, carry antibodies to diseases to which the dam has been exposed and passively transfers resistance to the same diseases to the newborn camel. Many camel owners, especially in certain East African countries, do not allow the young to suckle the colostrum, considering it bad for them. This practice certainly contributes to the high morbidity and mortality rate, which may be as much as 40% before weaning.

Death of the embryo or foetus in early gestation (reasons not yet known) and occasional outbreaks of abortion contribute further to overall mortality, poor real reproductive performance and slow herd expansion rates. Older camels usually have low death rates, 3 to 5% per year. In proplonged droughts, deaths in camels do not take place until heavy losses have been suffered by other livestock. Published information on the diseases of the camel is the most plentiful of all research done on this species. This indicates that camels may be carriers of, or are susceptible to, or suffer from, a vast array of infectious and parasitic diseases.

Q. Organisms of many diseases and antibodies to several other disease organisms have been found in camels. Discuss this statement in detail.

Although organisms of many diseases have been found in the one-humped camel yet this does not mean that camels are actually susceptible to all these diseases. The presence of antibodies to foot-and-mouth disease in 70% of camels in Egypt, for example, is not associated with clinical symptoms. It is not known if the camel acts as a carrier of infection or is able to transmit foot-and-mouth disease to other species of farm animals. The presence of antibodies to other disease organisms which are of major concern in other domestic animals but about which similarly little is known in relation to camel includes Anaplasma, Brucella, Toxoplasma, Coxiella (Q-fever), bluetongue, influenza, parainfluenza, pasteurella, African horse sickness and Rift Valley fever. These antibodies are present over wide geographical areas and in varying proportions of animals (Table 30).

Table 30. Presence and prevalence of some virus antibodies in camel

Virus	Countries and prevalence*
Parainfluenza-3	Djibouti 17/53, Sudan 81/102, Oman 80/30, Nigeria (types-1,2 and 3) 43/107
Influenza	Sudan (type 1) 5/42, Nigeria types (A&B) 13/157
Bovine virus diarrhoea	Sudan 16/102, Oman 7/30
Adenovirus, respiratory syncytial virus	Nigeria 1/157
Bluetongue	Sudan 17/445, Sudan 5/102, Saudi Arabia
Rift valley fever	Kenya 22/143, Mauritania 29/41
Food-and-mouth	Egypt 69/39 (serum neutralization test), 15/39 (virus infection associated antigen test)
African horse sickness	Egypt 10-23% in imported animals
Pox viruses	Iraq, former USSR, Pakistan, India, Kenya (in 5 of 6 herds examined)
Rotavirus	Morocco 49/55
Rabies	Mauritania

* Prevalence is expressed as percentage in number of samples, thus 17/53 is 17% in 53 samples.

Source: Wilson *et al.* (1990).

Q. Describe the etiology, pathogenesis, treatment and control of camel pox.

Camel pox is one of the most important viral diseases in East Africa and parts of South Asia. It is caused by *Orthopox cameli*. Its outbreaks mostly occur during early to middle periods of the rainy season. The disease is highly contagious, from one animal to another, but scabs, contaminated tools, cloth, grazing areas and human beings also serve as fomites. Camel pox is reported most often in young and immature camels. Recovered animals show a stable and lifelong immunity, but there is no cross protection with other types of pox virus, including contagious ecthyma being clinically similar. The main clinical symptoms are characteristic skin lesions, papules appear around nostrils and lips. These papules later on take the form of vesicles, which eventually rupture. There is fever and anorexia; mandibular lymph nodes are often enlarged. Facial oedema is quite common at this stage. The localized form of pox disappears in about 3 weeks. Clinical symptoms of generalized form are more severe. Affected animals show high temperature, severe depression and anorexia. Vesicles develop all over the body. The pox scabs become covered with a thick brown crust after some time. Severe secondary infections are common. Septicaemia, reduced feed intake and resultant general weakness can precipitate death of these animals.

In dry climates the disease cures itself. In wetter areas, the disease can be severe. Mortality in calves and immature camels is very high, especially under poor management conditions, but the effects of morbidity may be equally important because they cause heavy production losses, particularly in weight gain. Some traditional owners use a vaccine made from the mild form to prevent further spread of the disease. They take scabs from animals with low levels of infection and insert them in a wound (skin scarification) they make on the animal, which is to be protected from the disease. The Lister strain of vaccinia virus applied by skin scarification has been successfully used to control a severe outbreak in Bahrain. Along with a vaccination programme, improved management strategies could diminish the prevalence of the diseases. Further education of herd owners about the etiology of camel pox, strict separation of diseased and healthy young camels, improved health care including long acting antibiotics, improved

hygiene and general supportive treatment will decrease the harmful effects of camel pox (Schwartz and Dioli, 1992).

Q. Discuss all about contagious ecthyma in camel.

Contagious ecthyma is caused by the parapox virus. Both the one-humped and two-humped camels are prone to this disease. Pox-like lesions are produced by the affected animals. Modes of transmission are similar to those described under camel pox. The virus is morphologically different from orthopox virus and can easily be identified by electron microscopy.

Clinical symptoms are similar to those caused by the orthopox virus, but a diagnosis based on these lesions can only be presumptive. The main practical differences between camel pox and ecthyma are that the latter disease is more severe and affects camels of all ages. In immature camels the lesions are mainly found around the mouth and nostrils and occasionally on the eyelids. The mandibular lymph nodes are enlarged. Due to intensive pruritus animals spend a lot of time scratching and rubbing the affected area, resulting in haemorrhages and skin excoriations. Grazing and suckling ability is impaired. Both localized and generalized skin lesions have been observed. Whether recovered animals have a lasting immunity is not clear, but according to field observations, recovered animals were not affected during new disease outbreaks. Control and care are similar to those for camel pox.

Q. Write a note on camel papillomatosis.

Simultaneous outbreaks of contagious ecthyma and papillomatosis have been reported in camel herds mainly during rainy season. Definite modes of transmission of the disease are inconclusive. Morbidity rate is quite high. Mortality in adult animals is nearly nil, but among affected calves mainly 6 to 18 months old under poor management and inclement weather, mortality rate might be high. Recovered animals were not affected during new outbreak. The zoonotic potential of the disease for human beings or other livestock is not clear.

In adult animals, the disease resembles bovine papillomatosis. Nodules are found mainly around head, neck, shoulder and udder. These become persistent and may require surgical removal. Proliferative localized or generalized skin lesions develop in immature animals. These lesions are very itchy and affected animals resort to intensive scratching and rubbing, resulting into haemorrhages. A high incidence of conjunctivitis with severe secondary bacterial infection has also been noticed. Other clinical findings include marked oedema of the head and swelling of the mandibular and

cervical lymph glands. In some cases, cauliflower like skin lesions about 0.1 to 0.5 cm evolve around nostrils and lips. Approximately 3 weeks after formation, the scabs drop off. Clinical symptoms of camel pox, contagious ecthyma and camel papillomatosis in immature animals being similar, can be easily confused. Electron microscopy has proven to be a useful tool to differentiate pox like lesions (Schwartz and Dioli, 1992).

Q. Discuss haemorrhagic septicaemia in camel in detail, including its etiology, epidemiology, pathogenesis and treatment.

Haemorrhagic septicaemia (HS) also called pasteurellosis is a disease of bacterial origin. *Pasteurella multocida* is the usual causative agent. It is prevalent in buffaloes, cattle and camel. Its outbreaks occur mainly during the rainy season and are commonly seen in low lying areas that have seasonal floods. The disease is usually seen in adult animals, but all age groups can be affected. Mortality can reach 50-80% among affected animals. Mode of infection is believed to be either by ingestion of contaminated feedstuff or by arthropods. The bacteria are not particularly resistant and do not survive longer than 24 hours on pasture.

Disease onset is acute. Clinical characteristics include high fever over 40°C, increased respiration and pulse rates and general depression. In camels, localization chiefly to subcutaneous tissue results in hot painful swellings around the neck. The mandibular lymph nodes and/or cervical lymph nodes are usually enlarged. Signs of respiratory dispnoea such as dilated nostrils or open mouth breathing and cyanotic mucous membranes are seen. In the majority of cases, haemorrhagic enteritis is present characterized by obvious clinical signs of acute abdominal pain and tarry faeces and coffee-coloured urine. Affected animals seldom recover and usually die in the next 24 to 48 hours.

On post-mortem the most obvious findings are generalized internal petechiation under the serosa of the intestines, the heart and the lymph nodes. Haemorrhagic enteritis and lesions of early pneumonia may be present. Differentiation from anthrax, blackleg and septicaemic salmonellosis is usually done by bacteriological examination. The absence of bloody discharge from the natural body orifices and a normal appearing spleen on post-mortem can help differentiate HS from anthrax.

Since HS is an acute and quite often fatal disease, early treatment is essential. Treat with antibiotics such as amoxycillin, tetracyclines or sulphonamides. Give 110 mg/kg body weight of sulphadimidine by mouth each day for up to 4 days. Recently being used more effective treatment is

the injection, popularly known as Doctor Jin. It is injected (IM) at the rate of 1ml/10 kg body weight.

Q. Is brucellosis a common problem in dromedary camels? What organisms cause it? Suggest appropriate control measures for brucellosis.

Varying incidences of brucellosis in camel (2 to 15%) have been reported from different countries. Except three countries, the incidence of occurrence of this disease in camel is mostly between 1 and 2%. The incidence is very low in Indo-Pakistan region. Camel may be infected by *Brucella melitensis* and *Br. abortus* and possibly by *Br. suis*. The precise pathogenicity of the disease in camels is not known. The *Brucella* organisms have been isolated from camel milk, aborted fetuses and vaginal swabs. It is well recognized that there are many causes of abortion and stillbirth in the camel and this complicates the diagnosis. There is little doubt that *Brucella* infection may be a factor in infertility in the camel, but it may not be as important as it is in unvaccinated buffaloes/cattle. There is supporting evidence that where camels and cattle are closely intermingled, infection in the camels has generally been significantly less than in cattle.

Experimental infection in non-pregnant camels has resulted in only mild signs of reduced appetite, slight lameness and lacrimation. Some authorities feel that the most significant result of infection may be premature birth.

Control is best achieved in other species by the use of vaccines. Both killed and attenuated vaccines have been successfully used in camels. Many countries have eradicated the disease by reducing incidence by a few years of careful vaccination followed by test and slaughter. Brucellosis is an important zoonotic disease. In man it is a debilitating disease characterised by recurrent fever, night sweats, joint and back pains and depression. People at greatest risk are those who drink unpasteurised milk, handle raw meat and attend parturient animals. Cooked meat and treated milk is safe since the organisms are readily killed by exposure to heat in excess of 65°C (Manefield and Tinson, 1997).

Q. What do you understand by respiratory diseases complex? Discuss it in detail in relation to camel.

A combination of various diseased conditions of lower respiratory tract of camel is called respiratory diseases complex. A variety of viral, fungal, bacterial and parasitic microorganisms have been associated with outbreaks of respiratory disease problems among camels. The most common predisposing factors for respiratory diseases are sudden changes of climate,

generally poor management and lowered nutritional status. Animals under other forms of stress such as overcrowding, unsanitary conditions, draft, cold, rain and those suffering from other health problems and young stock are the classes most at risk. Mode of infection and spread depends solely on the infectious agent. Despite low morbidity and mortality rates, the recovery period of affected animals is quite long. The negative impact on overall productivity should not be underestimated due to the long recovery period. Abortion can occur in pregnant animals, particularly during mid pregnancy.

Typical clinical signs of acute onset of lower respiratory diseases are a change in respiratory rate and depth, wheezing, coughing, uni-or bilateral nasal discharge (serous, purulent or haemorrhagic), increased temperature, anorexia, reluctance to move or work, hyperlacrimation, abnormal posture such as abduction of the elbows, extended neck, head to neck angle is wider than usual, swelling above the sinus frontalis. Chronic cases of respiratory disease are characterized by weight loss and intermittent fever despite grazing. General immuno-depression makes the affected animals more prone to other infections (Table 31).

Table 31. Pathogenic agents associated with respiratory disease outbreaks in camel

Agent	Prevalence	Disease
Parainfluenza type 1:2:3	regional widespread	Pneumonia, influenza
Influenza virus A/B	Regional	Influenza
Adenovirus	Regional	Influenza
Respiratory syncytial virus	Regional	Influenza
Infectious bovine rhino-tracheitis	Regional	Influenza, pneumonia
<i>Pasteurella multocida type A</i>	Widespread	Bronchopneumonia
<i>Mycobacterium bovis</i>	Uncommon	Miliary/nodular tuberculosis
Streptococcus sp. <i>Corynebacterium</i> sp. <i>Actinomyces</i> sp. <i>Klebsiella</i>	very common	Pulmonary abscessation

<i>pneumoniae</i>		
<i>Mycoplasma mycoides</i>	regional	Pleuropneumonia
<i>Rickettsia sp.</i>	Widespread	Pneumonia
<i>Trypanosoma sp.</i>	very common	Pneumonia
<i>Dictyocaulus vivipara filaria</i>	Widespread	Verminous pneumonia
<i>Echinococcus granulosus</i> <i>Cysticercus dromedarii</i>	very common	Hydatid disease
<i>Dipetalonema evansi</i>	Regional	Pneumonia pleuritis
Fly larvae (nasal myiasis)	Widespread	Rhinitis
Leeches	regional but common	Rhinitis

Source: Modified from Schwartz and Dioli (1992).

Typical signs of respiratory diseases of viral origin are often masked by secondary bacterial invasion. Bacteriological and histological examination should be performed if clearcut etiological diagnosis is needed. Principal treatment of affected animals includes antimicrobial therapy, improved management practices such as better housing, hygiene and good nursing care. High doses of long-acting broad spectrum antibiotics should be used in case of bacterial infections. Fistula formation between the sinus and the nasal cavity is a common sequel in most cases of sinus infection. In case of nasal airway obstruction due to purulent discharge, relief can be achieved by regular cleaning and flushing of the nasal cavity with saline solution. If treated early, prognosis is usually good (Schwartz and Dioli, 1992).

Q. Discuss the prevalence of Johne's disease in camels.

Johne's disease also called paratuberculosis occurs worldwide. It is caused by *Mycobacterium paratuberculosis*. The organism is shed in the faeces and it can be ingested with contaminated feed or water. The disease is widespread in Russia. It has been reported in dromedaries in Indo-Pakistan subcontinent, Saudi Arabia, UAE and in a camel in a zoo in USA. In Russia, the infected Bactrian exhibits severe diarrhoea. Clinically affected animals are usually 2 to 3 years of age and they die within 4 to 6 weeks from the onset of clinical signs. Many are of the opinion that the disease is more severe in camel than that in cattle. In some species infection occurs at or soon after birth by the neonates contact with an infected dam. Infection in utero occurs in advanced cases in buffalo and cattle. The organism is present in milk of 10% of subclinical and 30% of clinical cases. The losses

due to this disease per annum, mainly in buffaloes/cattle, are conservatively pegged at over US\$ 1 billion worldwide.

Diagnosis has been based upon the occurrence of chronic, intractable diarrhoea and the identification of acid fast bacilli in faeces and rectal biopsies. The complement fixation test appears to be reliable. CSL Ltd market a commercial ELISA test under the name of parachek which has been found very satisfactory in cattle. It is also being used in sheep and goats and should be applicable to camels. The condition shows little response to antibiotics and the infected dromedary may take up to a year to die. The genome of the bacterium *Mycobacterium paratuberculosis* has been sequenced very recently (Anonymous, 2002). The gene combinations that produce the bacteria responsible for the disease have been identified. These genes will serve as targets for the development of new generations of diagnostic tests that are critically needed for the detection and ultimate eradication of the disease.

Q. Are haemorrhagic disease and HS the two different names of the same ailment. Discuss.

These are not the two names of the same disease. However, similarity of signs sometimes may cause confusion. Certain other diseases such as haemorrhagic enteritis, salmonellosis also exhibit somewhat similar signs.

This is a serious disease of camels. Mainly racing camels in the UAE and Qatar are affected. Heavy mortalities have been reported. Major symptoms are: fever up to 41°C, animals go off feed and stop rumination, frequent dry cough, lymph nodes around neck show swelling, after a few days sickness the faeces are mixed with either fresh and red or black/tar-like blood with no signs of diarrhoea, the animal sits down and refuses to get up, death takes place after 3 to 7 days.

After death when the animal is cut open, blood can be seen at various spots such as inside the mouth, nose, windpipe, in the last stomach and kidneys, on the sac around the heart and on the guts.

This disease is also known as haemorrhagic diathesis (HD), *Bacillus cereus* intoxication. It is caused by a bacterium called *Bacillus cereus*. This may be carried on feed contaminated by cattle dung. If a camel is fed with grain and other concentrates but not enough roughage, the contents of the ruman (the first stomach) become very acid. The acidic conditions also help the bacteria multiply quickly and produce harmful toxins. To avoid creation of favourable conditions for multiplication of bacteria, feed plenty of

roughage in the feed. Do not store freshly cut feed in bundles since heat is generated which favours multiplication of bacteria.

Since the disease takes a very rapid course, therefore treatment usually fails. However, if HD is suspected, treat the animal quickly. Dissolve 500 g of sodium bicarbonate in water and drench the camel twice a day for at least 2 days. This reduces acidity in the rumen. Inject antibiotics and antipyretic (Tomanol) drugs. Give a drip with electrolytes, glucose and vitamins.

Q. What type of disease is salmonellosis? At what age camels are usually affected? Give salient symptoms, cause and treatment of this disease.

It is a bacterial infection caused by bacteria of the genus *Salmonella*. It is passed on by an animal eating feed or drinking water contaminated with faeces from infected animals. Calves over 2 weeks of age are the usual victims. It starts as gastroenteritis with diarrhoea and can develop into blood poisoning or septicaemia. It often results in death. In suckling calves up to 20% deaths have been reported. Animals that recover often have the bacteria in their faeces for a long time, thus become a source of infection for other animals. This disease is equally dangerous for other animal species and people, especially small children, old people and those with poor immunity. Therefore infected animals should be handled with great care. Proper diagnosis is only possible by culturing the bacteria in a laboratory.

Salient symptoms are: yellowish or greenish-grey, foul-smelling diarrhoea, faeces often contain blood, fever, dehydration, sunken eyeballs, dry mucous membranes. More often the animal dies 1 to 2 weeks after the disease symptoms appear, but in very acute cases may die within 24 to 48 hours. In septicaemic cases, body temperature rises rapidly, the animal becomes dull, rests and does not get up, shows difficulty in breathing, uncoordinated movements, lungs and joints may become inflamed (K. Rollefson *et al.*, 2001).

To treat the infected animals, give oxytetracycline antibiotic by mouth as well as through injection. Inject enrofloxacin (e.g. Baytril) 5 mg/kg body weight. Treat with oral rehydration fluid. Give a drip of 5 litres or more of lactated Ringer's solution mixed with sodium bicarbonate. However, if the animal is not treated within 24 to 48 hours, it is likely to die. Moreover, once the septicaemic form has developed, treatment is often not successful, especially if lungs are also involved.

Since prevention is better than cure, therefore, vaccinate breeding females during pregnancy so that the antibodies are transferred to the newborn calves. Make sure that calves get as much colostrum as possible and as early as possible after birth. Separate sick animals from healthy ones. New animals entering the herd should be kept separate for about a month. Keep drinking water and troughs clean and free of contamination by faeces. People treating sick calves should not handle healthy calves at the same time.

Q. Give the local names of Anthrax. Discuss all about this disease.

There are several local names of Anthrax. Some of these are sut, sujhan, mohri etc. It is a highly infectious disease. The sick animal meets a fatal end. *Bacillus anthracis*, which is extremely resistant to high temperatures and drought, is the causal agent. The disease is transmitted through grazing close to the ground and by inhaling dust. Biting flies (tabanids) and nasal bot flies are also the probable sources of transmitting this disease. Watering points, livestock markets and other places where animals are crowded, predispose them to anthrax.

The usual signs are: high temperature, rapid death with no signs of illness before hand, blood coming out of mouth, nose, anus (blood dark red and does not clot), most often best animals in the herd are affected, diarrhoea and pain in the abdomen, bloat, painful swellings on the throat and neck, fast irregular pulse, the spleen enlarged 3 to 5 times.

Treatment requires immediate injection of penicillin 10,000 units/kg body weight and streptomycin 8 mg/kg body weight into the muscle twice a day. It must be remembered that anthrax is a highly infectious disease that can kill people. Be careful when handling animals that are sick with anthrax. Do not touch them or their blood. Wear plastic bags on your hands in case you must touch them. Vaccinate camels with Blanthrax or anthrax vaccine. Avoid grazing where anthrax has previously occurred. Do not open the carcass. Avoid touching a carcass of an animal died of anthrax. To stop the disease from spreading, destroy the carcass by burning rather than burying it. Make sure it burns completely (K. Rollefson *et al.*, 2001).

Q. Write a note on prevention and treatment of tetanus in camels.

Tetanus is rare in camels, mostly humans and horses are affected. Clean deep wounds promptly with potassium permanganate or hydrogen peroxide. Put the animal in a quiet, dark place or plug its ears and put patches on its eyes. Inject 3000 units tetanus antitoxin under the skin. Inject penicillin for at least 7 days. Inject propionylpromazine (Combelen). To

calm the animal, inject a muscle relaxant such as Methocarbamol (Robaxin). Locate the infected wound, open it to expose it to the air, drain out the fluid and dress it with an antiseptic such as potassium permanganate. If the animal cannot eat, feed with milk, oatmeal gruel and linseed gruel by working it into mouth from the side.

Q. What type of disease is skin necrosis of camel? Discuss briefly its various aspects.

Skin necrosis is an infectious disease. A variety of infectious agents have been isolated from necrotic skin lesions, including *actinomyces cameli*, *streptococcus sp.*, *staphylococcus aureus* and *corynebacterium sp.* Dietary salt deficiency has been associated with outbreaks of this disease. Spread of the disease occurs through close physical contact such as crowding at water sites and night enclosures as well as through contaminated fences and trees where affected animals resort to rubbing and scratching. Immature animals are affected more than adults. Mortality is usually low.

A single, flat ulcerative lesion is characteristic of the disease but multiple lesions may be seen occasionally. The head, neck and shoulder region are the commonly affected sites. Painful swellings of small skin areas mark the beginning of the disease. Skin necrosis starts in the center and spreads outward, followed by sloughing of necrotic tissue. Circular ulcers of varying diameter (2 to 10 cm) are clearly demarcated from surrounding healthy skin. Secondary bacterial infection results in purulent discharge. The draining lymph nodes are enlarged and painful. Healing takes 3 to 4 weeks and scar formation is common. Risk of septicaemia is high when lesions develop on top of regional lymph glands.

Septicaemic animals should immediately be administered broad-spectrum antibiotics and provide good nursing care. Treatment of lesions consists of good debridement (removal of foreign material and contaminated tissue), flushing with iodine and topical dressing with anti-bacterial and insecticide preparations. Regular supplemental feeding of salt may reduce the incidence of skin necrosis.

Q. What type of disease is rabies? Discuss its etiology, clinical findings along with treatment/control.

Rabies is an important zoonotic viral disease. It is widespread throughout Africa and most of the Asian countries. All animals apart from reptiles and birds are susceptible to the disease. Important carriers are domestic and stray canines and wild carnivores such as jackals and wild dogs. It is mainly transmitted by bite wounds. Incubation period ranges from one month to

several months. Rabies is considered a fatal disease, however, recovery has been reported.

When an animal is bitten by a rabid dog, infectious saliva enters its body tissues, the virus replicates, then travels to the brain and from there to the salivary glands. Typical behavioural changes in rabid animals are often accompanied by progressive paralysis. Common behavioural changes are viciousness, increased activity or excitation and pica (compulsive eating of non-nutritive substances). Dumb and furious are the two forms of rabies observed in camels as well as other animals. The furious form of rabies is common. Rabid camels show profuse salivation due to paralysis of the throat, the animal being unable to swallow. There is aimless running off from and to the herd and increased aggressiveness. It must, however, be kept in mind that behavioural changes do occur in animals affected with brain diseases. Normal ingestion, locomotion, rest and sleep behaviour can be modified exhibiting an increase or decrease. Marked changes in social behaviour towards man and other animals are also seen. Increased aggressiveness and activity in camels have also been noted in case of coenurosis, a bacterial meningitis caused by *Listeria sp.* and nasal bot.

Since rabies presents a high zoonotic risk for human beings, animals with rabies-like symptoms should be immediately isolated and killed if evaluation of their history is suggestive of rabies, such as previously attacked by wild carnivores or stray dogs. Controlling rabies in endemic areas is only possible through mass vaccination of stray dogs and immediate elimination of suspected rabid animals. It is strongly recommended that all persons who frequently handle domestic or wildlife should receive a pre-exposure immunization. Titres should be checked every year.

Q. Discuss the frequency of occurrence, etiology and control of toxoplasmosis in camel.

On serological evidence, the camel has been found to have quite high incidence of *Toxoplasma gondii* infection in widespread locations; Afghanistan 73%, Egypt 3 to 6%, Indo-Pakistan subcontinent 11 to 13%, Somalia 16%, Sudan 23% and Turkmenia 28 to 73%. In one camel showing dyspnoea and pyothorax (pus in pleural cavity) 24 litres of turbid fluid were drained from pleural cavity. *Toxoplasma tachyzoites* were found in macrophages (any form of mononuclear phagocytes) in smears. The fluid had a titre of 1:20000 for *T. gondii*. There is a possibility that infection may be a factor in infertility and/or occurrence of abortion. Because of *T. gondii*

infection, the camel must be regarded as a significant public health risk to closely associated humans. Infections may range from slight fever, sore throat, lymphadenopathy, splenomegaly, joint soreness to abortion, stillbirth or neonatal death when human females are infected.

Diagnosis is based upon a variety of serological tests (complement fixation, fluorescent antibody and ELISA) and demonstration of the organism in affected tissues. Focal necrosis is the typical lesion.

It is a common cause of sporadic abortion and infertility in sheep. Control can be effected by deliberately exposing young sheep to infection sufficiently in advance of their first pregnancy for immunity to develop. The known hosts of the parasite are the domestic cat, mountain lion, leopard cat and bobcat. In these animals, oocysts are formed and passed in faeces. Infection initiates in non immune animals that ingest them. Ingestion of oocysts results in sporulation and release of sporozoites that pass to extra intestinal tissues. Carnivores are infected by ingestion of cysts present in infected flesh. The parasite is intracellular. Treatment is based upon combination of sulphonamides and pyrimethamine, but may not be possible on a herd basis in large animal species. Control is based upon hygiene and adequate cooking of meat. Cat litter and faeces should be disposed of in a safe manner and gloves worn during the process (Manefield and Tinson, 1997).

Q. Discuss the occurrence of mastitis in camel, indicating the causative organisms, symptoms and treatment.

Mastitis appears to occur less frequently in the camel than in other domestic milch stock. It is interesting since domestic milking camels are often fitted with udder covers to prevent suckling, which become contaminated with milk and are rarely washed. Despite its contamination, probably the cover reduces incidence by providing protection against trauma and gross contamination. It is possible that twin duct anatomy of the camel teat in some way protects against mastitis. The fact that camels are mainly found in dry arid climate, which generally helps in the reduction of contamination.

Peracute gangrenous mastitis does occur, but rarely. It usually just results in the sloughing of the affected mammary unit(s). Adequate antibiotic treatment should be provided for about 7 days. It has been associated with *Klebsiella pneumoniae* and *Escherichia coli* infection. In milder cases swelling, heat and pain of the infected mammary unit may be seen, while in some signs may be restricted to changes in the milk in the form of faint

discolouration with blood and may be some flocculated material present. *Staphylococcus aureus*, *Streptococcus sp.* and *Pasteurella haemolytica* are the most common primary pathogens, while *E. coli*, *Pseudomonas sp.*, *Miorococcus* and *Klebsiella* are believed to be secondary infections. Abscess formation in the inguinal lymph nodes (mammary nodes) occurs occasionally but causes considerable discomfort. Usual treatment is local poulticing with phlegmon ointment for about 5 days. Surgical drainage is sometimes required to relieve pain.

Subclinical mastitis is probably more common. There is reasonably a good correlation between somatic cell count (SCC), California mastitis test and the presence of subclinical infection. Subclinical cases had 7.4 to 12 X 10⁶/ml milk. Surf field mastitis test developed by Muhammad *et al.* (1995) has shown good response in detecting subclinical mastitis. It is very cheap too.

Treatment is best based on culture and sensitivity and the use of an appropriate antibiotic infused into the infected quarter(s) and administered parenterally. The infusion of bovine antibiotic mastitis ointment is complicated in the camel because each teat has two relatively fine ducts, which do not allow insertion of ointment tube nozzles without discomfort. Since the ducts originate from separate cisterna, therefore both ducts of any infected quarter should be infused with ointment. Really difficult animals may have to be tranquillised and rolled on their sides with the hind legs roped back. Before udder infusion, oxytoxin, 5 ml IM, is administered to induce 'let-down' and allow a more complete emptying of the udder. The teat should be cleaned with alcohol and disinfected with pyodine prior to infusing ointment. Commonly used infusions are Mastalone once daily, Ampiclox 12 hourly and Orbenin LA one tube three times at 48 hour intervals. Time of withholding the milk from human consumption subsequent to the final treatment, as indicated by the manufactures should be strictly observed. Full doses of a compatible antibiotic are injected parenterally to maintain blood levels for a period of 5 days. Baytril (enrofloxacin) has been found to enter milk very quickly after injection (Manefield and Tinson, 1997).

Q. Name important zoonotic diseases with reference to camel production and give very brief account of some of them.

Anthrax: It is a bacterial disease and can cause considerable losses in camel in affected areas. It can be confused with black leg (blackquarter caused by *Clostridium chauvoei*), but anthrax does not cause skin

crepitation (crackling sound). Death is sudden in peracute cases. The organism invades man by inhalation, ingestion or skin contact. It is highly fatal in man unless treated promptly.

Brucellosis: Both *Brucella melitensis* and *B. abortus* and probably *B. suis* can infect camel. However, abortion and premature birth has many causes in camel. The organism has been isolated from camel milk, aborted foetuses and vaginal discharge. Man can be infected by ingestion, handling infected material and conjunctival contact. The infection in man is severely debilitating to fatal.

Echinococcosis (Hydatidosis): The camel is an important intermediate host in this disease. The incidence is high wherever camels are found. Cysts occur in both liver and lungs but camel is intermediate host only. It is a slowly developing but potentially fatal disease in man resulting from cyst formation in liver, lung, and often in brain. In some countries human infection rate is up to 4%. Dogs and other canids should be prevented from eating raw organs, especially those containing cysts.

Influenza: There is plenty of evidence of various mammalian species including camel being naturally infected with influenza virus. A strain of virus that caused illness in both the local Bactrian camels and human population has been isolated in Mongolia.

Leptospirosis: The incidence in camels has been reported only from Egypt. *L. icterohaemorrhagica* has been shown to cause haematuria and abortion. The disease is usually mild in man with influenza like symptoms lasting about 10 days; in rare cases meningitis has been reported. Infection is by contact with skin or conjunctiva. Milk, urine as well as wet soil may be sources of infection.

Plague: Camels can intensify plague caused by *Yersinia pestis*, classically carried by rodents and transmitted by fleas, by interaction with the rodent population. In man the disease has an acute highly fatal septicaemic form, and a less acute form shown by lymph node enlargement. The handling or ingestion of camel products can be dangerous. The bacterium can survive up to 5 days in milk, 23 in pelts and 165 days in sputum and exudates.

Q Fever: Q Fever is a rickettsial disease and ticks can be involved in transmission. The organism (*Coxiella burnetti*) causes no noticeable disease in camels, but serology has been positive in up to 39% camels in some regions. Humans may be infected by inhalation of dung contaminated dust and ingestion of, or contact with contaminated camel products. Symptoms

in man are similar to severe influenza, fever and secondary pneumonia lasting 5 to 15 days.

Rabies: It is spread mainly by bites of infected animals. The virus present in their saliva is inoculated in the bite trauma. Foxes are the main reservoir of the disease. Camels can be infected by dog or fox bites, but the chances of spread from camel to man appear to be small. Nevertheless, camel bites in endemic (prevalent in a population or geographical areas at all times) areas should be regarded potentially dangerous, especially if the animal is showing signs of unusual behaviour at the time of bite or does so within next 7 to 10 days (signs such as unusual aggression, chewing inanimate objectives with salivation or self mutilation).

Rift Valley Fever (RVF): RVF is a serious, sometimes fatal, viral disease of man and ruminants. Transmission is by insects including mosquitoes of the genera *Culex*, *Anopheles* and *Aedes* and *Culicoides sp.* Mainly it occurs in African countries of Egypt, Nigeria and Sudan. In camels the only reported sign of the disease has been an increase in abortion rate during epizootics of RVF usually associated with increased seasonal rainfall. Man can be infected by handling infected carcasses. The symptoms are malaise, headache, chill and fever, while fatal haemorrhagic forms have also been reported.

Dermatophytosis (Ringworm): It is a skin disease in camels under 3 years of age with a peak incidence between age 3 to 12 months. Small, round alopecic areas appear on different parts of camel's body. Handlers may become infected and exhibit typical ringworm lesions on their skin. Secondary bacterial invasion causes inflammation and suppuration.

Salmonellosis: It is suspected as being a common zoonotic bacterial disease. Sometimes serious outbreaks have been reported in the camel characterised by foul smelling blackish-green diarrhoea. Chronic cases exhibit intermittent diarrhoea and gradual wasting. Abortion is common, also death may occur. Man becomes infected from contaminated surroundings or animal products. The disease takes the form of diarrhoea, abdominal pain and vomiting. Adults mostly recover but the disease is very dangerous to children.

Sarcoptic Mange: The mite *Sarcoptes scabiei cameli* causes this important disease leading to debility and disrupted productivity. Man can be infected from close contact such as riding an infected camel. Infected humans suffer intense hand and body irritation.

Toxoplasmosis: Infection with the parasite *Toxoplasma gondii* can cause abortion and/or infertility in the camel. Humans can be infected by handling raw products or consuming inadequately cooked meat leading to mild fever, lymphadenopathy or to serious sporadic cerebral involvement. Abortion and stillbirths have also been reported.

Tuberculosis: This bacterial disease is rare in camels. An occasional incidence in a herd, however, may reach a level of 9 to 10%, resulting into slow wasting to emaciation, with coughing and respiratory distress. Transmission to man is via milk, saliva or water contaminated by affected animals. Evidence of the disease is similar to that in animals.

Q. Describe etiology, clinical findings, pathogenesis, treatment and control of trypanosomiasis in camel.

Trypanosomiasis, usually caused in camels by the protozoan *Trypanosoma evansi*, is a major clinical disease and cause of economic loss. Unlike other trypanosome species, *T. evansi* does not have to undergo part of its life cycle in tsetse flies and it is transmitted mechanically by other biting flies. These flies are usually of the tabanid group, mainly of the genus *Tabanus*, but some so called stable flies of the genus *Stomoxys*, also transmit the disease. In some of East African countries, the major tabanid vectors are *Philoliche zonata* and *P. magretti*.

Trypanosomiasis is most prevalent in the rainy periods of the year. Herders usually keep animals away from tsetse-infected areas and other known centers of infection but when systems are forced to become sedentary, the risk of infection increases. Riverine areas, large irrigation channels and watering points are always major danger areas, which cannot be avoided completely. All age groups are susceptible and repeat infections are common. Animals under any form of stress, including lactating females, are especially vulnerable to infection. Because of the suppressive effects on the immune system, infected animals also become susceptible to other diseases. Having been present in the blood and lymphatic system, trypanosomes can penetrate the central nervous system and joints and thus may become less accessible to treatment and to clinical diagnosis by demonstration of the protozoan in the peripheral blood stream. The trypanosomes are present in the blood when the camel has fever.

Many older tests for detecting trypanosomiasis, including mercuric chloride, are still used for *T. evansi*. Modern, rapid and effective techniques are increasingly being employed, including complement fixation and card agglutination tests as well as enzyme-immunoassay (ELISA) and radio-

immunoassay (RIA). These are much more effective in detecting the disease than the older ones. Research has shown immuno-assay to be at least six times more sensitive than haematocrit centrifugation and it is recommended that ELISA should be used in the routine diagnosis of infection. New techniques are being developed rapidly and even ELISA may no longer be the most useful diagnostic tool in near future.

Another method for the detection of live trypanosomes in blood is by the use of ion exchange columns. The ion exchange gel is packed into plastic syringe bodies and the trypanosomes are collected in sealed Pasteur pipettes. After centrifugation, the pipette tip while immersed in a very shallow water bath, is examined with a 20 X objective. Trypanosomes may be seen undulating in the fluid within the pipette tip. The method is claimed 98% accurate, but requires more apparatus, preparation and skill development time. More recently a latex agglutination antigen test has been developed and is marketed as 'Suratex'. It comes with all necessary equipment and reagents and can be completed in the field in about 20 minutes. The test has been declared a diagnostic breakthrough by the manufacturer.

The major symptom of the acute form of the disease is severe anaemia. However, in camels the disease due to *T. evansi* is usually chronic. This is typically shown in slow weight loss, intermittent high fever, general muscular weakness, especially in hind quarters, pale mucous membranes and collection of fluid, especially in the abdominal region. Packed cell volumes of blood plasma are usually 18-20% in infected animals compared to an average of 30% (range 24-42%) in healthy ones. In more severe cases, late term abortions and premature births of calves are very common in pregnant animals, resulting also in loss of milk production.

Health care and hygiene programmes can help in control. Watering at night or at midday reduces the risk of being bitten by flies. Preventive measures before the onset of the disease (Chemoprophylaxis) and curative measures after the disease is clinically evident (Chemotherapy) have shown varying success in controlling and combating the disease (Table 32). As for all trypanosome diseases, drug resistance due to misuse and especially by using too small doses or diluting the drug with water or some other liquid is an increasing problem. In addition, some drugs that are effective in other domestic livestock are poorly tolerated by camels. Newer drugs, particularly a new arsenic-based compound and pour-on repellents are helpful in controlling/preventing the disease. Many new drugs are easy to

handle, can be administered by a variety of routes, have wide tolerances, are long acting and may be released into the metabolism over a long period of time for even greater effect.

Until eradication becomes feasible, regular monitoring is necessary to prevent large scale death losses in areas having acute outbreaks and diminished production and athletic performance with the chronic form. The efficiency of monitoring will be greatly assisted by the availability of the ELISA and PCR tests. Simple monitoring on the basis of frequent (1 to 2 weeks apart) estimation has proved useful in areas with high death risk. All camels with a PCV <25% were treated.

Table 32. Drugs and their dosage for treating camel trypanosomiasis

Drug		Dosage and route	Effect	Remarks
Chemical name	Trade name			
Isometamidium chloride	Samorin	50-100mg/100 kg body weight IV	Curative	Severe local reaction by IM route
Cymelarsen		0.25 mg/kg	Curative –90 days	Deep IM injection
Suramin	Naganol, Antrypol	12 mg/kg body weight IV	Curative (not <i>T.congolense</i>), prophylactic 3 weeks	Paravenous injection causes severe reaction & abscesses
Quinapyramine methylsulphate	Trypacide sulphate Antrycide sulphate Noroquin	3-5 mg/kg body weight, subcut	Curative (<i>T.congolense</i> & <i>evansi</i>)	Local tissue reactions common
Quinapyramine chloride methyl sulphate	Trypacide prosalt	5-8 mg/kg body weight subcut	Curative prophylactic (4-6 months)	Local tissue reactions common

Source: Wilson (1998).

Q. Discuss the cause, symptoms and treatment of Dipetalonemiasis.

It is caused by a parasitic worm (*Dipetalonema evansi*), which lives in the spermatic cord, blood vessels in the lung, the heart, the lymph nodes and the mesentery. The worm larvae live in the blood. The disease is carried by *Aedes* mosquitoes. Whether the disease can be carried by other biting insects such as ticks or flies is not precisely known.

It is a serious problem in Pakistan and has also been reported from some other areas. It reduces the condition of the affected animals leading to shrunken hump, difficulty in breathing and enlarged testicles. The disease

has a long course and renders the camel unable to work. The worm larvae can be seen through a microscope in a wet blood film, moving around like a snake. The larvae measure 250 to 290 μm long and 6 to 7 μm wide. This disease can be confused with trypanosomiasis and conditions arising from other internal parasites and poor nutrition. Prevention may be effected by controlling biting insects. Sick animals should be treated with Ivermectin injection (0.2 mg/kg body weight) subcut. Repeat it after 3 weeks (K. Rollefson *et al.*, 2001).

Q. Are camels prone to parasitic diseases?

Yes, a wide range of parasitic diseases are found in camels, including internal and external parasites. Although mortality directly due to parasitic diseases is very low yet economic loss because of parasite infestation is undoubtedly important.

Q. Name the important internal parasites found in camel. Also mention their sites and disorders caused by them.

Helminths (roundworms) and cestodes (tapeworms) of the gastrointestinal tract are the most common internal parasites. Some e.g. *Haemonchus contortus*, are common in many animals, while others including *H. longistipes*, *Camelostrongylus mentulatus* and *Globidium cameli*, are virtually restricted to camels. *Trichuris*, *Impalaila*, *Trichostrongylus*, *Cooperia* and *Oesophagostomum* are some other important round worms of camels.

The major clinical symptom of parasitic gastroenteritis is severe diarrhoea. Diarrhoea may result from other causes such as sharp changes in diet, especially at the beginning of the rains. Parasitic gastroenteritis may, however, be linked to the rains through an upsurge in parasite burden at this time. In acute cases of diarrhoea, there is severe loss of body fluid and minerals resulting into rapid loss of body weight and condition. Parasitic diarrhoea can usually be cured by broad-spectrum anthelmintics used strategically. If bacterial or viral infection is also suspected, long-acting broad-spectrum antibiotics and sulpha drugs reduce the severity of the problem along with oral replacement of body fluids and supplemental feeding. Close attention should be given to management including cleanliness of watering points, rotational grazing and frequent changing of night enclosures or bedding grounds.

The Arabian camel is a principal intermediate host of hydatidosis, which is also commonly referred to as echinococcosis. This disease is a major zoonotic (animal disease transmissible to man under natural conditions)

problem in many camel-rearing areas. Cysts of *Echinococcus granulosus* are found in camels over a very wide area (Table 33). Prevalence rates are usually higher in camels than in other domestic animals, as is the proportion of viable cysts. Most cysts are in liver but the lungs are also seriously affected. In nomadic lifestyle, failure to dispose of hygienically the human faeces and living in close association with dogs is probably a major etiological factor in man-dog-camel cycle of this disease.

Table 33. Distribution and prevalence of hydatidosis in camels

Country	Animals examined	Infection level (%)	Remarks
Egypt	155	31.6	Mainly in lungs (70.8% infection with complement fixation test)
	204	8.3	0.2% infection in cattle, 0.4% in sheep
Ethiopia	78	5.1	
India	40	50.0	All in older camels, 14.7% fertile
Iraq	152	20.4	Mostly in lungs, 51.6% fertile
Libya	204	16.7	59% in adults, 5% in young, 58% in lungs, 40% in liver
Morocco	n.a	80.0	
Nigeria	3598	55.5	Lungs, liver and spleen, 38% fertile
Saudi Arabia	612	4.7	Mainly in lungs, 38% fertile
Somalia	958	14.8	
	300	6.0	
Sudan	51	35.3	83% in lungs, 46% in liver and 17% cysts in liver fertile
	141	45.4	Lung involved in 91% cases

n.a. = not available.

Source: Wilson *et al.* (1990).

Bacterial and other microbial parasitism of the gastrointestinal tract is also widespread. Coccidiosis (due to *Eimeria sp.*, usually *E. cameli* and *E. dromedarrii*) is a major debilitating disease of young stock. Other common pathogens such as *Salmonella sp.*, *Eimeria coli* (causes coccidiosis), *Clostridium perfringens* and *Mycobacterium paratuberculosis* also cause severe morbidity. *M. paratuberculosis* causes Johne's disease leading to very severe diarrhoea and wasting (Wilson, 1998).

External Parasites

Q. Give a detailed account of sarcoptic mange in camels.

Sarcoptic mange is one of the important diseases of camel. It is caused by *Sarcoptic scabiei cameli* (a minute burrowing mite). It is a widespread and contagious disease. It is transmitted through close physical contact at watering holes, dust bath areas and housing enclosures. Contaminated

objects such as grooming tools, blankets and saddles also act as fomites (agents of transmission of an infection). Young, immature, stressed adults and debilitated animals are generally affected and usually develop into the chronic generalized form of mange. Healthy animals if affected, have localized lesions. Poor management and inclement weather can increase morbidity and mortality rates.

Eggs deposited by female mites in the horny outer layer of the skin undergo three development stages (larvae, nymphs and adults) in about 17 to 21 days. The adult mites mechanically damage the skin of the host by making minute burrows. Allergic reaction is shown to mite saliva and faeces usually followed by secondary infection. Intense pruritis evolving small vesicles and inflammatory reaction of the skin characterize the beginning of the disease. Pruritis is severe and affected animals resort to extensive rubbing and scratching. Affected areas show loss of hair and become moist and suppurative. Fully developed mange is characterized by scab formation and thickening of skin. Most affected areas are the head, axillary, inguinal and perineal areas. Chronic cases of mange show grey coloured and folded hyperkeratotic skin. Affected animals show a general loss in condition, decrease in milk production and poor reproductive performance.

Successful treatment requires improvement in management practices and overall sanitation. Overcrowding, mingling of affected animals with healthy and contact with contaminated tools should be avoided. It is recommended that whenever possible, affected animals should be treated and handled by only one person, who is not involved with handling unaffected animals, because herders can also serve as fomites. Topical application of acaricides present an effective, but labour intensive treatment. Vigorous brushing of affected areas with dip solutions is necessary. The treatment may be repeated each ten days until healing is complete.

Systemic treatment with ivermectin, subcutaneously injectable antiparasitic drug, has shown good results in controlling and treating camel mange. The recommended dosage for cattle 1ml/50 kg body weight is effective in camels. Occasionally local tissue reactions such as swelling or abscessation can be observed. Despite efficacy of ivermectin, its clinical response takes time and treated camels can still be a source of infection until clinical response has fully taken place. In addition, spraying with an acaricide to kill mites on the skin is advisable.

Q. Describe the etiology, symptoms and treatment for camel dermatomycosis.

Dermatomycosis also known as ringworm is the skin condition resulting from infections by one or several fungi. These usually include the three genera namely *Trichophyton*, *Microsporum* and *Epidermaphyton*. The first is the most common organism in camels. High humidity, overcrowding and nutritional deficiency (vitamin A?) are conducive to the disease. As many as 80% of calves show symptoms in affected herds but spread is slow and mortality directly from dermatomycosis is rare. There are two clinical types of ringworm. The first shows typical 'ringworm' lesions that are grey-white in colour, circumscribed 1 to 2 cm in diameter, slightly raised hairless patches. The second is a more generalized infection and in this case the problem may initially be confused with mange. Infections in older animals are rare, presumably immunity develops after an attack. Diagnosis can be made tentatively on symptoms but should be confirmed microscopically. For direct microscopic examination, samples are placed on a glass slide, then covered with 20% potassium hydroxide or sodium hydroxide, shortly heated up and then examined for presence of fungal mycelia and spores. Scrapings for examination should be obtained from the edge of the rings as the aerobic fungi cannot survive under the crusty lesions.

A variety of medications for treating ringworm in other livestock are available (Table 34). Lesions should be scrubbed clean with soapy water first and all scabs and lesions removed must be burnt as they are likely still to be infective. Whole body treatment using sprays and washes is recommended when an entire herd is affected. Where secondary infections of bacteria are evident, an antibiotic treatment should be added to the curative regime.

Table 34. Common medications used to treat dermatomycosis in other livestock species

Dispersion/drug name	Directions
Ointments	
Whitfields ointment	
2-4 % thiabendazole ointment	two to four times/day every 5 days
Propionic ointment	
Solutions	
Lugol's iodine solution	once every 2 nd day
1:200-1:1000 quaternary ammonium compounds	once every 2 nd day
Hexetidine	once a day

0.01% - 0.1% natamycin	twice every 4 th day
Sprays/washes	
Agricultural Bordeaux mixture	once daily for 5 days then weekly
0.5% lime sulphur	
0.5% sodium hypochlorite	
1:300 Captan	
0.5% chlorhexidine	
Systemic	
10% sodium iodide 1g/14 kg body weight	intravenous (once), repeat after one week

Source: Schwartz and Dioli (1992).

Q. Ticks commonly found on camels belong to which family? In what way ticks harm camels?

Ticks commonly found on camels belong to the family *ixodidae*, the so called true ticks. Female ticks deposit their eggs in sheltered spots. The newly hatched larvae also called seed ticks wait on vegetation till they are attached to a suitable host where they feed themselves on blood and or lymph of the host till they are fully engorged. They detach after having engorged. Each development stage (larvae, nymph and imago) of the tick requires a new host after feeding. Inclement weather has a negative effect on hatching and moulting time. After rainy season there is a marked seasonal decrease in tick burdens on camels. Average tick burden in dromedaries kept under pastoralists and nomadic conditions is about 50 to 100 ticks per animal during the dry season.

Physical irritation and wounds caused by ticks may allow entry of other disease organisms and blood loss from heavy infestations can cause anaemia, especially in young calves. An adult female tick can remove 2 ml blood. Adult ticks are usually seen around anus and genitalia but nymphs often hide in the longer hair along the back, hump and neck. Heavily infested animals show anaemia, general loss of productivity and body weight.

A thorough examination is necessary to diagnose tick infestation. Heavily infested animals should be treated with pour-on acaricides or sprayed. In adult animals, regular application of tick grease to common sites is recommended. Immature animals especially suckling calves should be regularly treated in the first few months with pour-on acaricide to reduce preweaning mortality due to heavy nymph infestation. Avoiding heavily

tick infested grazing areas, overcrowding at watering sites and holding enclosures will also help to control tick infestation.

Q. Discuss tick infestation of camels in detail.

Tick infestation of camels is a universal problem. All age groups are prone to it. It can be particularly troublesome where high-density husbandry is involved such as resting camps of racing and breeding camels. Most of such ticks are members of Ixodidae family, commonly known as hard ticks. Infesting ticks vary from region to region e.g. *Hyalomma dromedarii* is the most common on the Arabian peninsula with *H. anatolicum excavatum* also being common there and in North Africa. *Dermacentor sp.* are commonly found in Asian region. In Australia, *Boophilus microplus*, the common cattle tick, also infests camels but cattle are its preferred host. *Amblyomma sp.* are found on camels in Africa and Arabia. *Rhipicephalus sp.* occur in Ethiopia and Kenya. In Australian East Coast regions, where *Ixodes holocyclus* is found, clinical cases of paralysis may be seen in young camels recently introduced to the environment.

The life cycle of ticks may vary from two to three hosts depending upon the environmental conditions and host availability. Clinical signs vary and depend upon the age of the host animal and the degree of infestation. In young animals very heavy infestation with larval and nymphal stages (thousands of ticks) may cause marked debility, anaemia and death. Camels aged 2 to 3 weeks have been observed to die due to thousands of larval and nymphal ticks attached. These are not obvious unless the examiner runs his fingers through its coat. The legs of camels introduced into rested camel yards may be literally attacked by large numbers of adult ticks. The camels thus attacked are found running around within the yard stamping and shaking in distress due to irritation. Ticks most commonly attach to perineal, inguinal and axillary regions but generalized attachment masked by winter coat, can lead to irritation which results in some hair being lost from rubbing and biting.

Most commonly the results of tick infestation manifest as secondary problems. This may be focal of bacterial abscessation at the points of attachment, especially under the tail and on the perineum. Myiasis may result at these sites of abscessation or, especially in screw worm areas, as a result of bleeding from attachment sites. Corneal ulceration can result from attachment of a tick to the eyelid margin. The cornea may be scratched due to the head being used to rub an irritable leg area with tick attached.

Camel ticks may be involved in the epidemiology and spread of many diseases. Some of these are of no clinical significance in the host animals but of considerable importance to other livestock and dangerous to man. Among these are *Yersinia pestis* infection (plague), Crimean Congo Haemorrhagic Fever (CCHF) a deadly zoonosis, dermatophilosis, FMD, rinderpest etc. Full significance of the tick/camel role as a vector/reservoir for many diseases is not known as yet. It is, however, advisable in the interest of animal hygiene, to minimize tick infestation in camels whenever possible.

The old method to pluck the ticks off the animal body does not work and is highly risky. Most commonly available acaricides are effective for tick control but overuse of understrength solutions appears to have led to tick resistance developing in some areas. Barricade 5[®] gives good continuing protection if repeated every 4 to 6 weeks. Nucidol[®] and Malathion[®] and Amitraz are effective as long as resistant strains are not involved. The larval stages of many ticks are highly resistant to chemical treatment. It has recently been shown that intensively stocked areas such as housing yards and dry lots can be subjected to burning over with a flamethrower. Heavy tick infestation may result from congregation of the animals at feeding, watering, sheltering and stabling places. These areas should be sprayed with a long acting acaricide like Barricade 5[®], 2 to 3 days before introduction of the camels (Manfield and Tinson, 1997).

Q. Are psoroptic mange and sarcoptic mange one and the same?

No, these are different, caused by different mites. Psoroptic mange is caused by *Psoroptes cameli* in camels in Indo-Pakistan subcontinent. It is usually a relatively mild and superficial infestation with varying degrees of pruritis. It most frequently causes lesions between the mandibles, in the axillae, around the tail, on the mammary gland and on the prepuce (see sarcoptic mange). Organophosphate sprays (Barricade S[®]) be done at weekly intervals, 2 to 3 times. The animal should be thoroughly wet all over.

Q. Name the fly that causes myiasis. Discuss the disorder caused by this fly.

Probably the most important of the flies, which causes myiasis, is the nasal bot, *Cephalopina titillator*, a fly belonging to the family Oestridae of the order Diptera. The adult is short lived and rarely seen. The larvae, which hatch from eggs laid by the female fly in the camel's nostrils, are widespread, numerous and almost universally present in camel sinuses.

Later the emerging larvae migrate to the naso-pharynx. After completing their development, the larvae are usually removed by sneezing. The characteristic symptoms are bleeding from the nose, nasal discharge due to swelling and secondary infection of the respiratory tract and respiratory distress. If the larvae penetrate the turbinate bones, nervous symptoms, including difficulties in movement and apparent fear of people even already well known to the camel, may also result. Diagnosis is based on presence of neurological signs. Rabies should be kept in mind as a differential diagnosis. If necessary, treatment with several available injectable antiparasitic drugs can be effective. *Hippobosca camelina* a large and sturdy biting fly belonging to the Tabanidae family is specific to camel and is almost always found around camels, especially favouring their abdominal and inguinal regions. It is somewhat difficult to kill it by slapping or squashing. Its role in disease transmission, especially of trypanosomiasis, is not known but secondary losses due to stress and disturbance to animals are probably considerable (Wilson, 1998).

Q. Discuss the causes, clinical findings and treatment of gastrointestinal disorders in camel.

With pastoralists and nomads, the most commonly occurring diseases of the gastrointestinal tract in adult camels are mostly related to severe endo-parasitism, sudden diet changes and some specific diseases such as chronic trypanosomiasis and plant poisoning. Most cases of diarrhoea related to endo-parasitism and diet are seen at the beginning of the rainy season. The onset is usually acute and 20 to 30% of the adult animals of a herd are involved. Mortality is usually low. Neonatal calf diarrhoea is mainly caused by bacterial infection including *Escherichia coli* enterotoxaemia and salmonellosis. Morbidity can be up to 30%, but without immediate and proper treatment, mortality can be very high. Poor management practices such as no or inadequate colostrum feeding, unsanitary feeding, faecal contamination of watering sites facilitate disease outbreaks. Dietary diarrhoea caused by ingestion of excessive quantities of milk is rare in young calves, since suckling intervals are strictly controlled by herdsman. Faecal water content increases in diarrhoea resulting in the frequent passage of loose faeces. Gross examination of faeces may show alterations in colour, odour and presence of blood, mucus, parasites and undigested feed or sand. Underlying mechanisms for increased faecal water content can be

hypersecretion, exudation, altered motility, malabsorption and osmotic retention of water. In acute diarrhoea, excessive amounts of fluid and minerals are lost as indicated by sunken eyeballs, decreased skin turgor and sticky mucous membranes. Persistent diarrhoea also results in continuous soiling of rear quarter (tail hairs get matted with dried faeces and progressive loss of condition (hump is reduced to nothing, ribs become prominent and there is general muscular atrophy).

Animals usually become debilitated due to acute bacterial diarrhoea and show additional clinical signs such as fever, abdominal pain, anorexia and general depression. Cases of chronic diarrhoea show a persistent loss of weight, decreased productivity, but grazing activity and feed intake may still be near normal. An etiological diagnosis is usually difficult, but affected age groups, seasonal incidence and type of diarrhoea might be helpful to identify the underlying cause. If definite etiological diagnosis is needed, samples must be submitted for laboratory analysis.

Dietary induced diarrhoea usually resolves itself, if diet change is corrected and usually does not require any specific treatment. However, if endoparasitism is the cause of diarrhoea, treatment with a broadspectrum anthelmintic and general improvement of sanitation regarding clean water holes and clean night enclosures will limit spread and reinfection. To treat the diarrhoea caused by bacterial or viral infection, long-acting antibiotics should be accompanied by oral replacement of fluids, supplemental feeding, good sanitation and, to limit spread, isolation of the affected animal. Despite the prevalence of dietary and parasitic induced diarrhoea, the importance of clinical work-up and at least the consideration of different possible causes should not be overlooked before and during treatment. Careful monitoring of response to treatment, condition of the animal, spread of the disease etc. is mandatory and will aid making and confirming the diagnosis.

Q. Give symptoms and treatment of colic in the camel.

Initially the camel manifests colic usually in the form of varying degrees of restlessness while in sternal recumbency. Rolling from side to side may be exhibited. Ballottement (a palpatory manoeuvre to test for a float object such as a foetus) and prodding of the abdomen will be resented. Intensification of pain is characterised by rolling and cramped (painful spasmodic muscular contractions) repetitions of rising and couching. At this stage the heart rate will be >60 (normal 30 to 40).

Every effort should be made to determine the underlying cause of the colic and to treat that condition. When abdominal sounds are spasmodically augmented, Buscopan Compositum, 20 ml IV in adults, usually gives good relief. Occasionally, in severe cases of colic associated with gastrointestinal obstruction, Rompun 100, 0.5 to 1.5 ml IM injected every 4 hours, has been found useful. Along with Tympanyl-liquid paraffin may be administered to relieve obstruction.

Sand Colic: Ingestion of sand may occur under certain circumstances such as haemonchosis, insufficient salt intake and boredom. It should be suspected as a cause of colic when tethered camels are not muzzled and faeces contain appreciable amounts of sand. Sand colic is difficult to treat when large amounts are present. Dosing with Methyl cellulose and Metamucil is effective. Metamucil 60 to 90 g once or twice weekly may be administered prophylactically but muzzling is easier (Manefield and Tinson, 1997).

Other allied gastrointestinal problems in camels and their most likely causes include:

- Abdominal distension: bloat due to diet, ingestion of excessive quantities of sand, obstruction of large intestine, watered camels, late term pregnancy.
- Anorexia: high ambient temperature, prolonged dehydration, fever.
- Constipation: impaction of forestomachs, bloat, obstruction of large intestines, complete recto-vaginal tear; prolonged dehydration.
- Impaired grazing/drinking: paralysis of tongue or dulaa, rabies, painful oral lesions caused by camel pox, FMD, BVD, contagious ecthyma, foreign bodies, decayed teeth, fractured mandible.
- Pain: bloat, peritonitis, enteritis, poisoning, abdominal hernia.
- Tenesmus (painful straining): endo-parasitism, genital tract diseases such as vaginal prolapse, vaginitis; recto-vaginal tear, urethral obstruction.
- Vomiting: behavioural display of stressed or furious camels when restrained.

Q. Are stiff neck and wry neck syndrome in camels one and the same thing or are different conditions? Justify your answer with reasonable explanation.

Stiff neck and wry neck syndrome in the camel are two different diseased conditions. The latter is characterized by a S-shaped deformation of the camel's neck. The onset of the disease is acute and spontaneous recovery without treatment is not uncommon. Apparently the condition does not appear to be painful and the animals behave normally. In severe cases gazing is impaired and animals lose condition progressively. Most commonly animals at weaning age are affected. The disease does not seem to be contagious. Systemic treatment with vitamin B complex hastens recovery but it is not clearly known that the disease is related to deficiency of vitamin B complex. Pastoralists resort to the traditional treatment of bilateral branding of the neck of the camel.

Stiff neck, on the other hand, is a distinctive disease condition having both acute and chronic forms. Clinical findings in the acute form appear similar to tetanus, whereas the described chronic form does not fit the clinical picture of tetanus. The acute form is characterized by stiff neck, general rigidity of muscles and inability to open mouth. The acute form is quite often fatal and lasts 10 to 15 days with progressing signs. All age groups are susceptible. Since only single animals are usually involved, therefore the disease does not appear to be contagious. The condition, however, is very painful. Spontaneous recovery is not uncommon, however, convalescence period is quite long.

There is permanent stiffness of the neck, head and neck are held in extended manner exhibiting severe pain. The chronic form lasts about 3 to 12 months. During this period the animals lose condition and eventually die. Nomads and pastoralists treat this condition by extensive branding of the neck region. Suggested differential diagnosis in chronic form has included rheumatism and muscular disorder during surra. Subluxation (partial dislocation) of the atlantoccipital articulation or other musculo-skeletal injuries to the cervical column have to be included in the differential diagnosis.

Since the acute form of the disease has many similarities with tetanus, therefore, it seems logical to discuss here about tetanus. Tetanus is a widespread disease in tropical and subtropical regions. *Clostridium tetani*, an anaerobic organism causes this disease. It is commonly present in soil or intestinal tract. Mortality due to tetanus is quite high. Recovered animals develop no immunity against reinfection. In wounds contaminated with soil containing clostridial spores, especially deep puncture wounds covered by scabs or dirt, a favourable anaerobic condition is created in which *C. tetani*

can multiply and grow. Upon stagnation of growth, autolysis of bacterial cell membranes occurs and neurotoxin is released which stimulates nerve endings. Incubation period is between 10 to 14 days. Characteristic symptoms are localized stiffness of the head and the neck muscles, generalized muscle rigidity, lock jaw and erect ears. External stimulation including noise, sudden movement and sensation of contact provoke sudden general spasms. Severity of spasms and outcome of disease depend on the amount of toxin released and animal susceptibility to the neurotoxin. Respiration rate and body temperature are increased. In mild cases recovery is possible. Fatal outcome is common in severe cases.

Application of dark eye patches and ear plugs is recommended to reduce exposure to external stimulation. Preferably affected animals should be put in a quiet and dark environment. However, if no such facility is available, the animal should be sedated. Before putting the animal there, the area should be inspected for any standing out bricks, rocks, or any protruding out nails to reduce the risk of injury during general spasms. Also, clean and soft bedding should be provided. The animal should be inspected for any wounds and treated accordingly. Tetanus antitoxin and antibiotics be administered systemically. Keep in mind the possibility of anaphylactic shock (a manifestation of immediate hypersensitivity) due to antitoxin. Animals responding to treatment should receive good nursing care during the recovery period (Schwartz and Dioli, 1992).

Q. Give the causes and clinical findings of facial paralysis in camel.

Common causes of facial paralysis in camel are direct trauma to facial branches of otitis medial or interna nerves and skull fractures into the petrous temporal bone. Paralysis is usually unilateral. Main clinical findings are immobility and dropping of the ear and deviation of the nose to the unaffected side. In permanent facial paralysis there is atrophy of muscles on the affected side. Treatment for acute cases includes administration of antiinflammatory drugs, application of hot packs and good nursing care plus use of appropriate nervine tonics.

There are some other nerve dysfunctions such as paralysis of the radial nerve after prolonged lateral recumbency, inability to get up after prolonged restraint with ropes in sternal recumbency, post-partum ataxia in first calvers with dystocia and transient paralysis of the tongue presumably related to vigorous manipulation of the tongue or resulting from trauma. Restoration of normal function in most of these cases depends on the extent

and nature of damage. However, good nursing care and persistent treatment can yield unexpected success.

Q. Discuss in detail the occurrence of ocular ailments in camels.

Ocular ailments are common among herded camels and are mostly of traumatic origin including blows, thorns and other foreign bodies. Most of the time one eye is affected. On pastures where vegetation consists mainly of shrubs and acacia trees, the incidence of trauma is high. Injuries also occur during the night, when the animals are confined in small enclosures usually built of thorny branches of acacia. Excessive rubbing due to irritation of the eye lid caused by fly or tick infestation can also lead to eye injuries and secondary bacterial infections. During the fly season, infestation with *Thelazia leesi*, a nematode can be seen. The eye worm is found in the conjunctival sac. It may cause conjunctivitis and hyperlacrimation. Eyelid inflammation is also seen with camel pox and contagious ecthyma infections. Occasionally eye infections result in impaired vision or complete blindness caused by corneal opacity and scars. Opacity of the lens is a common ailment among older camels. The etiology is not clear. Depending on the degree of cloudiness, vision can be partly or completely impaired. Such animals usually lose condition rapidly unless supportive help is available, since their grazing ability is seriously impaired. They are also at a higher risk of predation if not thoroughly guarded. Cases of temporary blindness in adult camels without apparent lesions have been observed. The animals recovered full eyesight after a few weeks. They showed photophobia and apparent blindness as indicated by insecure gait and walking into objects. This idiopathic (of unknown cause) blindness was thought to be related to previous severe outbreak of camel pox in the herd. Night blindness also occurs in camels but at a very low incidence. It has been seen in both sexes while otherwise they are completely normal.

Most eye ailments cause a lot of discomfort to the animal, which may result in reduced feed intake. There are signs such as hyperlacrimation, head tilt, wounds, swelling of periocular tissue, separation from the herd, seeking shade, extensive rubbing of the head, squinting, insecure gait and bumping into obstacles. Thorough examination of the eye will often reveal the cause. Superficial wounds of the eyelid and the periorbital region usually do not require any specific treatment beside wound cleaning, removal of any ticks present and prevention of fly-strike. Treatment of swelling and inflammation of the eyelids and secondary bacterial conjunctivitis caused by

camel pox or contagious ecthyma lesions includes cleaning of the eye and repeated application of topical antibiotic ointment into the conjunctival sac. Inflamed conjunctiva or keratitis due to foreign bodies such as sand, grit, thorns can be treated by careful removal of the foreign body and repeated application of topical antibiotic ointment. Furthermore, the animal should be kept in shade or a temporary eye patch placed over the affected eye. In case of severe pain as indicated by loss of condition, the short term use of analgesics is recommended. Feeding and watering of animals with temporary or permanent impaired vision should be done separately from the herd to prevent feed being taken by other animals. Also, the animals should be confined in an enclosure to reduce the risk of self inflicted injuries (Schwartz and Dioli, 1992).

Q. What are the usual sites and signs of snake bite in the camel? Suggest suitable curative measures.

Snakes can bite the camel on the legs, udder, lips and any part of the body while it is sitting or browsing. If the bite is on a hairy part of the body, it is often hard to locate it.

There are so many types of snakes, thus the signs depend on the type of snake and the body part bitten. The camel bellows loudly and for a long time. It becomes restless and loses coordination. It stops grazing. There is swelling at the site of the bite, foaming from the mouth and protruding tongue. The bite wound may bleed when bitten by certain types of snakes. If the bite is on the udder, the affected quarter may ultimately slough off. The bite in the throat leads to death.

To treat a case of snake bite, tie a tourniquet (a tight rope or bandage) above the bite. Widen the location of the bite using a knife and allow it to bleed. It is hoped that the poison flows out together with the blood. Treat the wound like any other wound. Apply an electric shock as soon as possible after the animal is bitten. Put the affected areas (usually a leg) on the ground (to earth it electrically). Use a cattle prod or a lead from a car spark plug to apply an electric shock to the bite for 1 to 2 seconds. Repeat 4 to 5 times at intervals of 5 to 10 seconds. If treated soon enough (within 30 minutes of the bite), all pain disappears in 10 to 15 minutes. If available, inject antihistamines and antivenin (to counteract poison).

Q. What do you know about red urine in camels? Discuss in detail.

Red urine also called haematuria (Rut Mootra). Red urine is caused by blood in the urine. There are several causes of excretion of blood mixed urine. However, it is not a common problem in camels. The urine may have

a tinge of blood or it may be deep red. Sometimes there are signs of discomfort in the belly and straining while passing urine.

Different causes of this problem are: infections of kidneys or other parts of the urinary tract, damage to kidneys caused by a blow on the back, wounds to the scrotum or penis, possibly caused by bites by other males during the rut season, bladder stones, parasites in the kidney and plant poisoning.

If red urine is due to bladder stones: inject 20 to 30 ml of Buscopan Compositum or 20 to 30 ml of Novalgin into the muscle or vein and treat as for infections. If red urine is due to an infection, inject an antibiotic such as ampicillin (10 mg/kg body weight intramuscular twice a day for 7 days or norfloxacin (5 mg/kg body weight IM for 7 days). Give the camel plenty of water to drink (drench with water if it does not drink) (K. Rollefson *et al.*, 2001).

When haematuria is due to an injury, press a cold, damp cloth on the wound and then apply an antiseptic dressing. Inject a systemic coagulant such as carbazochrome or vitamin K. Give a urinary antiseptic such as nitrofurantion (4 g twice a day by mouth) for 10 to 15 days. Inject an antiinflammatory drug such as phenylbutazone (10 mg/kg body weight) once a day for 7 to 10 days. To prevent secondary bacterial infections, inject an antibiotic such as ampicillin (10 mg/kg body weight twice a day IM for 7 to 10 days. As a preventive measure avoid injuries to the kidney region i.e. the camel's back behind the hump.

Q. What are the salient signs of sunstroke in the camel. Suggest appropriate preventive and curative measures for this ailment.

In very scorching hot and/or humid weather, an overworked and heat exhausted camel may fall down and lose consciousness. It may die immediately, or remain weak and go off feed and water, possibly dying later. This problem is encountered commonly in draught camels and animals that are stall-fed.

The more commonly observed signs are: convulsions, dizziness and sudden loss of consciousness, off feed and water, no response to movements nearby. The animal seeks shade and hides its head in bushes. Scorching heat and deficiency of minerals and vitamins in the feed are the usual causes.

Preventive Measures: Do not use the animal for long hours of draught work in very hot and/or humid weather. Provide mineral and vitamin supplements to stall-fed camels. Provide a drink made of 1 to 2 kg of ground sorghum once a day.

Curative Measures: Put the animal in the shade: Pour cold water over its head and body. Give a drip of 7 to 10 litres of normal saline solution per day for 3 days. Give a drip of 3 litres of oral rehydration liquid (9 g salt, 50 g of sugar and 10 g of sodium bicarbonate dissolved in each litre of water) for 7 days. Inject the following each day: vitamins ADE IM for 3 days, dexamethasone (40 mg into the vein for 3 days) and analgin or paracetamol (e.g. paracetamol 30 ml IM for 2 days. Do not give corticosteroids such as dexamethasone to a female camel during the last 4 months of pregnancy because abortion can take place (K. Rollefson *et al.*, 2001).

Q. Define allergy and give the common signs of allergy in one-humped camel.

When the body over-reacts to a certain substance, this phenomenon is called allergy. The substance can enter the body if it touches the skin, or is injected, or the camel eats it or breathes it in. Either the whole body can be affected by allergy or only the part that comes into direct contact with the antigen. Some animals have allergies to certain substances, while others may not be affected at all.

Q. Write down the possible causes of allergy and suggest suitable treatment of this problem in camels.

Body overreacts: to injection of certain medicines e.g. in case of trypanosomiasis, to certain types of vaccines especially those with oily base; to insect bites (such as wasps, bees and ants) and to certain types of feed. To treat such cases inject an antihistamine, inject corticosteroids such as dexamethasone (do not give these to female camels during the last 4 months of pregnancy because they can cause abortion). When one part of the body is affected, apply creams containing prednisolone to the affected parts.

Q. Discuss dry coat syndrome, giving its causes, signs and treatment.

This problem is commonly reported by camel herders. It is also named as anhidrosis and hypohidrosis. Dry coat syndrome is common in the summer. Although the exact cause is not known but lack of enough salt intake, overwork and improper rest may lead to dry coat syndrome.

Important signs are: reduced amount of sweating or none at all. A normal draught camel will start sweating within 30 minutes of work during the summer. Unwillingness to drink (a typical sign) and eat, rapid loss of condition, the animal seeks shade, depression, fever more than 103°F (40°C) during the morning, possibly higher in the evening, rapid pulse and

breathing, breathlessness. The animal becomes tired quickly. The temperature stays high even when the camel is resting.

Treatment: Force the camel to drink or drench with water. Provide 0.5 kg salt in the feed or water every 4 to 8 days. Make a drench of ground garlic, ginger, Kalizeeri (*Vernonia anthelmintica*), skimmed milk, jaggery and common salt. Give 500 ml of this drench twice a week. Drench with 250 ml of Taramira (*Eruca sativa*) oil. In addition to the traditional treatment, modern treatment suggests: rest for 1 week. Make a solution of 120 to 240 g of commercial oral rehydration salts, plus 0.5 kg of glucose (sugar) or prepare 3 to 4 litres of oral rehydration fluid. Drench once a day for a week. Give 5 to 6 litres of Ringer's lactate-dextrose solution and vitamin B-complex as a drip once a day for 1 week. Give 2 to 3 g of vitamin E in the mouth once a day for 1 week.

Q. Write a note on urolithiasis.

In the male, ascending infections can lead to calculus formation. Urolithiasis has also been associated with a diet high in concentrates. The calculi usually lodge in the urethra just before or in region of the sigmoid flexure. If the blockage caused is partial, the signs are frequent passage of small amounts of urine or prolonged urination time. The bladder, if intact, is likely to be full and the animal apparently incontinent. It is wise to confirm that rupture of bladder has not occurred before attempting relief by urethrotomy. In the female, uroliths have occasionally been seen during routine trans-rectal ultrasonic examination. These would only cause a problem if impacted into the neck of the bladder. It may be possible to massage them back into the bladder fundus from this site. Urethrotomy may be performed above or below the scrotum. The lower site is preferred since there is less haemorrhage and less problem from subsequent urine scald. The wound may be allowed to heal by granulation and general wound treatment.

Q. Define wounds. How would you proceed for the treatment of a basic wound and an infected wound?

Wounds are injuries that cause breaks in the skin. In case of deep wounds, tissues underneath the skin are also involved. Wounds may be shallow such as scratches caused by thorns or deep such as a spear wound. The type of wound depends on what caused it. Wounds often heal slowly, especially if they are infected. Camels are very prone to wounds.

Treatment of Basic Wounds: Clean the wound with salt water (mix 2 teaspoons of common salt with a bottle of clean boiled water or with diluted vinegar or sodium bicarbonate, diluted the same way as the salt. Clean the wound with pyodine. Renew the dressing once a day until the wound heals. Clean the wound with an antiseptic, cut out any dead flesh and sew the skin closed with a needle and suitable thread. Do not sew any old or infected wounds. To stop bleeding, apply tincture benzine or a 10% solution of alum or the juice or flesh of *Aloe* leaves.

Treatment of Infected Wounds: Cut off the hair around the wound. Clean the wound with hydrogen peroxide. Pick out, if any, maggots either with a forceps or by applying a ball of cotton soaked with phenyl or turpentine oil, for 10 minutes or dip a swab of cotton wool in Maggacite and pack into the wound for at least one day. Next day clean the wound and remove the dead maggots. Make sure any pus can drain out by cutting a slot into the skin. Remove dead tissue from the edge of the wound with a scalpel or clean sharp knife. Flush the wound with an antiseptic lotion. Apply an antibiotic dressing. If the animal is valuable, give it a shot of anti-tetanus serum. Deep wounds should be treated with an antibiotic used against mastitis. Squirt the antibiotic into the wound through the nosel of the antibiotic tube (in some countries these antibiotics come in a syringe with a blunt point instead of a needle). If the wound is deep and produces pus, use the above treatment, and flush it out with an antiseptic once a day for several days (K.Rollefson *et al.*, 2001).

Q. What are the various causes of wounds in camel and the factors that further complicate the wounds? Suggest suitable wound treatments.

Injuries of varying severity are a common problem in camel management. Browsing areas mainly having shrubs, acacia trees, other thorny vegetation and stony ground often become source of skin, foot pad and sternal pad wounds. In addition, predators, venomous snakes and intertribal enmities can also contribute to a higher incidence of wounds. During the rutting season, fighting wounds on withers, hump, front legs and scrotum among male camels are a common problem. Occasionally female camels are accidentally injured by breeding males during courtship. The foot pad and the pedestal pad are predisposed by their function to penetration by foreign bodies such as thorns, nails, sharp pebbles. Humid and wet weather increases the liability by softening the horny tissue.

Lesions can be superficial or involve deep tissue. Factors such as time lapse since injury, further contamination with soil, blood supply, presence of necrotic tissue, foreign bodies, flystrike greatly influence physical appearance. Wounds caused by penetrating foreign bodies are usually small and deep and are thus easily overlooked, especially foot pad and pedestal pad lesions. Foot pad lesions usually result in lameness, hot and painful swelling and reluctance to move. Grunting in the act of rising or sitting down suggests a pedestal wound. Pedestal wounds can impair reproductive performance. Affected male camels show a decreased libido, since weight bearing during copulation is done mainly by pedestal pad. Biting wounds can either appear as small puncture wounds, extensive laceration or even amputation of soft tissue. A bite from a venomous snake is characterized by two small puncture wounds. Bleeding may be minimal. If animal survives, extensive tissue swelling develops followed by local tissue necrosis. Anti-venom serum should be administered immediately.

While undertaking the treatment of a wound, an assessment needs to be made of the extent of lesions, status of blood supply and the time lapsed since injury. Primary closure should not be undertaken in the case of grossly contaminated wounds, where excessive tension will result from closure e.g. wounds close to joints and where dead spaces are present. These wounds are left open, debrided, a drain placed, broad-spectrum antibiotics administered systemically and allowed to heal by second intention (healing by granulation from base and both sides towards surface). Since all wounds are predisposed to fly-strike, application of insecticidal preparations should always be included in the treatment protocol. Biting wounds must be opened and the wound cavity explored, since biting wounds usually result in extensive trauma and contamination of deep tissue. These should be flushed with diluted iodine or a sterile saline solution. Prognosis is generally good.

Q. What care needs to be observed in treating wither wounds, nasal peg and pedestal pad wounds?

Vigorous treatment is necessary for proper healing of these three wounds. Any neglect can render the animal useless. Recurrent contamination, reopening of the wound by birds or brushing tree branches and insufficient drainage are common, especially in case of wither wounds. After dressing the lesions with pyodine and antibiotic wound powder, these must be covered with adhesive plaster (or protective bandage) so that the lesions are not recontaminated or reopened by birds. Treatment of an injured pedestal

pad presents a serious challenge. Position and function of pedestal pad lead to continuous soiling and irritation of the wound. To prevent this a dough shaped bandage can be applied. Thus the pedestal pad no longer comes in contact with soil when the animal lays down. Abscessation of the pedestal pad usually results from deep pedestal pad lesions and again has to be treated vigorously, since secondary infection of the chest cavity is possible from fistulas of migrating foreign bodies. Good drainage is very important. Prognosis is guarded, but good nursing care, dressing with pyodine and rest have yielded successful results. In neglected cases excessive formation of fibrous tissue results in an enormously enlarged pedestal pad. Such cases then require surgical amputation. Deep solar wounds also require vigorous debridement, flushing of the wound canal, removal of any foreign bodies, use of protective bandage and rest for early recovery of the animal.

Q. Write a note on saddle sores (saddle gall).

Riding as well as baggage camels may be affected by saddle sores. The skin where the saddle presses becomes raw or dry. It can take the form of an abscess. When the saddle is put on, the animal feels pain. Continuous rubbing and pressure from the saddle damages the skin and tissues underneath. Pecking by birds may keep the sore open. For treatment restrain the animal; preferably sedate it. Using a scalpel, open the sore to drain out the pus and remove the dead tissue. Put magnesium sulphate powder in the hole. Flush daily for 3 to 4 days with 0.1% solution of potassium permanganate. Then put in some more magnesium sulphate powder. When the wound begins to heal, apply an antiseptic, fly repellent ointment. Cover it to protect from birds. Inject a broad-spectrum antibiotic for one week. Do not put the saddle back on until the sores have healed.

Q. What is an abscess? Discuss abscess formation in camels.

An abscess is a circumscribed collection of pus surrounded by a wall of fibrous tissue. Abscess formation is a slow process. At the site of injury a hot and painful swelling develops indicating inflammatory tissue reaction. The presence of pyogenic bacteria or an irritant solution leads to various amounts of pus formation resulting in gradual enlargement of the abscess. Initially it is firm but during maturation becomes soft. At this stage spontaneous rupture may occur discharging a thick and viscous pus. Due to the excessive formation of fibrous tissue, drainage is usually insufficient and recurrence of the abscess and prolonged treatment are common.

Invasion of the organism into the blood or lymphatic system can result in internal abscessation, septic polyarthritis, joint ill and septicaemia.

Singular or multiple external and internal abscesses are a common health problem in camels. Several organisms have been isolated from abscesses such as *corynebacterium sp.*, *streptococcus sp.*, *staphylococcus sp.*, *pseudomonas sp.* and *actinomyces sp.* In adult animals abscessation is usually a common sequel to traumatic skin penetration. Infected fighting wounds, puncture wounds caused by thorns, wounds from predators, saddle sores, microlesions caused by ectoparasites and faulty or non-sterile administration of drugs can lead to single or multiple subcutaneous abscess formation. Abscessation of lymph nodes is a common feature in camel. Furthermore, a diseased condition resembling caseous lymphadenitis occurs mainly in camels over 3 years old. Cold, painless and closed abscesses are present commonly stabilizing at about the size of an orange. However, the etiology remains unclear. In neonate camels, multiple subcutaneous abscess formation and joint ill is a common sequel to neglected umbilical cord infections. Joint ill is an important disease of neonate camels in which bacteria colonize joint spaces. Tarsal and carpal joints are most commonly affected.

Improved management and sanitation are mandatory. Affected animals should be treated by surgically excising the abscesses. Proper drainage, irrigation with antiseptic solution such as diluted iodine, pyodine or potassium permanganate solution and application of insecticidal preparations to prevent myiasis are essential parts of treatment. Hydrogen peroxide solution can be used in the initial treatment to dissolve and break up the abscess core. Application of petroleum jelly on the skin below the incision is helpful to prevent seepage induced excoriation (abrasion of the skin). In addition, systemic application of broad-spectrum antibiotics in cases of joint ill and septicaemia is necessary. Surgically incised simple abscesses usually show good healing.

Post-Mortem Examination

Q. Give an overview of the anatomy of the camel in such a manner that can be helpful to the field or farm worker in conducting post-mortem examination.

Skeleton: The skull of the camel resembles that of a horse. The most striking feature is a prominent projection of the occipital bone to which the powerful nuchal ligament is attached to support the weight of the head and the neck. The vertebral column of the one-humped camel is kyphotic

(having increased convexity in the curvature of the thoracic spine) and has seven cervical, twelve thoracic, seven lumbar, five fused sacral and 15 to 21 caudal vertebrae. The sternum consists of seven sternebrae. There are 12 pairs of ribs, of these four are asternal. The asternal ribs are bent backwards, the last one at an angle of approximately 45 degree thus enclosing a larger portion of the abdominal cavity. The limbs are long and slender. Radius and ulna as well as tibia and fibula are completely fused. There are two toes with distinctive nails and no vestigial digits. The distal phalanges of each toe are supported by digital cushions consisting of adipose tissue encapsulated in connective tissue. These are supported by thick layers of connective tissue and the thick undivided sole.

Skin: It is thick, tight and relatively immobile. There are only a few subcutaneous elastic connective tissue patches such as at the withers, the cranial medial foreleg, the abdomen, the caudal lateral hindleg, where subcut injections can be applied. There are four modified epidermal structures (callosities), situated at carpal, elbow and stifle joints, and at the sternum. These are the sites where the camel comes in contact with the ground when in sternal recumbency and consist of dark horny substance. The skin cover over hump is elastic. It contracts or expands easily with hump, but remains rather tight at all times. The hump itself consists mostly of fat and fibrous connective tissue and its size depends mainly on the nutritional status of the animal. The camel has no other subcutaneous fat deposits of any importance.

Topography of the Viscera: The lungs are occupying the major portion of the thorax. To view the heart properly, the cranial lobe of lung needs to be removed. The compartmented stomach plus spleen are the prominent organs on the left side upon opening the abdomen. The heart is visible on the right side only when the lung is removed. When abdomen is opened, small intestines appear to be the major organ. To see the liver properly, the last three ribs have to be removed. The right kidney is more cranially situated than the left one.

Respiratory System and Heart: The nostrils of the camel are slitlike and can be voluntarily closed against the entry of sand and dust, and still be actively opened to provide an adequate airway. The trachea is wholly cartilaginous and is necessarily quite long (1.3 to 1.5m) in adult camels. The pleural cavities are completely separated. The lungs are not lobed. The right lung is larger than the left. In many camels there is an os diaphragmaticus. In the galloping camel it would allow the

forward/backward movement of the viscera to assist respiration without impeding venous return. The diaphragm connects to the 10th through 12th ribs and it often contains a floating bone (os diaphragmaticus). The heart has a pointed shape. It is situated between the fourth and fifth intercostal space on the left side, whereas on the right side it is between the fourth and sixth intercostal space. The pericard is quite thick and non-transparent. It is white in colour. The pericardic fluid is clear, odourless with the viscosity of water. The total amount is 3 to 10 ml.

Digestive System: The camel has a prehensile, split upper lip, the lower lip is slack, often pendulous. The upper jaw has a tough dental pad. The oral mucosa are pigmented. Large conical and buccal papillae are present. The soft palate (dulaa) in males has an expandable diverticulum. Protrusion of the inflated dulla is part of the rutting behaviour. The tongue is quite long and spatulate in shape. The oesophagus runs left of the trachea. The stomach consists of three obvious compartments. Compartment 1 acts and functions much as does the rumen in the true ruminant. Compartment 2 corresponds to the true ruminant's reticulum. Compartment 3 is a relatively long tubular organ and may be regarded as a combined omasum and abomasum. The latter is a relatively small terminal portion. Compartment 1 occupies the left side of the abdomen, compartment 2 (reticulum) is to its right, the omasum (compartment 3) extends cranioventrally and then caudally from below the reticulum and terminates in a relatively small abomasum (part of compartment 3). The small intestines have a total length of 40m, while the large intestines are 19.5m. The crescent shaped spleen is situated in the left flank in close proximity to the left kidney. The proportion of interlobular connective tissue is quite high. The malphigian corpuscles are visible on gross inspection. The spleen is attached to the left dorsocaudal wall of the rumen (not anterior as in buffalo, cattle, sheep and goat) and to the greater omentum. Its weight in the adult camel is about 0.6 to 1 kg. The pancreas has one pancreatic duct which joins the common bile duct near the duodenum. The left lobe is larger.

The camel's liver is dark brown when fresh and weighs 6.5 to 10 kg in the adult. It is situated mainly to the right of the abdominal midline, in contact with the diaphragm anteriorly and protected by ribs 5 through 12. The dorsal border is thick and has a concave renal impression, which accommodates the right kidney, an oesophageal notch and a vena caval groove. The lobes are vague but lobules are quite distinct on the visceral surface. There are present many narrow 'knife cut' fissures on both surfaces. There is no gall

bladder. The two hepatic ducts unite to form a common bile duct 10 to 11 cm in length. The pancreatic duct joins the common bile duct before it enters the duodenum. Tubercular and other abscesses and hydatid cysts may occur in liver.

Kidneys: They are smooth and bean shaped. They are retroperitoneal and held against the dorsal abdominal wall. The right kidney is slightly longer but slightly less in mass than the left (1.08 kg and 1.13 kg respectively). It is situated below the 2nd to 4th lumbar processes and its cranial pole occupies a corresponding hepatic depression. The left kidney is situated below the last three lumbar transverse processes and it is in contact with the spleen. It can be palpated rectally and visualized by rectal ultrasonography. The hilus of both kidneys is directed medially. The cortex and medulla are distinctive and by volume have a ratio about 1.3:1.

Endocrine Glands: The thyroid gland shows a marked seasonal fluctuation in size and weight. In most animals an isthmus is present. It is situated a few centimeters from the base of the mandibula. Again, the adrenal glands show a great variation in size and shape. The cortex is light brown and the medulla brownish yellow. In camels, the medulla may extend as irregular cords into the cortex. The right adrenal lies adjacent to the right crus of the diaphragm and is attached to the vena cava. The left adrenal is flat, discoidal shaped and covered by a thin capsule, whereas the right adrenal is triangular and covered by a strong capsule. The left lies 8 to 10 cm in front of the left kidney. The ratio of cortex to medulla is approximately 4:1. Females tend to have marginally heavier adrenals than males, as it is in many other species. The pituitary is a small, pea shaped organ. Morphometric values of some of the internal organs, typical for a healthy adult camel, are given in Table 35.

Table 35. Morphometric values of some of the internal organs of a healthy adult camel

Organ	Colour	Weight (kg)	Length (cm)	Width (cm)
Heart	dark brown	1.5 – 2.0	22	19
Lungs	pink	5 – 6		
Spleen	greyish pink	0.6 – 1.0	30 – 40	8 – 10
Liver	dark brown	6.5 – 10	60 – 70	35 – 50
Pancreas	pink	0.4 – 0.5	42	
Kidneys	light brown	1.08 – 1.13	19	10
Adrenal glands		(g)		

Right	greyish pink	15 – 37	5 – 8	3 – 5
Left	greyish pink	15 – 33	4	3.5
Thyroid	reddish brown	Fluctuates	3 – 8	1 – 4
Pituitary	Grey	3 – 4 g	0.8 – 1.2	

Source: Schwartz and Dioli (1992).

Male Organs: The penis is composed of fibroelastic tissue and has a postscrotal sigmoid flexure. When relaxed the penis is normally completely contained within a subabdominal prepuce. Anteriorly the penis hangs down within a triangular reflection of skin and other preputial tissue so that the terminal penis and the preputial orifice, point backwards. Urine is thus voided in a backward direction. The urethral opening is very small. The glans penis is represented by the urethral process. Four vestigial teats are usually present on posterior part of the prepuce. The sigmoid flexure may be palpated just posterior to these teats. The testicles show a marked seasonal fluctuation in size, weight and texture. They are situated high up in the ischiatic arch. One testical tends to be smaller and relatively softer. There are two accessory glands, the prostate and the bulbourethral gland. Cryptorchism is not uncommon.

Female genitalia: The uterus is a T-shaped organ. The left horn is always larger than the right. Division between the uterine horns is pronounced and proceeds well into the uterine body. The uterine body is short (8 to 14 cm). In older multiparous females the uterus extends well into the abdominal cavity. The cervix has longitudinal folds and is 3 to 6 cm long. The cervical os never closes tight. The ovaries are relatively small (18-25 mm in dia), thin and oval shaped. In multiparous animals the existence of corpora albicantia cause the shape to be distorted. In young animals the ovaries are to be found caudal to the pelvic brim. Follicles develop peripherally and can be detected ultrasonically when they are 3mm in diameter or larger.

Udder: The udder is situated between the hind legs and is divided into four glandular quarters with four teats. Each teat has a pair of orifices and ducts. The right and left udder halves are distinctly separated by laminae mediales. The separation of front and rear quarter within each half is indistinct. The front quarters are usually larger than the rear. Presence of accessory teats is not uncommon. The udder size varies with stage of lactation. Machine milking of camels is being investigated.

Q. Give a tabulated comparison of some of the anatomical characteristics of the camel with those of bovines and horses.

Table 36. Comparative anatomical characteristics of the camel, cattle and horse

Organ	Camel	Cattle	Horse
Vertebral column	C7, T12, L7, S5, CD 15-21	C7, T13, L6, S4, CD 18-20	C7, T18, L6, S4 Cd 15-21
No. of ribs	12 (8:4)	13(8:5)	18(8:10)
Heart	pointed	round	pointed
Lungs	no fissures, pink colour	fissures, pink colour	no fissures, red colour
Diaphragmatic bone	yes	no	no
Stomach	3-compartment	3 forstomachs + 1 true stomach	1 true stomach
Small intestines	40 meters	27-49 meters	22 meters
Large intestines	19.5 meters	14 meters	7.5-8 meters
Colon	coiled	coiled	horseshoe shaped
Liver	6.5-10 kg dark brown	4.5-10 kg light brown	5 kg brown red
Gall bladder	none	Yes	none
Spleen	crescent 0.8-1 kg dark purple	long oval 0.7-1.2 kg grey purple	crescent 1-2 kg steel blue
Kidney	bean shaped	lobulated	right: heart shaped left: bean shaped
Capsule	very adhesive	non adhesive	non adhesive
Pancreas	0.5 kg one pancreatic duct	0.6 kg one pancreatic duct	0.3-0.5 kg two pancreatic ducts
Male genitals			
Preputium	caudally	cranial	cranial
Penis	fibroelastic	fibroelastic	musculocavernous
Location	ischiatric arch	pendulant	pendulant
Female genitals			
Uterus	bicornuate T-shaped	bicornuate	biocornuate Y-shaped
Body	8-14 cm		30 cm
Oviduct	25-28 cm	20-28 cm	20-30 cm

Horns	left larger than right	35-45 cm	22-25 cm
Vesicular gland	none	yes	yes
Udder			
Quarters	4	4	2
Teats	4	4	2
Ducts per teat	2	1	2
Skin callosities	yes	no	no
	(carpal, elbow, stifle and sternal)		

Source: Schwartz and Dioli (1992).

Q. What are the objectives of performing necropsy or post-mortem examination?

Post-mortem examination is done with the following objectives in view:

- i) To assess whether a carcass is safe for human consumption or not.
- ii) For diagnosis and control of diseases.
- iii) For research purposes, to determine the effects of various drugs or treatments on various body systems.

Q. What guidelines have necessarily to be kept in view while conducting a post-mortem of the camel?

For useful findings it is very important that the time lapse between death and beginning of the post-mortem (PM) examination should be as short as possible. PM carcass deterioration starts much sooner under high ambient temperature. The gastrointestinal tract, adrenal glands and the central nervous system are among the first organs to show signs of deterioration. Characteristic signs of beginning PM deterioration are desquamation (shedding of epithelium) of epithelium, liquidisation (adrenal medulla and central nervous system) and general friability of organs (gastrointestinal tract, liver and kidneys). Pale, watery and cooked appearance of muscles is a sign of advanced PM deterioration. Valuable indicators to estimate time of death are rigor mortis, blood clotting and imbibitions (absorption of a liquid). Viability of endoparasites can also be a useful indicator e.g. *Cephalopina titillator* larvae die a few hours after their host has died. Rigor mortis is best assessed upon opening the heart. Prior to rigor mortis the left ventricle appears dilated and contains various amounts of red unclotted blood. During rigor mortis the left ventricle is contracted and nearly empty

of blood. After rigor mortis has passed by, the left ventricle contains dark haemolised blood.

Rigor mortis takes place and subsides more rapidly in animals that were either stressed or emaciated before death because of their already depleted glycogen storage in muscles. In ruminants a condition similar to bloat can develop by PM bacterial fermentation of ingesta.

Q. Necropsy examination results under field or farm conditions are based on what criteria?

These are based on visual examination, palpation, description of tissues, organs and their cut surfaces using morphometric (forms of structures of organisms) measurements assessed by gross inspection (Table 37).

Table 37. Check list for necropsy performance and gross inspection in the field or at farm

Items	Findings
Whole animal	Body condition e.g. obese, thin, emaciated
Skeleton	Abnormalities, fractures
Skin and membranes	1) colour 2) hair coat e.g. complete, length, clean
Muscle and fat	1) colour 2) consistency
Organs (heart, lungs, kidneys, spleen, liver, endocrine glands, genitals)	1) colour 2) weight 3) length, width, diameter 4) consistency 5) topography (only if displaced) 6) adhesions

	7) ratio of cortex-medulla (kidneys, adrenal) 8) ratio of ventricles to septum 9) foreign bodies (gastrointestinal tract) 10) float (lung tissue in neonates)
Fluid (all body cavities, all capsules)	1) colour, 2) amount, 3) viscosity, 4) odour, 5) foreign particles
Structural change	1a) type of lesion e.g. abscess, ulcer, tumour, haemorrhage, scar, wound, cyst 1b) depth of lesion e.g. superficial, deep 2) distribution e.g. localized, generalized 3) size and shape 4) amount or number e.g. single, multiple 5a) consistency e.g. firm, soft, liquid 5b) texture e.g. smooth, rough 6) odour 7) colour
Parasites	1) type e.g. tick, maggot, worm, hydatid cyst 2) amount or number 3) alive, dead

Source: Schwartz and Dioli (1992).

Variations from expected parameters such as size and weight provide helpful information to assess hypertrophy, hypoplasia (incomplete development) or aplasia (lack of development of an organ or tissue). However, it should be kept in mind that age, sex and environmental factors such as nutrition are known to influence physiologically size and shape of some organs. Moreover, standard units such as millilitre, litre, centimetre and kilogram should be used for morphometric measurements.

Q. Give details of an appropriate dissection procedure for post-mortem examination of a camel.

A complete history is taken including data about owner, patient, previous and present medical history and management. Performing the post-mortem with the animal on its left is usually faster and more convenient. Detail is as follows:

- a) Lift the right hind leg as high as possible and cut towards and through the hip joint to allow the leg to be totally reflected back over the top of the sacral area. The knife blade should be directed posteriorly, away from the belly wall while performing these cuts.
- b) Standing behind the cadaver the knife blade is inserted flat, cutting edge to the right, beneath the skin at the anterior edge of the initial cut in (a). Commencing adjacent to the mammary gland or penis, the skin is incised by cutting from inside out. The incision is developed in the direction of the animal's ventral midline and continued to the mandibular symphysis. The pedestal may be by passed on its immediate right or removed. Working back along this incision, the skin is reflected from the upper surface of the cadaver, along with the right fore limb, and thrown over the dorsal midline. Particularly in juveniles, the skin of the camel is tightly adherent in the flank region.
- c) The abdominal cavity is opened by carefully incising the tissues immediately behind the last rib. The incision is enlarged; first behind the rib margin towards the xiphoid cartilage and then in another direction, upwards and backwards, close under and along the line of the lumbar transverse processes; and then down again to the udder or penis. The resulting inverted 'U' flap of flank tissues is reflected ventrally over the midline, thus exposing much of the abdominal viscera. If required, samples of gut may be obtained at this stage.
- d) The diaphragm is incised near the right costal margin.
- e) The right rib cage is removed. This is easily achieved in the mature animal by cutting the ribs close to their sternal attachment with a large pruning shear and then repeating this close to the vertebral attachments. These cuts can be made with a suitable saw or axe. If the operator prefers to reflect the right chest wall by breaking it back over the vertebral column, knife cuts should be made between every two ribs at least. Breaking back the chest wall as a whole is difficult if not impossible. In animals up to a few months old, the rib cartilages can be cut with a knife. Thus, the whole right side of the cadaver can be removed quite quickly and with a minimum of manipulation, all the viscera exposed to view. Specimens for laboratory examination are selected and obtained in the proper manner.

In case of necropsy inspection of animals slaughtered by traditional method the sequence given above has to be disregarded and PM examination is performed with slaughter sequence. If the animal has been slaughtered by Muslim method (cutting of major cervical vessels), the carcass appears overall paler and blood storage organs such as spleen will be contracted and empty (Schwartz and Dioli, 1992).

Q. Give an example of a post-mortem examination sheet with itemwise findings recorded therein.

The main purpose of presenting here this example is that in case a trained expert is not available when necessity arises to perform PM examination, a subprofessional person can do this job keeping this example in view. This is important to get a better insight into the epidemiology (study of the factors determining and influencing the frequency and distribution of disease) in camel populations and may be even more important, to evaluate the risks to public health arising from the camel as a domestic livestock.

Example of post-mortem examination sheet with findings recorded herein.

Part 1: Gross inspection before dissection		
Recorder	Kamal	
Owner	Karam Din	animal brought to Shahkot market, obviously sick
Death		10 a.m., slaughtered
Post-mortem		immediate, during butchering
Animal	Breed	camel
Condition	Body	almost good, well musceled
	Hump	Well developed, firm, round shape
	Haircoat	complete, hind legs soiled with faeces
	Udder	small, non-active, usual shape, firm consistency
	Teats	old healed wound close to orifice of right cranial (anterior) teat, other teats of usual shape
	Pads	small spherical deep pedestal wound, necrotic tissue at the edges and small amount of pus
	Nostrils	clean, dilated, no lesions
	Mouth	no lesions, normal

Body openings	Eyes	Eye balls sunken in, cornea surface wrinkled and slightly traumatized (small abrasions)
	Ears	normal
	Anus	slightly dilated, dark faeces around sphincter
	Vulva	disfigured, healed perineal wound
History	Symptoms	fever, diarrhoea, swollen glands, loss of appetite
	Onset	acute
	Duration	two days
	Herd	no other animal affected
	Treatment	none

Part 2: Inspection of internal organs		
Thorax	Serosa (any serous membrane)	transparent, adhesions between pleura and heart, multiple small haemorrhagic spots, three small abscesses close to adhesions
	Pericard	white, one adhesion to body wall, 5cc transparent watery fluid
	Heart	dark brown, 1.5 kg, firm, dark haemolised blood in left chamber, multiple petechie on surface
	Valves	tricuspid and mitral slightly thickened
	Trachea	inner mucosa lining red
	Thyroid	normal
	Lungs	red, puffy consistency, four small hydatid cysts
Abdomen	Serosa	Transparent
	Oesophagus	inner lining reddened
	Stomach	very small amount of feed, several small superficial ulcers in compartment 3
	Small intestines	dilated, liquid faeces
	Large intestines	dilated, multiple haemorrhagic spots, no formed faeces in rectum
	Liver	dark brown, 10 kg, one small abscess
	Pancreas	multiple haemorrhagic spots
	Spleen	red, swollen, 1.5 kg, multiple haemorrhagic spots
	Kidney	normal
	Adrenal	multiple haemorrhagic spots
Bladder	medium filled, haemorrhagic spots on mucosa	
Genital organs	Ovaries	nonactive, no follicles, several old corpora lutea
	Horns	no remark
	Body	no remark
	Cervix	dilated
	Vagina	no remark

Lymph nodes	All internal and external lymph nodes swollen, surface
-------------	--

	dark red
Nervous system	No remarks
Skeleton	No remarks
Muscles	No remarks
Diagnosis	Acute haemorrhagic septicaemia, probably pasteurella or Salmonella infection
Additional findings	One narrow, but deep and suppurating pedestal wound connected by a fistula to the thoracic cavity, adhesions between serosa and pericard, three abscesses in close vicinity to the fistula channel, three hydatid cysts in the thoracic cavity.

Source: Schwartz and Dioli (1992).

The most obvious findings in this example were generalized internal petechiation especially under the serosa of the intestines, the heart and the lymph nodes. In other cases gelatinous fluid may be present around the lymph nodes.

The picture may be complicated by signs of haemorrhagic enteritis and lesions of early pneumonia. In many cases the clinical and necropsy findings may not be conclusive and differentiation from anthrax, blackleg, septicaemic salmonellosis and acute leptospirosis has to be done by bacteriological examination. The absence of bloody discharge from the natural body orifices and a normal appearing spleen on post-mortem can be used to initially differentiate haemorrhagic septicaemia from anthrax. Infections of the gastrointestinal tract are not easily diagnosed by necropsy procedure alone. For definite etiological diagnosis, sample must be submitted for laboratory analysis. Infections of the respiratory tract present a similar problem in post-mortem diagnosis. Depending on the involved infectious agent, localized or generalized pathological lesions of the respiratory tract are found. However, typical signs of respiratory diseases of viral origin are often masked by secondary bacterial invasion. Bacteriological and histological examination should be performed if accurate etiological diagnosis is needed.

OVER ONE HUNDRED SPECIMEN **OBJECTIVE QUESTIONS**

Fill in the blanks:

- Q. i) For microchip identification method, the chips are implanted in the nuchal ligament of the neck.
- Q. In the equation $P=G+E$; P,G and E stand for phenotypic measurement of a trait, genetic effect of all pertinent genes and environmental factors influencing the trait respectively.
- Q. A low correlation between genotype and phenotype indicates a low heritability estimate.
- Q. DNA techniques should be exploited for future research e.g. in camel breeding, disease control, parentage verification, population differences, archeological studies.
- Q. The hindlimbs of the camel provide the main forward propulsive force.
- Q. Couching
means.....
- Q. The foot pad of camel is filled with fat consisting of 75% unsaturated fatty acids.
- Q. An area or a structure that does not reflect ultrasound waves and does not produce an echo is called anechoic or nonechogenic.
- Q. In camels, ovulation takes between 24 and 48 hours after mating.
- Q. GnRH stands for Gonadotrophin-releasing hormone.
- Q. The placenta in dromedary is diffuse in nature and not cotyledonous.
- Q. In camel, about 99% pregnancies are in the left uterine horn.
- Q. Ovulation in camel is mainly induced by coitus.
- Q. Encircle the correct answer. The camel udder has: 5 teat ducts, 4 teat ducts, 8 teat ducts, 6 teat ducts, 2 teat ducts.
- Q. Encircle the correct answer. Rabies is a: parasitic disease, bacterial disease, non-infectious disease, viral disease, zoonotic disease.
- Q. Encircle the correct answer. Camel calves are found actively foraging by the age of: 2 week, 4 weeks, 2 months, 6 months, 3 weeks.

- Q. Encircle the correct answer. The finest wool is obtained from the: Bactrian camel, baggage camel, Arabian camel, racing camel, dromedary.
- Q. Encircle the correct answer. Camels deprived of water in 42°C environmental temperature lose body weight per day at about the rate of: 4%, 5%, 2%, 8%, 1%, 6%.
- Q. Name all the keratinised pads found on the body of an adult camel. Elbow, knee, hock, stifle and chest pads.
- Q. T/F: A lot of water is available in winter, therefore, the camel drinks 55 litres/day. Encircle accordingly.
- Q. T/F: Female camel calves are provided more milk than male calves by traditional camel herders. Encircle accordingly.
- Q. Which one is more productive: Milking the camel twice a day or four times a day?
- Q. What is the recommended age for weaning a camel calf? Encircle the correct answer. 16 months, 360 days, 185 days, 40 weeks.
- Q. Average gestation period in camels is 360 days, 12 months, 370 days, 56 weeks. Encircle the most correct answer.
- Q. Perineal device is used in camel for what purpose? For acceptance of calf.
- Q. Encircle the correct answer. Surgical castration in camel is performed to remove the: urethra, gall bladder, testes, kidneys, bladder.
- Q. Which one is more prominent in camel: hindquarters or forequarters?
- Q. Encircle the correct answer. Normal body temperature is higher in: (a) old camels. (b) young camels (c) adult camels.
- Q. Encircle the correct answer. Body temperature in rutting camel is: (a) higher than normal (b) normal (c) lower than normal (d) subnormal.
- Q. Encircle the correct answer. High temperatures in camel during morning are indicative of (a) milk fever (b) fever (c) oestrus (d) stress.
- Q. Encircle the correct answer. Laboured breathing is always an indication of (a) dystocia (b) respiratory disease (c) congested sinus (d) anorexia.
- Q. Is it possible or not to get stomach fluid samples from camel's stomach by passing a stomach tube? Yes, it is possible.

- Q. Encircle the correct answer. Total blood volume in the camel is: (a) 930 ml/kg (b) 309 ml/kg (c) 93 ml/kg (d) 39 ml/kg
- Q. Encircle the correct answer. (a) Ovulation in camel takes place 36-48 hours after stimulation. (b) Ovulation in camel takes place 20-24 hours before stimulation.
- Q. Among farm animals, which is the best adapted to hot arid environment? One-humped camel.
- Q. What is the main mechanism by which the camel survives in the desert? Its ability to conserve body water.
- Q. Is it a myth or truth that camel stores water in its hump or stomach? It is a myth and it has been disproved since long.
- Q. Can all the animal species equally tolerate dehydration? No, the tolerance varies largely in different species.
- Q. Due to dehydration, efficiency of use of water decreases in camel. Do you agree with this statement? No.
- Q. Cattle would die in 4 days at a total body weight loss of 28%. Do you agree with this statement? Yes.
- Q. Fill in the blanks. Low water turnover is a characteristic of arid adapted animals.
- Q. Fill in the blanks. The camel produces about 16 litres/day saliva when dehydrated.
- Q. To compensate, feed intake increases in dehydrated animals. Do you agree with this statement? No.
- Q. Fill in the blanks. The camel is able to reabsorb water from alimentary canal when dehydrated.
- Q. Under dehydration a relatively high osmolarity further decreases. Do you agree with this statement? No.
- Q. Fill in the blanks. In comparison with other farm ruminants the response of camel to improved conditions is only one-eighth of that of cattle and one-sixth of that of sheep.
- Q. Fill in the blanks. Wet hide of camel is about 10% of body weight.
- Q. What is recycled urea? Recycled urea in reality is the same protein that is used more than once.
- Q. Does the camel has gall bladder? No, it does not.
- Q. What is the major site of water absorption in the camel? The colon is the major site of water absorption in camel's body.
- Q. Plant species reaching the higher strata of the vegetation as a rule belong to which group? They belong to the dicotyledon group.

- Q. Fill in the blank: Free ranging camels spend less than 5% of their feeding time near ground level.
- Q. Correct the sentences. The scrotum is small in camel. It is attached high up between the four legs and does not hang below the udder.
- Q. Correct the sentence. The glans penis in camel is rectangular. It is like a crochet-needle.
- Q. Male camels become infertile when their testicles are heaviest (correct the sentence). It is the otherway round.
- Q. Encircle the correct answer. (a) The camel is an induced ovulator (b) The camel is a spontaneous ovulator.
- Q. Fill in the blanks. Mixing of bhoosa of two leguminous crops is called missa bhoosa.
- Q. The gestation period in one-humped camel varies from 380-390 days. Fill in the blanks.
- Q. Rut in camel can be induced by gonadotropin treatment and better nutrition. Fill in the blanks.
- Q. What are the main objectives of determining age of camels? (i) For trading, (ii) For treating, (iii) For breeding.
- Q. Do camels have incisor teeth in both jaws? Yes, in both jaws
- Q. What is other name for canine teeth? Tushes
- Q. Deciduous teeth of camels erupt after temporary teeth. Do you agree with this statement? No.
- Q. Mare and she-camel are large animals having the same number of teats. Do you agree with this statement? No.
- Q. Give the formula to calculate the average age at which most females leave the herd. (Age at first calving plus interval between parturitions multiplied by number of young equals the age at which most females leave the herd).
- Q. On an average, what is the percentage of breeding females in a camel herd? 40 to 45%.
- Q. Give the total number of deciduous and permanent teeth respectively in dromedary camel. Deciduous = 22; permanent = 34.
- Q. What is the best branding method for pastoralist's camel? Hot-iron branding.
- Q. What is the most appropriate posture for slaughtering a camel? Sternal recumbency.

- Q. For examination, urine of camel can be collected through: (a) free catch (b) a catheter (c) a syringe (d) a suction pump. Encircle the most correct answer.
- Q. Encircle the correct answer. Daily average output of urine in camel is: (a) 55 litres (b) 5.5 litres (c) 0.55 litres (d) 2.5 litres.
- Q. Where on the body of the camel is located pre-scapular lymph node? In front of scapula.
- Q. Encircle the most correct answer. Most convenient site for collection of blood is: (a) medial metacarpal vein (b) jugular vein (c) dorsal metatarsal vein (d) femoral artery.
- Q. Encircle the most correct answer. A preferred site for subcutaneous injection in camel is: (a) in front of the shoulder (b) under the belly (c) behind the stifle joint (d) at the back of the hump.
- Q. Encircle the most correct answer. For intramuscular use, injected volumes per injection site in camel should not exceed: (a) 1 to 100 cc (b) 50 to 100 cc (c) 15 to 20cc (d) 40 to 60 cc.
- Q. Fill in the blanks. A tourniquet is used to put pressure to raise a vein or to check bleeding.
- Q. Fill in the blanks. The udder of the camel is divided into four glandular quarters.
- Q. Fill in the blanks. The uterus of the camel is T shaped.
- Q. Fill in the blanks. Important diseases caused by ectoparasites in the camel are: sarcoptic mange, dermatomycosis, tick infestation, fly infestation, nasal bot (myiasis).
- Q. Fill in the blanks. Ticks commonly found on camels belong to the family Ixodidae.
- Q. Fill in the blanks. The gallbladder in the camel is absent like that in horse.
- Q. Encircle the correct answer. Curative measures after the disease is clinically evident are called: (a) chemotherapy (b) chemoprophylaxis (c) hydrotherapy (d) prophylactic therapy.
- Q. Encircle the correct answer. *Trypanosoma evansi* is transmitted by biting flies belonging to genus: (a) Stomoxys (b) Tabanus (c) Philoliche.
- Q. Fill in the blanks. A synonym for tapeworms is cestodes.
- Q. Fill in the blanks. Sarcoptic mange in camel is caused by Sarcoptes scabiei.
- Q. Fill in the blanks. Ivermectin is useful for mange.

- Q. A synonym for pasteurellosis is Haemorrhagic septicaemia.
- Q. T/F: Dehydration of camels occurs more commonly in arid regions. Encircle accordingly.
- Q. Debridement means: Removal of necrotic tissue and foreign material.
- Q. T/F: Separation of front and rear quarters of the camel udder is distinct. Encircle accordingly.
- Q. After death of the camel, what organs are among the first that get deteriorated soon? Gastrointestinal tract and central nervous system.
- Q. Fill in the blanks: Fluctuation in morning/evening body temperature in camel in summer can save it 4 to 5 litres water daily.
- Q. Tenesmus denotes: Painful straining.
- Q. Fill in the blanks. The clear liquid that separates from blood when it clots is called serum.
- Q. Normal body temperature of humans is 37°C. What is the same in camel? 37.5°C.
- Q. T/F: Encircle accordingly. Heart rate and breathing rate of the camel mean the same.
- Q. What is the importance of center of gravity of the camel body? Give two points to indicate the importance of this center in the camel.
- Q. Give the average birth weight, weaning and adult weights of camel breeds in Pakistan.
The average birth weight, weaning weight and adult weight vary from 33 to 50 kg, 75 to 135 kg and 550 to 700 kg respectively.
- Q. What is the average age at first breeding in camels in Pakistan?
The average age at first breeding in Pakistani camels varies from 4 to 4.5 years.
- Q. Give the average daily milk yield and lactation length in camels in this country.
The average daily milk yield and lactation length in camels in Pakistan range from 3.0 to 8.0 litres and 250 to 510 days respectively.
- Q. What is the average length of dry period and calving interval in local camels?
On average, these vary from 275 to 325 days and from 715 to 785 days respectively.
- Q. What is the average annual hair production from a Bactrian camel?
It is about 5.5 kg.

- Q. What is the total population of camels in Pakistan?
According to FAO (2000), the population of camels in Pakistan is 1.2 million.
- Q. Give percentage distribution of the camel population in various provinces of Pakistan.
Provincewise distribution of the camel population is as follows:
Balochistan 36.43%, Punjab 33.51%, Sindh 22.76% and NWFP 7.30%.

GLOSSARY

a.i. Active ingredient.

AI. Artificial insemination.

Abdomen. The belly.

Abomasum. Fourth stomach of a ruminant.

Abortifacient. Substance that causes abortion or miscarriage,

Abortion. Miscarriage: when the foetus is expelled before it is due.

Abscess. A collection of pus in the tissue.

Acaricide. Chemical used to control ticks.

Actinomyces. A type of disease-causing bacteria.

Active ingredient, active principle, a.i. Ingredient or chemical component of a drug, which has a healing effect.

Acute. Critical, sudden and of short duration.

Aetiological. Relating to the origin of or cause of a disease.

Aetiology, etiology. The cause of a disease.

Afterbirth. Placenta and other membranes that come out after birth.

Agroecological zones. Areas which have similar physical and climatic features and in which farming systems can be expected to be similar.

Alimentary canal. The digestive tract.

Alimentary. Pertaining to, or caused by, food.

Allergen. Substance that may cause an allergic response.

Allergy. Hypersensitivity of the body cells to specific substances, such as an antigen or allergen, resulting in rashes or other reactions.

Ambient. The immediate surroundings (e.g. ambient temperature = the temperature in the local area).

Anaemia. Below-normal number of red blood cells and quantity of haemoglobin in blood.

Anaesthetic. A medicine that stops all feeling. It makes the animal (or the part of the body it is applied to) numb.

Analgesic. A medicine that reduces pain but does not cause numbness. ,

Androgen. A male sex hormone.

Anhidrosis. Absence of sweating (Dry coat).

Anthelmintic. Substance that removes intestinal worms from the host animal.

Anthrax. Disease caused by a bacterium called *Bacillus anthracis*.

Antihistamine. Substance used to treat allergy and colds.

Antibiotic. A chemical substance produced by microorganisms that kills (or inhibits the growth of other microorganisms).

Antibody. A protein in the blood that is produced in response to an antigen.

Anticoagulant. Substance that prevents or slows down blood clotting.

Antidote. A treatment which counteracts or destroys the effect of poisons or other medicines.

Antiemetic. Substance that relieves vomiting.

Antigen. Substance that may induce an immune response (e.g. bacteria, toxins).

Antiinflammatory. Counteracting inflammation.

Antipyretic. Substance that lowers body temperature to the normal level; used against fever.

Antiseptic. Substance that destroys or inhibits disease-causing bacteria.

Antispasmodic. Substance that prevents or relieves muscular spasms or cramps.

Antivenin. Substance that counteracts the poison from an animal, such as a Snakebite.

Anus. The opening at the end of the intestines where the dung comes out.

Artery. A vessel that carries the blood away from the heart to other parts of the body.

Arthritis. inflammation of joints.

Artificial insemination, AI. Breeding by putting semen into the vagina or uterus without sexual contact.

Ascariasis, Infestation by an intestinal parasite called ascaris (Internal parasites).

Ascarid. A roundworm nematode (a type of parasite) found in the intestines.

Astringent. Substance that shrinks tissues and prevents secretion of fluids from wounds.

Bacillus cereus intoxication. haemorrhagic disease.

Bacterium, bacteria. Tiny microorganisms, some of which cause disease.

Balling gun. Tool to apply pills, capsules and boluses.

Balm. A soothing or healing medicine.

Blackleg. Blackquarter.

Blackquarter. Disease caused by a bacterium called *Clostridium chauvii*.

Bladder. The organ that holds the urine.

Blister. A vesicle, a skin lesion.

Bloat. The build-up of gases in the stomach or intestines.

Boil. Infected, painful, hard swelling of the skin.

Bolus. A ball or tablet of medicine. **Branding.** Marking the skin with a hot iron.

Broadspectrum medicine. A medicine effective against several disease causing microorganisms.

Bronchitis. Inflammation of the bronchi.

Bronchus, bronchi. The pair of air passages at the end of the trachea, leading to the lungs.

Buffy coat. Reddish-grey layer in a centrifuged tube, consisting of white blood cells between the red blood cells and the serum.

Caesarean section. Operation to cut the uterus open and pull the calf out.

Calf diarrhoea. Diarrhoea in calves caused by too much milk or by a virus.

Camelid. An animal that is a member of the camel family or Camelidae.

Cancer. A malignant, cellular tumour.

Canines. The pointed teeth beside the incisors; they can grow very large in male camels.

Cannula. Tube attached to a trocar.

Capillary tube. Thin tube with a very small inside diameter.

Carcass. Dead body of an animal or slaughtered animal after skin removal.

Carrying capacity. The number of animals that can be kept permanently on a given area of land (usually expressed in terms of one hectare or one square kilometre) without causing degradation of the land and its vegetation and which ensures that all animals receive an adequate amount of feed for both maintenance and production (production can be growth, milk production, being pregnant etc (see also stocking rate).

Castration. Removal of testicles.

Catarrh. Inflammation of nose and mucous membranes.

Catgut. An absorbable, sterile thread made from the small intestine of sheep; used as a suture material.

Cauterization. The burning of flesh with a hot iron or a chemical,

Centrifuge. Piece of laboratory equipment that spins very fast. Used to separate parts of a liquid from one another, such as components of a blood sample.

Cervix. The narrow, front part of the uterus.

Cestodes. Tapeworms.

Chemoprophylaxis. Prevention of infection by diseases through the use of drugs before the onset of a disease; chemotherapy is treatment of a disease by drugs. A vaccine, strictly speaking, is a biological product but vaccination is usually considered to be a part of chemoprophylaxis.

Chronic. Persisting for a long time.

Closed fracture. Broken bone where the skin remains intact.

Clostridiosis. Blackquarter.

Clostridium. A type of disease causing bacteria.

Cold struck. Wry neck.

Colibacillosis. Disease caused by a bacterium called *Escherichia coli*.

Colic. Pain caused by gas in the stomach or intestines.

Colostrum. Thick yellow milk, rich in antibodies, protein and micro-nutrients, produced by mothers after giving birth.

Compress. A dry, often warm, substance applied firmly to a part of the body.

Concentrate. A carefully formulated mixture of nutrients (grains, oilcakes having high protein and energy contents).

Concoction. A preparation from crude materials, made by combining different ingredients.

Congenital. Present at and existing from the time of birth.

Congested. Closely packed.

Congestion. Abnormal accumulation of blood in part of the body.

Conjunctiva. The membranes around the eyeball.

Conjunctivitis. Inflammation of the conjunctiva.

Constipation. Infrequent or difficult bowel movement with hard dung.

Contagious skin necrosis. A skin disease.

Contagious. Diseases which are readily passed on to others.

Contamination. Introduction of microorganisms, for example when using surgical instruments that are not sterile.

Contusion. Bruise, injury where the skin is not broken.

Convulsion. A violent, involuntary contraction of the muscles.

Cornea. The transparent part of the eyeball.

Corneal opacity. Whitish film on the eyeball.

Corneal ulcer. Injury of the cornea.

Corpus luteum. Part of the ovary that forms after ovulation and produces hormones during part of the heat cycle.

Corticosteroids. Type of hormones; their synthetic equivalents are used as drugs. Corticosteroid drugs are used to treat certain diseases and decrease inflammation and itching.

Corynebacterium pyogenes. A type of disease causing bacteria.

Crepuscular. Showing a preference for activity in dim light, around dawn or dusk.

Cud. The ball of feed that ruminants chew and then swallow again.

Culling. Selective removal (e.g. of animals for poor reproductive or growth performance).

Cyst. A closed sac or capsule containing a liquid or semisolid substance.

Decoction. Medicine made by boiling ingredients in water.

Decongestant. Substance that reduces congestion or swelling.

Defaecate. Passing of faeces.

Deficiency. A lack or shortage.

Dehydration. Lack of water in the body.

Dermatitis. Inflammation of the skin.

Dermatomycosis. Ringworm.

Dermatophilosis. A skin disease caused by fungus.

Dermatophytosis. Ringworm.

Dermoid. Egg-shaped growths on the skin.

Detergent. Cleansing substance.

Diagnosis. The determination of a disease. It includes the name of the disease, its cause, and the prognosis.

Diarrhoea. Frequent passing of thin, watery faeces.

Digestive tract. The tube through which feed passes: the mouth, oesophagus, stomach, intestines and anus.

Dipetalonemiasis. Disease caused by a parasitic worm called *Dipetalonema evansi*.

Discharge. Substance excreted by the body, such as PUS.

Disinfectant. A chemical that kills microorganisms.

Dislocation. Bone displaced from a Joint.

Diuretic. A drug or preparation that causes urination.

Dosage. The determination and regulation of the amount, frequency and number of doses.

Dose. The quantity of a medicine to be administered at one time.

Downer. Disease where a camel refuses to get up; can have various causes.

Drench. Forcing the animal to drink a liquid medicine

Dressing. Material used to cover and protect a wound.

Drip. Slow, drop-by-drop injection of a liquid into a vein.

Dromedary. Another name for the one humped camel; derived from the Greek for 'to run'.

Dry coat syndrome. Anhidrosis, absence of sweating.

Dulaa. Protrusion of soft palate of camels.

Dysentery. Inflammation of the intestines, with liquid and bloody diarrhoea and painful straining.

Dystocia. Difficult birth.

Echinococcosis. Disease caused by small tapeworms (Hydatid disease).

Ethyma. Infection of the skin with large pustular vesicles.

Ectoparasite. external parasite.

Eczema. Inflammatory skin disease characterized by redness, itching and formation of scales and crusts.

Edema. Oedema.

EDTA. A substance (ethylenediamine-tetraacetic acid) that stops blood from clotting.

Ejaculation. To eject semen during the act of sexual intercourse.

Electuary. A medicinal preparation consisting of a powdered drug made into a paste with honey or syrup or Gur.

Embryo. A new calf in the earliest stage of development. Becomes a foetus.

Emetic. Substance that causes vomiting.

Encephalitis. Inflammation of the brain.

Endogenous. Internal; arising from inside the animal rather than from the outside.

Endoparasite. Parasite that lives inside the body (in the intestines, lungs etc.).

Enema. Liquid preparation introduced into the rectum.

Enteritis. Inflammation of the intestines.

Enterotoxaemia. Haemorrhagic enteritis.

Eosinophil. Type of white blood cells.

Epidemic, epizootic. A sudden outbreak of disease in a relatively small area.

Epidural anaesthesia. Injecting an anaesthetic into the canal of the backbone.

Epsom salt. Magnesium sulphate.

Erythrocytes. The red cells of the blood.

Estrus, Oestrus. Heat.

Etiology. Aetiology. The cause of a disease.

Expectorant. Substance to remove fluid from the lungs and trachea.

Expiration. Breathing out.

External parasite. Parasite that lives on the surface of the body (on the skin, in the skin, in the ears etc.).

Faeces. Feces, dung.

Fetus. Foetus.

Fever. Increase in the body temperature; an abnormally high body temperature.

Firing. Application of a red hot iron to the skin (Branding).

Flatulence. Excessive gas formation in the digestive tract.

Foetus, fetus. The developing young calf in uterus.

Fomentation. Application of a warm, moist substance such as a wet cloth to ease pain and inflammation.

Foreign body. Any object not normally found in the body.

Fracture. Breaking of a bone.

Fungus, fungi. A group of microorganisms, some of which cause diseases.

Galactagogue. Substance that promotes milk flow.

Gangrene. Death of body tissue.

Gas oedema. Blackquarter.

Gastroenteritis. Inflammation of the stomach and intestine.

General anaesthesia. Giving an anaesthetic to make the animal lose consciousness and not feel pain anywhere in the body.

Gestation period. The time from conception to birth; it varies from species to species (about 387 days in camels).

Gestation. Period of pregnancy, term of life of embryo/foetus within the uterus.

Ghee. Clarified, semi-fluid butter made from milk (common in Indo-Pakistan).

Giemsa. A dye to stain blood samples used to check for blood parasites.

Gland. An aggregation of cells that secrete or excrete materials.

Glomerular filtration rate. The speed at which the kidney filters waste products.

Glucose. Table sugar.

Goitre. Enlargement of the thyroid gland caused by iodine deficiency.

Gram-positive. Types of bacteria that are coloured deep purple in Gram's method.

Haematocrit. The volume percentage of red blood cells in the whole blood.

Haematoma. A swelling filled with blood,

Haematuria. Blood in the urine (Red urine).

Haemoglobin. Protein found in red blood cells.

Haemolysis. Destruction of the red blood corpuscles and the consequent escape of haemoglobin.

Haemorrhage. Bleeding.

Haemorrhagic disease. Disease caused by *Bacillus cereus* bacteria.

Haemorrhagic enteritis. Disease caused by *Clostridium* bacteria .

Haemorrhagic septicaemia. Disease caused by *Pasteurella multocida* bacteria (HS).

Heart. Organ in the chest that pumps blood around the body.

Heat. The time when the female accepts the male for mating and can become pregnant.

Helminthiasis. Disease caused by worms.

Heparin. A substance that stops blood from clotting.

Hereditary. Characteristics passed from parents to offspring.

Heritability. That which may be inherited; the capacity of being transmitted from one generation to another; the hereditary or genotypic variance expressed as a percentage of the total variance in the feature being examined.

Hernia. The abnormal protrusion of the intestines through the peritoneum, or part of another organ through the membrane or muscle that contains it.

Heterosis. (Also referred to as hybrid vigour) the effect achieved in a two species or two breed cross by which the values of a trait in the offspring exceed the simple mean of that of the two parents.

Hormones. Chemicals formed by glands in the body; they control the activity of organs.

Hybrid. An animal resulting from a cross between animals not taxonomically very close, are often infertile or subfertile in one or both sexes.

Hydatid cyst. Fluid-filled sac with young tapeworms in it (Hydatid disease).

Hygiene. The science of health and its preservation.

Hygroscopic. Said of something which takes up and retains moisture from the surrounding air.

Hyperglycaemia. Having very high levels of glucose.

Hyperplasia. Excessive growth of tissue or an organ.

Hypnotic. Induces sleep.

i.m. Intramuscular.

i.v. Intravenous.

Immersion oil. Oil used to examine objects under a microscope using a special lens.

Immune response. Reaction of the body to an antigen: production of antibodies that fight a disease causing organism.

Immune. Resistant to a disease due to the formation of antibodies.

Immunity. Body's defence against disease; can be passed to offspring through colostrum or through exposure, vaccination or inoculation.

Incision. Cutting the skin or tissue.

Incisors. Flat teeth at the front of the mouth.

Infection. Disease caused by microorganisms.

Infectious. Caused by infection, able to cause infection.

Infertile. Not able to reproduce.

Infested. Over-run by large numbers.

Inflammation. The reaction of living tissues to injury, infection or irritation; characterised by pain, swelling, redness and heat.

Infusion. Herbal medicine made by adding water to plant ingredients in a pot, covering, and allowing to stand, usually for about 15 minutes. An infusion can be either hot or cold.

Injection. The forcing of liquid into a part of the body (e.g. under the skin, into the vein or muscle).

Inoculation. Introduction of disease causing microorganisms or other material to stimulate immunity.

Insecticide. Chemical that kills insects.

Internal parasites. Parasites that live inside the body.

Interstitial. Spaces between individual cells or tissues.

Intestines. Part of the digestive tract between the stomach and anus.

Intracellular. Within a cell.

Intramammary. Into the udder, **Intramuscular, i.m.** Into the muscle.

Intravenous, i.v. Into the vein (vessel that carries blood towards the heart).

Iodine deficiency. Shortage of iodine in the body.

Iris. The coloured part of the eye.

Jaggery. A palm sugar made in some Asian countries.

Joint ill. Navel ill.

Joint. The point where bones meet (e.g. the knee).

Jugular vein. Large blood vessel in the side of the neck.

Karyotype. The appearance (size, shape and number) of the set of chromosomes of a somatic cell.

Keratitis. Inflammation of the cornea.

Kidney. Pair of internal organs that filter wastes from the blood and produce urine.

Kumri. Camel disease in Indo-Pakistan, causing shivering of the back legs (Myopathy).

Lactation period. The period of time (in days, weeks or months) during which a female animal gives milk.

Larva, larvae. Immature stage in the life cycle of an insect, maggot, caterpillar.

Larynx. Voicebox.

Latent heat of evaporation. The quantity of heat required to change a liquid to a vapour without a change in temperature.

Lateral recumbency. Lying on the side.

Laxative. Substance that encourages defaecation.

Leeches. Segmented worms, some of which suck blood.

Lesion. Alteration of skin or other body parts due to disease or injury.

Libido. Sexual, desire; the expression of sexual interest by male animals.

Liniment. A medicated liquid, usually containing alcohol, camphor and an oil, applied to the skin to relieve pain or stiffness.

Liver. Large, reddish-brown organ that secretes bile and is important in digestion.

Lobulated. Having lobes (as opposed to being smooth).

Local anaesthesia. Applying an anaesthetic only to a part of the body to stop pain in that part; the animal remains conscious.

Lockjaw. Tetanus.

Lower respiratory tract. The lungs and pleura (the membrane that lines the chest cavity).

Lung. Pair of organs in the chest that take in air, used for breathing.

Luxation. Dislocation.

Lymph node. Solid lump on lymph vessels which helps to protect the body against disease.

Lymphadenitis. Inflammation of lymph nodes.

Lymphocyte. Type of white blood cells.

Maggot. The larva stage of a fly.

Malnutrition. Poor nutrition caused by an inadequate or unbalanced diet.

Mandible. The bone of the lower jaw. **Mange.** Skin disease caused by mites.

Mastitis. Inflammation of the udder.

Membrane. A thin layer of tissue that covers a surface or lines a cavity.

Metabolic rate. The speed of or intensity at which the sum of physiological processes take place.

Microorganism. Very small organism, microbe, that can be seen only using a microscope. Microorganisms include bacteria, fungi, viruses and protozoa. Microorganisms that cause diseases are called pathogens.

Milk scours. Calf diarrhoea.

Milk teeth. Temporary teeth.

Millennia. For thousands of years.

Mites. Small parasites found in the skin, coat and ears.

Molars. Cheek teeth.

Monocyte. Type of white blood cells.

Morbidity. The incidence of disease; suffering from a disease.

Morphological characteristics. The outward appearance of an animal (colour, shape, size etc.).

Motility. The amount of movement of sperm.

Mucous membrane, mucosa. Membrane lining the respiratory and digestive tracts and other parts of the body. It secretes mucus.

Mucus. Slimy material formed to protect parts of the body.

Mycosis. Disease caused by fungus.

Mycotic. Caused by fungus.

Myiasis. Strictly speaking means ‘infestation with fly maggots’ or larvae; (nasal bots) often used loosely for other problems caused by flies.

Myopathy. A disease affecting the muscles.

Narcotic. A drug, which, in moderate doses, alleviates pain, reduces sensibility, produces sleep; in large amounts, induces stupor, coma or convulsions.

Nasal bots. Fly maggots living in the back of an animal's nose.

Nausea. Upset stomach, tending to vomit.

Navel ill. Infection of the navel cord in newborn animals.

Navel. Umbilicus, belly button, where the umbilical cord is attached during gestation.

Necrosis. Death of tissue.

Nematodes. Roundworms (internal parasites).

Nerves. Fibres that carry messages between the brain and other parts of the body.

Neutrophil. Type of white blood cells.

Nictitating membrane. The third eyelid.

Nomadism. A system with no fixed base but which wanders seasonally and in the longer term in search of feed and water resources. See also transhumance.

Nutrient. Nourishing substance.

Nymph. Stage in the life of an insect, after the larva stage.

Oedema, edema. Abnormal accumulation of fluids in the tissues.

Oesophagus. The tube that goes from the mouth to the stomach.

Oestrus, estrus. heat.

Omasum. Third stomach of a ruminant.

Open fracture. Broken bone that damages the muscles and tissue around it and pierces through the skin.

Oral. Belonging to, or taken through, the mouth.

Orf. A disease caused by a virus.

Otitis. Ear infection.

Ovary. The organ of a female animal that produces the egg or ova.

Ovulation. The discharge of eggs from the ovary.

Packed cell volume (PCV). Haematocrit. The proportion of blood plasma occupied by the cells of the blood; low PCVs indicate anaemia and a diseased state.

Pancreas. Internal organ that secretes fluids into the intestine and blood, and is important in digestion.

Pandemic. An outbreak of disease occurring over a very wide area, affecting a large percentage of the population (see also epidemic).

Paralysis. Inability to move a muscle or group of muscles, often coupled with loss of sensation in the affected urea.

Parameters. A factor or characteristic; a measurement or an item being measured.

Parapox. Orf.

Parasites. Organisms which have a harmful effect or cause a disease; usually refers to worms, ticks, fleas, mites, lice, leeches etc.

Parenteral administration. A method of giving medication that is not through the digestive tract (e.g. by injection).

Parity. The rank of a birth in the career of a breeding female.

Parturient. Giving birth or pertaining to birth.

Parturition. The act of giving birth; calving.

Pasteurellosis. Haemorrhagic septicaemia.

Patella. Kneecap.

Pathogen. Something that causes a disease, especially a microorganism.

PCV. Packed cell volume.

Pedestal. A camel's chest pad.

Pelvic. The area around the anus and the hips.

Penis. Male organ used in urinating and mating.

Peristalsis. Movement caused by a slight expansion of the diameter of an organ coupled with a shortening in length followed by a vigorous contraction in the opposite direction that result in movement and mixing.

Peritoneum. The membrane that encloses the internal organs (stomach, intestines, liver, spleen, pancreas).

Periurban. Around or close to towns or cities.

Pesticide. A poison used to destroy pests of any sort.

Physiological parameters. Those parameters relating to the physiology of an animal.

Pica. Licking, chewing and eating of unusual objects.

Placenta. The sac inside which the foetus grows and is attached to the mother's uterus, through which it is nourished.

Plaster. A mixture of materials that hardens; used for immobilizing body parts.

Pleura. Membrane that lines the chest cavity.

Pleuropneumonia. Inflammation of the pleura and lungs.

Pneumonia. Inflammation of the lungs.

Pododermatitis. Inflammation of the skin of the foot.

Polyoestrus. Having more than one oestrus cycle.

Post-mortem. After death; examination to discover the cause of death.

Post partum. After a birth.

Poultice. Soft, usually heated, preparation spread on a cloth and applied to a sore or inflammation.

Pox. A disease caused by a virus.

Predator. Animal that eats other animals.

Pregnancy. The development of the young inside the mother.

Prehensile. Capable of grasping.

Premolars. Cheek teeth in front of the molars.

Prognosis. A forecast on the probable outcome of a disease; the prospect for recovery. May be favourable, guarded, or unfavourable.

Prolapsed rectum. The lower portion of the intestinal tract (the rectum) comes out of the anus.

Prolapsed uterus. The uterus descends into the vagina and may be seen at the vaginal opening.

Prophylactic. Preventing disease.

Protozoon, Protozoa. Microorganism consisting only of one cell. Some protozoa (e.g. trypanosomes) cause disease.

Puberty. The time of sexual maturity, when an animal becomes capable of propagating its species.

Pulmonary. Pertaining to the lungs.

Purgative. Causing evacuation of dung from the intestines.

Pus. A whitish fluid produced by inflamed tissue and infected wounds.

Quarantine. Keeping sick animals separated from healthy ones for a certain period.

Rabid. Having rabies.

Rabies. A dangerous disease caused by a virus.

Radiation. Energy given out in the form of heat.

RBC. Red blood cell count: measure for the number of red blood cells in the blood.

Rehydration. The restoration of water to a body.

Reciprocal cross. Reverse cross in a two species (or two breeds) breeding programme; for example the donkey male–horse female cross produces the mule, whereas the less common *Reciprocal* horse male donkey female cross produces the hinny.

Rectum. The last part of the gut before the anus.

Recumbency. Lying down.

Repellent. Substance that repels or drives off other organisms, such as flies.

Reproductive tract. The organs involved in reproduction. In the female, the ovaries, uterus, vagina and vulva. In the male, the testicles, vas deferens (the tube leading from the testicles to the penis), prostate and penis.

Resistance. The natural ability of an animal to remain unaffected by noxious agents in its environment; the acquired ability of disease causing organisms to survive a chemical that normally kills them.

Respiratory tract. The organs involved in breathing. Includes the upper respiratory tract (nose, larynx, trachea and bronchi) and lower respiratory tract (lungs and pleura).

Retained placenta. A disease condition in which the placenta is not expelled after calving, requiring treatment.

Retention time. The amount of time that feed particles are kept in the stomach.

Reticulum. Second stomach of a ruminant.

Retina. The back of the eye which is sensitive to the light.

Retrospective survey. A survey in which owners or others are asked to remember what happened in the past e.g. the reproductive history of their animals.

Rhinitis. Inflammation of the nose.

Rift Valley fever. A disease caused by a virus.

Ringworm. A skin disease caused by a fungus.

Rumen. First stomach of a ruminant.

Ruminant. An animal (such as cattle, sheep, goats, buffaloes and camels) that has a stomach with four compartments (rumen, reticulum, omasum and abomasum). Ruminants regurgitate undigested feed from the rumen and chew it when at rest.

Ruminating. Chewing the cud.

Rut. The periodic sexual excitement of male camels (Rutting).

s.c. Subcutaneous.

Saddle gall or sore. Skin and tissue damage and abscess through badly fitted saddles.

Saliva. Fluid produced in the mouth.

Salmonellosis. Disease caused by bacteria of the genus *Salmonella*.

Sarcoptic mange. Mange.

Scabies. Mange.

Scalpel. Small surgical knife.

Sclera. The tough, usually white, outer coat of the eyeball.

Scrotum. The bag of skin around the testicles.

Secretion. Liquid produced by a gland.

Sedative. Drugs that reduce anxiety and make the animal easier to handle.

Septicaemia. The existence of microorganisms or poison in the blood.

Serum. The clear liquid that separates from the blood when it clots.

Sinus. Cavity; commonly refers to the cavities in the skull that are connected with the nasal cavity.

Specific agent. Remedy that has a special effect on a particular disease.

Spermatogenesis. The process of male gamete formation which results in the sperm.

Spermatozoa. The male reproductive cell, with a round or elongate head and a tail; the spermatozoa fertilize the ova shed by females.

Spinal canal. Hole running through the backbone. It contains nerves and liquid.

Spinal cord. The bundle of nerves located in the spinal canal.

Spleen. Internal organ that stores and cleanses the blood.

Splint. Pieces of wood put around a body part to keep broken bones in place.

Sporadic. An outbreak of a disease in a single or scattered location.

Spore. The inactive but infectious form of some bacteria (e.g. clostridium); the reproductive form of some fungi and blood parasites.

Sprain. A violent and sudden twist of a joint or muscles.

Staphylococcus. A type of disease causing bacteria.

Sterile. Free from living germs; not fertile.

Sternal recumbency. Lying on the chest.

Sternal. Pertaining to the breast bone (sternum).

Stimulant. Increases or hastens body activity.

Stocking rate. The number of animals actually kept on a given area (see carrying capacity).

Stomach tube. Long tube inserted into the mouth and used to put liquids directly into the stomach.

Stomach. The main organ where feed is digested. In ruminants, the stomach consists of four compartments: the rumen, reticulum, omasum and abomasum.

Stomachic. Stimulates activity of the stomach.

Stomatitis. inflammation of the mouth,

Streptococcus. A type of disease causing bacteria.

Streptothricosis. Dermatophilosis.

Stringhalt. Dislocated kneecap.

Styptic. Stops bleeding with an astringent.

Subcutaneous, s.c. Under the skin.

Substrate. The base on which an organism lives; a substance acted on chemically by an enzyme.

Surra. Trypanosomiasis.

Suture. Stitch, stitching.

Symbiotic. Said of the relationship of two kinds of organisms living close together and from which both derive benefit.

Symptom. Functional evidence of disease or of a patient's condition.

Syndrome. The collection of symptoms associated with a particular disease.

Synergistic. Said of an action or relationship between two or more organisms whereby the end result is greater than would have been achieved by each acting separately.

Systemic. Pertaining to or affecting the body as a whole.

Tabanid. Type of biting fly.

Tar. A dark-brown or black, viscid liquid obtained from various pine-tree species or from bituminous coal.

Taxonomy. The science of classifying living things, animals and plants according to their relationships with other organisms.

Tendon. The end of a muscle which attaches it to the bone.

Testicles, testes. The male reproductive organs, in which the sperm grow.

Tetanus. A disease caused by *Clostridium tetani* bacteria.

Third eyelid. The nictitating membrane: a fold of the conjunctiva.

Tick. Type of external parasite.

Tincture. Alcoholic extract of a plant drug.

Tonic. Produces healthy muscular condition and reaction.

Torticollis. Torsion of the neck, wry neck,

Tourniquet. A tight rope or bandage, used to restrict blood flow.

Trachea. Windpipe between mouth and lungs.

Tranquillizer. A medicine that calms or quietens an anxious patient.

Transhumance. Seasonal movements of livestock from and to a fixed base: strictly speaking the term should be (but rarely is) restricted to vertical movement between mountain summer and lowland winter pasture areas.

Trocar. A pointed, needle-like instrument equipped with a cannula; used to puncture the wall of a body cavity to withdraw fluid or gas.

Trypanosomiasis. Disease caused by trypanosome parasites.

Tsetse. Type of fly transmitting trypanosomiasis.

Tumour. An unusual growth in the body.

Turgidity. Swollen, thick or extended.

Tympany. Excessive gas, bloat.

Typology. An analysis of types; the results of such an analysis.

Ulcer. Inflammation or sore on the skin or mucous membrane, discharging pus.

Umbilical cord. Navel cord.

Umbilicus. Navel.

Ungulate. An animal with hooves.

Upper respiratory tract. The nose, larynx (voicebox), trachea (windpipe) and bronchi (air passages leading to the lungs).

Uterus. Womb, the organ inside a female where the young develops,

Vaccination. Applying a vaccine.

Vaccine. A preparation of killed, living inactivated or living fully infective microorganisms, especially viruses or bacteria, used to produce or artificially increase immunity to a particular disease. The process of administration, usually but not invariably by injection, is known as vaccination.

Vacutainer. Special tube used to collect blood.

Vagina. The portion of the female reproductive tract through which the baby animal must pass. It is separated from the uterus by the cervix.

Vermicide. Substance that kills worms or intestinal parasites.

Vermifuge. Substance that expels the worms or intestinal parasites; anthelmintic.

Verminous. Pertaining to, or due to, worms.

Vesicle. A small sac containing liquid.

Virus. A tiny microorganism, which causes disease.

Vitamin. Natural substance essential to the functions of the body.

Vulva. The opening below a female animal's tail to which the urinary and reproductive tracts are attached, which swells at time of oestrus and more so at calving time,

WBC. White blood cell count: measure for the number of white blood cells in the blood.

Wolf's tooth. First premolar on each side of the upper and lower jaw.

Womb. Uterus.

Wry neck. Camel disease causing the neck to be bent into an S-shape.

Zoonosis. A disease that is transmissible from animals to man.

(Wilson, 1998 and K. Rollefson *et al.*, 2001).

ANNEXURE

RESULTS OF THE WORKING GROUP DISCUSSIONS HELD AT THE INTERNATIONAL WORKSHOP ON RESEARCH AND DEVELOPMENT TO FORMULATE RESEARCH AGENDA FOR THE NEXT DECADE (WAD MEDANI, GEZIRA STATE, SUDAN, DECEMBER, 2002)

These results have been published in the proceedings of the above said workshop by H.J. Schwartz (ed.) (2003).

Excerpts of Editor's Comments: It was the general consensus that there has been a slowly increasing volume of published research on camels in the past decade, but this is not satisfying the needs arising from the increasing importance of the camel as a food animal and income earner. Due to the fact that camels are usually raised and exploited under the most marginal conditions in remote areas, there is only minimal research conducted, which is production related.

In a recent literature search conducted by the editor, some 320 articles on camels were found in refereed journals between 1991 and 2001. Less than 10% of those were in some way production oriented. Most of the remainder were dealing with physiological, biochemical and camel health case studies. Common to this type of research is that it is conducted with very small numbers of animals and in laboratories, experimental farms or other artificial environments.

The critical observer can also find out a certain preoccupation with modern high-tech methods (e.g. embryo transfer and genetic manipulation), which are economically irrelevant to a sector of the livestock industry, which is only just developing market integration in many countries where camels are raised. We still are not certain, which factors cause seasonality of breeding in camel or whether reputed breeds are indeed breeds in the true sense.

Consensus was developed in the workshop that promotion of interest in production oriented research is much needed both within the scientific community and research funding agencies. Keeping the same in view,

research topics were identified in the five working groups (given in Table 1) and listed in more detail in the summaries provided by the working group recorders.

The same have been reproduced as such in this book for the benefit of all those interested in raising camels or conducting research on them.

TABLE 1: Broad categories of research topics and/or items identified in the working groups

Working Group	Topic / Item	
Nutrition and Management	1	Nutrient requirements and feeding standards for all classes of animals
	2	Evaluation of available feeds and forages
	3	Grazing systems and resource utilisation patterns
	4	Reproduction and reproductive efficiency
	5	Production systems and system performance milk
	6	Production systems and system performance meat
	7	Working performance (draught, loading, riding, leisure)
Breeding and Genetics	8	Breed identification and genotype description
	9	Investigate genetic base of productivity parameters
	10	Improved reproductive efficiency
	11	Methods and programmes for breed improvement
	12	Conservation of genetic diversity
Camel Health	13	Production (intensification) related diseases
	14	Environmental change related diseases
	15	Ethno-veterinary (traditional) medicine
	16	Food safety and (hygienic) product quality
	17	International and public health issues

Camel Products	18	Quality and processing of milk
	19	Quality and processing of meat
	20	Product marketing and consumer preferences
	21	Added value products (by-products) .
Socio-economics	22	Social integration of camel production systems
	23	Economic importance and function
	24	Production economics
	25	Market structures and development

SUMMARIES OF THE WORKING GROUP RESULTS

Working Group I: Nutrition and Management

- Research needs and potentials were discussed separately for two production system types: Extensive systems, i.e. traditional subsistence systems which are entirely based on natural pastures, with little or no market integration, usually migratory and opportunistic and based on communal land use with no established individual land use rights,
- Semi-intensive and intensive systems, i.e. market oriented systems, either integrated with cultivation, commercial activities and/or based on privately owned land; usually sedentary with access to supplementary feeding.

Research on improved nutrition and feeding for extensive systems:

- Strategic supplementation to include: feed banks for easily digestible energy and deficient micro-nutrients.
- Multiple species grazing system to study selective grazing behaviour of different domestic herbivores, set proper stocking rates for different range conditions. Toxic elements in feed and anti-nutritive factors.
- Support of migratory systems
- Provide feed and water (animals go to feed or feed taken to animals).

Research on improved nutrition and feeding for semi-intensive systems

- Establish nutrient requirements for various age groups and productive stages
- Develop feeding standards for different use classes - milk, meat, draught, riding and load carrying
- Evaluation of common feedstuffs and forages used by camels

Research on improved management

- Improve reproductive efficiency (improve conception rates, manage seasonal breeding,

reduce post natal mortality, reduce calving intervals, increase life time performance of female breeding stock)

- Develop feedlot systems to finish immatures for meat production, study compensatory growth effects
- Improve milk production and hygiene
- Optimise grazing management for more efficient and benign land use (rotational grazing, range improvement, develop feed banks and forage conservation)
- Develop improved harnesses and equipment for work camels

Research and development priorities

1. Develop supplementation systems (extensive and semi-intensive)
2. Reduce calf mortality
3. Increase milk production and improve processing
4. Develop sustainable multiple-species grazing systems

Working Group II: Genetics and Breeding

The major objective of research in genetics and breeding of camels is to improve animal performances to make more efficient use of the camels, unique adaptation to arid and semi-arid conditions and marginal feed and water supplies. At present there are only few reliable data to support systematic breeding for higher performance.

It is therefore suggested to embark on a programme of breed (type, ecotype etc.) identification and description of regional and/or local camel populations to:

- determine genotypic and phenotypic characters
- determine the differences in production and reproductive performances
- determine the differences in disease tolerance
- determine breeders perception and preferences
- determine management or husbandry requirements

Methods of identification of the genotype and phenotype characteristics can include:

- Classical (conventional) methods whereby breeds can be identified according to ethnic origins (of the breeder), location, phenotype, size, colour and/or prevalent use (milk, meat, work etc.)
- Molecular-biological methods such as RAPD (randomised amplified polymorphic DNA-fingerprinting), micro-satellite DNA to determine the location

of the gene and the products. PCR (polymerase chain reaction detection assay), or DNA sequencing

Determination of performances will require extensive data collection and recording of:

- reproductive traits such as age at puberty, sexual maturity, and at first calving, length of gestation period, calving interval, conception rate, rate and cause of abortions etc. and of
- production traits such as birth rate and weight, weaning rate and weight, post natal mortality, mature weight, growth rate, milk yield, lactation length, productive life span as well as other performance characteristics (work capacity, wool and hair production, racing performance, medical properties of camel products etc.)

Development of breed improvement programmes will comprise of:

- Estimation of breeding value for different utilities such as preferred phenotype, performance (milk, growth, fertility, work capacity etc.)
- Choice of the system of breed improvement, i.e. within-breed selection or various crossbreeding schemes
- Choice of breeding techniques, i.e. natural mating, artificial insemination, embryo transfer or other advanced biotechnological methods

Conserving present genetic diversity in the world's camel population requires either:

- In-situ conservation of breeds within the production system or
- Ex-situ maintenance of live breeding groups outside the production system (zoos, parks, experimental farms, enclosures)
- or cryo-conservation (semen, embryos, somatic cells)

Working Group III; Camel Health

The group identified several different health related complexes which are treated separately.

I Diseases of intensification / diseases of production effects in camel

Brucellosis, mastitis, camel calf mortality, respiratory diseases, reproductive disorders, skin diseases, helminthoses (incl. schistosomosis), ticks and tick-borne disease (TBD)

Hypothesis 1: With increased intensification increase in disease incidence

Hypothesis 2: With increased intensification disease patterns will change

Expected favourable conditions:

- Under more intensive management better access to data
- Possibility of sentinel herds
- Improved monitoring

Country	Research capacity/ potential (low, moderate, high)	Research priority (low, moderate, high)
<i>Sudan</i>	Moderate	Low

<i>Somalia</i>	Low	Medium
<i>Kenya</i>	Moderate	High
<i>Pakistan</i>	Moderate	High

II Changing camel disease patterns with changing ecological conditions

Camel systems will experience environmental changes due to man-made agricultural schemes and due to displacement of pastoral systems by other more intensive forms of land use. This will lead to new research topics:

- monitoring newly emerging diseases
- Effects of stress on immunological status of camel
- Changes in endemic/enzootic stability
- Disease transmission dynamics within species and across species (trypanosomiasis, brucellosis etc.

Country	Research capacity/ potential (low, moderate, high)	Research priority (low, moderate, high)
<i>Sudan</i>	High	High
<i>Somalia</i>	Low	Low
<i>Kenya</i>	Moderate	Moderate
<i>Pakistan</i>	Moderate	High

III Ethno-veterinary medicine / indigenous knowledge in camel keeping societies

Research areas are:

- Taking stock of application and potential of herbal medicine
- Identification and assessment of indigenous practices, practitioners, and knowledge
- Identification / classification of diseases by camel herders as prerequisite for surveillance
- Application and validation of methods of participatory epidemiology

Country	Research capacity/ potential (low, moderate, high)	Research priority (low, moderate, high)
<i>Sudan</i>	Moderate	Moderate
<i>Somalia</i>	Moderate	High
<i>Kenya</i>	Moderate	Moderate
<i>Pakistan</i>	Moderate	Moderate

IV National and international issues with regards to camel in animal health

Specific fields are freedom from disease, control of trans-boundary diseases and disease surveillance. Research areas are:

Part – III

Production and Management of Camels

- Development of an adapted, epidemiologically sound sampling frame in nomadic-pastoral production systems
- Herd health monitoring and surveillance systems
- Refining disease detection methods
- Testing procedures
- Test protocol
- Involvement of all stakeholders along the production chain (particularly traders)
- Data collection and decision support research for international discussion in the various organisations and committees (OIE, FAO)

With regard to food safety specific fields are product quality and veterinary public health. Research areas are:

- Residues in meat and milk (pesticides, drugs)
- Application of HACCP and risk analysis to meat and milk all along the food chain
- Use of milk in alternative medicine
- Hygiene and consequences of raw liver consumption in Sudan
- Risks associated with by-products (e.g. hides) and monitoring of non-pasteurised camel milk
- Feasibility study in acceptance of camel food products (minced meat, sausage, intestines,, ice cream)

Country	Research capacity/ potential (low, moderate, high)	Research priority (low, moderate, high)
<i>Sudan</i>	Moderate/high	High
<i>Somalia</i>	Moderate	High
<i>Kenya</i>	Moderate	High
<i>Pakistan</i>	Moderate	High

Working Group IV: Camel Products

Research Agenda for Camel Milk Production / Processing / Marketing

Unlike Kenya and Somalia, Sudan does not have established camel milk markets. The same applies also to a slightly lesser degree to Syria and Pakistan. Therefore the following points are of specific importance, before considering research programmes relevant to improve camel milk production and marketing that are listed below:

- identify production areas with camel milk marketing potential estimate regional production surplus,
- introduce the concept of milk marketing to relevant camel milk producers,

- create consumer awareness on medicinal and nutritive value of camel milk, develop and test mobile collection and mobile processing strategy

Research priorities relating to camel milk

- Development and validation of camel milk quality tests
- Defining and evaluating quality standards for camel milk
- Analysis (HACCP) and participatory assessment of traditional & current practices to develop an adapted hygiene concept for camel milk
- Test possibilities to expand the shelf life of camel milk at the production level (Lactoperoxidase, heat)
- Examine the effect of Lactoperoxidase (LPS) and heat treatment on medicinal and nutritional properties of camel milk
- Develop and test simple small-scale camel milk processing methods / technology
- Diversify camel milk products (fermented milk, ghee and storable products)
- Investigate consumer demand and preferences
- Assessment of physical / chemical / organoleptic properties of camel milk under various environmental and physiological conditions

Research Agenda for Camel Meat Production / Processing / Marketing

Research on camel meat is an absolute priority for the Sudan, where export of slaughter camels through traditional marketing channels is well established. The emergence of new markets for quality camel meat (Saudi-Arabia, Egypt) should be monitored.

- Identification of new marketing channels for quality camel meat / new camel meat products
- Promotion of camel meat as a healthy product and assessment of consumer acceptance and consumer preference for quality camel meat / new camel meat products
- Study the current practice and acceptance among pastoralists for marketing of male camel weaners / young male camels
- Diversification of camel meat products (sausages/dried meat/burgers), application of standard cuts, vacuum packaging, meat hygiene and meat quality standards
- Assessment of optimum slaughter age / weight and carcass characteristics with regards to camel meat quality

Research Agenda for Camel Wool / Hides / Bones / By-Products

Wool: improve traditional methods through introduction of low-tech processing equipment

Hides/Bones/By-Products: no research priority at present.

Working Group V: Socio economics

General

- Socio-economics research is neglected in agricultural and livestock research in general, and in camel research in particular.
- Any research and development efforts should make people, in this case pastoralists, at the centre.

Part – III

Production and Management of Camels

- Camel is an efficient utiliser of resources in marginal areas which otherwise may not be utilized efficiently

Research issues identified by the group

I. Social issues

- Social integration of camel pastoralists into the main social system
- Sustainability of tribal/group pastoral system and the need for community based services
- Human-animal-environment relationships: nomadism/semi-nomadism; partial settlement/agro-pastoralism systems and their interaction with population and environment
- Socio political role of pastoralists (local administration & governance)
- Social development of pastoralists health, education, income, employment and livelihood security.
- Women's participation and role in camel pastoralism (milk processing, milk marketing, wool processing etc.)

II. Economic importance & function

- Food (milk, meat)
- Wool (tents, ropes etc), skin & hides (saddles, carpets etc.)
- Income contribution (GDP, exports, wage and revenue)
- Draught power contribution (transports, traction, riding, etc.)

III. Production economics

- Optimal herd size & composition
- Adoption and impact of improved animal/crop production technology in camel-based pastoral system, cost-benefit analysis
- Processing & promoting animal products
- Resource use & environment protection
- Marketing issues: marketing costs, market information, marketing system efficiency (e.g. ethical aspects of brokers & traders), market infrastructure, export promotion, instability of price and marketed volume of animals and animal products
- Policy issues and studies: sedentarization vs. nomadism/semi-nomadism, rights to grazing lands & water points/sources, extension policy for pastoralists, credit/finance policies

IV. Research agenda

- Justification: the camel sub sector is important in terms of economic and social roles and contributions.
- Objectives: To improve performance of camel sub sector in order to provide a better quality life for the community and to increase its contribution to the economy.

V. Research areas

- 1) Exploring the socio-economic importance of the camel sub-sector.
Social aspects

- Social role of camel in community
- Gender aspects in camel sub-sector
- Social situation of pastoralists

Economic aspects

- Economics roles of the camel sub-sector
- Contribution to GDP
- Contribution to exports
- Contribution to employment
- Contribution to household income
- Provision of food
- Provision of raw material for industrial and non-industrial uses

2) Production & productivity

- Input-output relationship in camel and camel production
- Competitiveness of camel sub-sector (e.g. Profitability & resource use efficiency)
- Optimisation of herd size and composition

3) Policy studies

- Export policy
- Taxation policy
- Credit policy
- Extension policy
- Environment policy
- Grazing & water rights policies
- Issue of sedentarization versus nomadism

4) Marketing system efficiency

- Market structure, conduct and performance
- Market infrastructure
- Market information
- Analysis of demand for camel products
- Price studies (instability)
- Camel product processing & promotion
- Internal & external market integration

REFERENCES

- Anonymous. 1989. Annual Report, National Research Center on Camel, Bikaner, India.
- Anonymous. 2000. FAO Production Yearbook. FAO, Rome.
- Anonymous. 2002. Near cure for Johne's disease in cattle. St. Paul Pioneer Press (USA), Nov. 21, 2002.
- Anonymous. 2002-03. Economic Survey, Economic Adviser's Wing, Ministry of Finance and Economic Affairs, Govt. of Pakistan, Islamabad.
- Chaudhary, Z.I. 2000. Reproduction in the dromedary. In: S.T.O.C. (T.K. Gahlot, Editor).
- Chaudhary, Z.I. and S.J. Akbar. 2000. The Camel and its Diseases. Al Bayan Press, Printing and Publishing Est., Dubai, United Arab Emirates.
- Coppock, D.L., J.E. Ellis and D.M. Swift. 1988. Seasonal patterns of activity, travel and water intake for livestock in Turkana, Kenya. J. Arid. Environ. 14: 319-331.
- Dagg, A.I. 1974. The locomotion of the camel (*Camelus dromedarius*). J. Zool. London. 174(1): 67-68.
- Engelhardt, W. von. 2003. The camel—an exciting animal for basic research. In: Proceedings of the International Workshop on Camel Research and Development: Formulating a Research Agenda for the Next Decade, held in Sudan in December, 2002.
- Gahlot, T.K. (Editor). 2000. Selected Topics on Camelids. The Camelid Publishers, Camel House 67, Gandhi Nagar West, Bikaner, India.
- Gahlot, T.K. and B.P. Chadha. 2000. Training and sport of dromedary camel. In: S.T.O.C. (T.K. Gahlot, Editor).
- Isani, G.B. and M.N. Baloch. 2000. Camel Breeds of Pakistan. The Camel Applied Research and Development Network (CARDN), Pakistan/ACSAD.
- K. Rollefson, I., P. Mundy and E. Mathias. 2001. A Field Manual of Camel Diseases. I.T.D.G. Publishing, 103-105 Southampton Row, London, UK.
- Khan, B.B., M. Lateef, M.Q. Bilal, A. Iqbal and H. Raza. 1996. Some of the activity patterns of *Camelus dromedarius* maintained in Thal area of Punjab, Pakistan. Pak. J. Agri. Sci. 33: 69-72.
- Khan, B.B. and A. Iqbal. 2001. Production and composition of camel milk (Review). Pak. J. Agri. Sci. 38(3-4): 64-68.
- Manefield, G.W. and A.H. Tinson. 1997. Camels—A Compendium. Postgraduate Foundation, University of Sydney, Sydney, Australia.

- Muhammad, G., M. Athar, A. Shakoob, M.Z. Khan and F. Rehman. 1995. Surf field mastitis test: An inexpensive new tool for evaluation of fresh milk. Pak. J. Food Sci. 5(3-4): 91-93.
- Saber, A.S. 2000. Statics and dynamics of locomotor system of the dromedary camel. In: S.T.O.C. (T.K. Gahlot, Editor).
- Schmidt-Nielsen, K. and B. Schmidt-Nielsen. 1952. Water metabolism in desert animals. *Physiol. Rev.* 32: 135-136.
- Schmidt-Nielsen, K., B. Schmidt-Nielsen, S.A. Jarnum and T.R. Houpt. 1957. Body temperature of the camel and its relation to water economy. *Amer. J. Physiol.* 186: 103-109.
- Schwartz, H.J. (Editor). 2003. Proceedings of the International Workshop on Camel Research and Development: Formulating a Research Agenda for the Next Decade, held in Sudan in December, 2002.
- Schwartz, H.J., R.B. Dolan and A.J. Wilson. 1983. Camel production in Kenya and its constraints: Productivity. *Trop. Anim. Hlth. Prod.* 15: 169-178.
- Schwartz, S. and H.J. Schwartz. 1985. Nomadic pastoralism in Kenya—still a viable production system. *Quart. J. Int. Agri.* 24:5-21.
- Schwartz, H.J. and M. Dioli (Editors). 1992. *The One-Humped Camel in Eastern Africa*. Verlag Josef Margraf, Weikersheim, FR Germany.
- Shereif, N.A. and A.H. Tinson. 2000. Genetics and breeding methods in the dromedary camels. In: S.T.O.C. (T.K. Gahlot, Editor).
- Skidmore, J.A. 2002. A successful cross between dromedary and llama produces 'Camella'. ET Unit, Al-Ain, UAE.
- Wilson, R.T. 1978. Studies on the livestock of Southern Darfur, Sudan. 5. Notes on camels. *Trop. Anim. Hlth. Prod.* 10: 19-25.
- Wilson, R.T. 1998. *Camels*. Macmillan Education Ltd., London.
- Wilson, R.T. and K.T. Wagenaar. 1982. An introductory survey of livestock population demography and reproductive performance in the area of Niger Range and Livestock Project. International Livestock Center for Africa, Addis Ababa, Ethiopia.
- Wilson, R. T. 1989. *Ecophysiology of the Camelidae and desert ruminants*. Springer Verlag, Heidelberg, Germany (from various primary sources).
- Wilson, R.T., A. Araya and A. Melaku. 1990. The one-humped camel. An analytical and annotated bibliography 1980-1989 (Technical Paper Series No. 3). United Nations Sudano-Sahelian Office, New York, USA.
- Yagil, R. 2000. Lactation in the desert camel. In: S.T.O.C. (T.K. Gahlot, Editor).

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