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CHAPTER 61

Giraffidae

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BIOLOGY[8,14]

This family contains two genera, each of which contains one species, with historical fossil records throughout Africa during the Miocene. Fossil records also show early member of this family in Europe and Asia.

Giraffes intrigue humans, as evidenced by prehistoric cave paintings of their likeness as early as 10,000 years ago to their appearance in most zoological collections today. The giraffe first appeared in human records in Egypt about 2.5 centuries BC. The Egyptians thought the giraffe was a cross between a camel and leopard, hence the scientific name, *Giraffe camilopardalis*. The encroachment of man and climate changes have restricted the giraffe's current habitat to sub-Saharan Africa in arid to semi-arid savanna zones. They are currently found in national parks and game farms in eastern and southern Africa, with small populations in northwest Africa.

As the tallest animal, giraffes have access to vegetation at heights not available to other species (2 to 5.5 m) and are reported to feed on at least 100 plant species. Their large size, keen eyesight, and good hearing also minimizes predation in adults; however, 75% of the calves die in their first year (in comparison to 7% their second year). The long neck and size of the giraffe is thought to aid in the heat distribution in a hot climate because they rarely seek shade, do not wallow in water, and are reported to go without water for extended periods. Giraffes are sociable animals that form loose female herds with adult males being solitary. Historically, nine subspecies (Table 61-1) will interbreed and produce fertile offspring. The subdivision has been based on body size, location, and coat pattern. The three races most commonly mentioned are Reticulated, Masai, and Rothschild giraffes.

The secretive and solitary Okapi *(Okapia johnstoni)* was first described to the scientific world in 1901; the first captive animal was displayed in Europe in 1918. Pieces of skin were sent to Harry Johnston in London in 1900; Johnston's name is incorporated into the scientific name. The animal is a rich chocolate-brown with white stripe on the legs and hindquarters. The skin is very oily and contains a reddish brown pigment. Currently, the okapi habitats are the equatorial rainforest of northern, central, and eastern Democratic Republic of the Congo, where they are protected, but they have suffered during the civil strife in that country.

Even though the giraffe and okapi are in the same family, enough difference in placentation appears to exist to preclude embryo transfer and hybridization. Evidence about the evolution of the okapi suggests that it may be more closely related to the nilgai antelope because of similar chromosome numbers, placentation, and development of fetal gonads, whereas the giraffe is sometimes compared to the pronghorn antelope.

UNIQUE ANATOMY[8,9,14,22]

The shared characteristics of this family include: (1) elongated necks; (2) long, dark prehensile tongues (in giraffes there are densely haired prehensile lips for protection against thorns); (3) no gall bladder in most animals; (4) forelegs longer than the hind legs, with a resultant "pacing" gait, but when running, the front and rear legs move together with the rear legs placed

Table 61-1

Biological Information for Giraffidae

SCIENTIFIC NAME	COMMON NAME	WEIGHT (ADULTS, kg)	GEOGRAPHICAL DISTRIBUTION	IDENTIFICATION BY THE SPOTS ON THE ANIMAL'S COAT
Giraffa camilopardalis reticulata	Reticulated Giraffe	Males 850–1950 Females 700–1200	Northeast Kenya, Ethiopia, Somalia	Large, polygonal liver colored spots outlined by a network of bright white lines
Giraffa camilopardalis tippelskirchi	Masai Giraffe	Males 850–1950 Females 700–1200	Central and Southern Kenya, Tanzania	Jagged-edge, vine-leaf shaped spots of dark brown on a yellowish background
Giraffa camilopardalis rothschildi	Rothchild or Baringo Giraffe	Males 850–1950 Females 700–1200	Uganda, western Kenya	Dark brown blotched or rectangular spots with poorly defined cream lines
Giraffa camilopardalis camelopardalis	Nubian Giraffe	Males 850–1950 Females 700–1200	Eastern Sudan, Northeast Congo	Large four-sided brown spots and off white background. No spots on inner legs or below hocks
Giraffa camilopardalis antiquirum	Kordofan Giraffe	Males 850–1950 Females 700–1200	West and southwest Sudan	Small more irregular spots that do not cover inner leg
Giraffa camilopardalis peralta	Nigerian or Chad Giraffe	Males 850–1950 Females 700–1200	Chad	Numerous pole, yellowish red spots.
Giraffa camilopardalis giraffa or capenisi	Cape Giraffe	Males 850–1950 Females 700–1200	Southern Africa	Rounded or blotched spots; some have star like extensions on a tan background that extend to the hooves
Giraffa camilopardalis angolensis	Angola Giraffe	Males 850–1950 Females 700–1200	Angola, Zambia	Large spots with some notches around the borders that extend to the hooves
Giraffa camilopardalis thornicrofti	Thornicroft Giraffe	Males 850–1950 Females 700–1200	Eastern Zambia	Star- or leaf-shaped spots that extend to the lower leg
Okapia johnstoni	Okapi	210–250	Democratic Republic of the Congo	The oily coat is a rich chocolate-brown with striped hindquarters and legs.

between the front legs; (5) their coat pattern helps provide camouflage in their respective habitats. The okapi has larger ears, and the giraffe has large eyes located laterally, thus providing a good field of vision.

Skulls of this family contain large sinuses that are relatively larger in the giraffe and are thought to minimize injury during fighting. The giraffe's horns are unique in that they: (1) are present in both sexes; (2) appear at birth; and (3) are covered with skin and hair throughout life except for older males that rub off the skin at the tip. Giraffe horns are more erect, whereas the okapi's horns angle more posteriorly. The okapi horns occur only in males, are devoid of skin at the tip, and are not present at birth. The giraffe's head has a bony protuberance anterior to the horns and above the eyes (sometimes called the median horn), which is larger in males and like other skull exostoses increase with age. Okapi are born with a mane that disappears with age.

The giraffids dental formula is 2× (I-0/3, C-0/1, P-3/3, M-3/3), with rugose molars that are low-crowned with rough enamel and lobed incisiform canines, which are different from other mammals. The giraffids also have an elongated diastema.

Giraffes are unable to swim. Giraffes lack preorbital, inguinal, and interdigital glands for marking their territories, whereas the okapi has interdigital glands. Giraffes lack cuticular muscles and therefore are unable to move the skin to discourage insects. Adult giraffes are 4.25 to 5.5 m tall and weigh from 500 to 1950 kg, depending on the race and sex; males are larger. Adult okapi are 1.5 to 1.75 m tall and weigh from 210 to 250 kg with the females being larger. The giraffe's hooves are extremely hard and flat to the ground, with the fetlock almost touching the ground. The okapi's hooves are more upright. No lateral digits exist in either species.

Despite its height and long neck, giraffes have seven cervical vertebra (with one report of a modified eighth cervical vertebra). Early anatomical studies of the larynx led to the belief that giraffes were mute, but braying occurs in all age groups. Females roar and bellow. The okapi also have a repertoire of vocal sounds.

SPECIAL PHYSIOLOGY[8,10,11,15,17,23]

The giraffe's long neck has generated studies of respiratory dead space. Like most physiological studies of this species, these studies are controversial. There are two theories: (1) the large dead space is overcome by slow deep respirations (8 to 10/min with a 4-liter tidal volume at rest) and a large lung capacity; and (2) the relatively small tracheal diameter helps minimize water loss, and its dead space is within predicted values. Giraffids can alter their body temperature several degrees to minimize water loss and help with heat regulation.

The dynamics of the giraffe's cardiovascular function are challenging. The blood reaches the brain by increased aortic blood pressure. Fainting is prevented when the animal lifts its head after drinking by modifications in the cerebral vessels (rete mirabile), jugular valves, and the CSF to help buffer the rapid changes in pressure because some studies doubt whether a functional carotid sinus exists to regulated blood pressure. Peripheral edema is prevented by the thick tight skin acting as a "G Suit," with thickened arterioles to limit passage of fluid. The vessels' thickness seems to vary in response to the hydrostatic pressure; the distal limbs have the thickest vessels.

SPECIAL HOUSING REQUIREMENTS

Giraffes should have large outdoor paddocks with indoor heated housing that contain separate stalls. Females can be housed together, but adult males and mothers with small calves should be separated. The exterior doors do not have to be as tall as a giraffe because they will lower their heads to pass through. The choice of flooring is critical. Indoor areas should have well drained roughened concrete for good footing and proper hoof wear. The outside yard should have dense substrate that also drains well. Avoid substrates of small crushed stones as the sharpened stones work through the bottom of the hoof. Giraffes should be maintained indoors at temperatures below 50°F (10°C), and definitely kept inside to prevent injuries from slipping and falling if there is snow or ice. Although giraffes tolerate high temperatures without shade in the wild, shade should be provided. Containment for giraffes does not have to be extensive because they are reluctant to cross a water moat or a moderately steep dry moat or to step over fences.

Okapi also require a spacious outside yard and a heated indoor facility in cooler climates. The considerations for good footing are also important, but caution is advised; concrete that is too rough can cause excessive hoof wear.

The design of the exhibit for giraffes, okapi, and other species should include an area to routinely confine them for closer examination, treatment, or other medical and/or management procedures.

FEEDING

Giraffes are selective browsers that choose the high-protein parts of the plants, such as leaves and buds. Their highly papillated forestomachs adsorb nutrients in a shorter time for this concentrate selector. The captive diet of both the giraffe and okapi requires a protein content from 15% to 18% that includes a combination of high-protein pelleted ration and good-quality hay. Their diet should contain adequate levels of vitamin E and selenium to prevent nutritional myopathy, and they should have access to a trace mineral salt block. It is also advantageous to provide them with selected browse (nontoxic and free from chemicals) to supplement their diet and provide enrichment, which helps reduce stereotypic behaviors. The feeding stations for giraffes are usually elevated, as is the source of the water in many situations; however, this prevents the public from watching the animal spread its front legs and lower its head to the ground to drink as it does in the wild. The overzealous use of fruits and vegetables is discouraged because of their low protein content, but they can be used in moderation as treats for training animals, especially in a confinement chute.

RESTRAINT AND HANDLING[5,24]

Physical restraint of giraffes with chutes or gates applies for minimally invasive procedures such as blood sampling, rectal examinations, minor hoof-trimming, and tuberculin testing, but giraffes can present dangers to the handlers and to themselves during such procedures. The giraffe's weapons are powerful kicking, striking with the forelegs, and bashing with the head. If the footing is slippery, the animal can fall and injure itself or ground support staff. The design of a giraffe-restraint facility varies from a small stall with a movable wall or a crate to sophisticated squeeze cages. Success depends on facility design, training, and conditioning of the giraffe plus a well-trained staff. A combination of IM azaperone (250 µg/kg) plus detomidine (15 to 30 µg/kg) to produce tranquilization and moderate analgesia (Table 61-2) will allow more extensive manipulations. To increase sedation, 10 mg of butorphanol IV is used in adults. Detomidine is partially reversed with yohimbine (0.1 mg/kg) or atipamezole (0.2 mg/kg), and butorphanol is reversed with naltrexone (2 mg naltrexone/mg of butorphanol).

The temperament of the okapi is calmer than the giraffe, which allows greater ease of manipulation in most situations with proper conditioning and training. This is usually accomplished without confinement because they tend to fight it. The defensive weapons of the okapi include kicking and use of head and horns. Xylazine (100 to 200 mg/adult) or azaperone (50 mg/adult) will aid the procedure by providing additional sedation (see Table 61-2).

CHEMICAL RESTRAINT/ANESTHESIA[3,4]

The reader is referred to the references for more detailed discussions of these procedures in giraffe (see Table 61-2). Giraffe anesthesia/immobilization has a history of problems of unacceptable mortality and morbidity, which can be minimized in captive animals with preplanning: (1) Fasting for 48 to 72 hours and withholding water for 24 to 48 hours to minimize regurgitation, which can lead to fatal aspiration pneumonia; (2) work in a confined space with smooth solid walls, sound footing, and a catwalk for access to the animal's head during the procedure; and (3) an experienced staff to assist patient monitoring and support is mandatory. Procedural complications can still occur in captive situations but are amplified in free-ranging giraffes because control of the variables is minimal.

Standardized procedures for handling an immobilized/anesthetized giraffe in lateral recumbency includes supporting the neck with the head maintained above the rumen and the nose pointed down to ensure an open airway and facilitate drainage of rumen or pharyngeal fluids. A board or ladder can be used to support and position the neck and to keep it straight. The angle of the neck is altered every 10 to 15 minutes to minimize muscle spasms that in the postrecovery period are life-threatening. The animal is blindfolded, and earplugs are inserted. Because of the mortality associated with secondary aspiration pneumonia, it is tempting to consider inserting an endotracheal tube; however, vomiting/regurgitation usually occurs when the animal initially falls. The access to the larynx is difficult without a flexible endoscope, and stimulation of the posterior pharynx can induce vomiting. The giraffe's size is a major factor in the success of the procedure; smaller animals usually have a better success rate than the very large adults.

Monitoring a recumbent giraffe is critical for patient safety and initially includes close evaluation of the respiratory function because respiratory failure usually occurs first and is followed rapidly by a cascading of events, including cardiac depression and death. Respiratory tidal volume is monitored by feeling the amount or air moved on exhalation. End-tidal CO_2 may be altered in giraffes because of the respiratory dead space and respiration rate. Cardiac function is evaluated by

Table 61-2

Chemical Restraint Agents Used for Standing Sedation in Giraffidae

GENERIC NAME	TRADE NAME	DOSAGE	REVERSAL AGENT/DOSE	SOURCE
Giraffe				
Azaperone	Azaperone	A = 250 µg/kg IM	Yohimbine	Y = Wildlife
Detomidine	Dormosedan	D = 20–25 µg/kg IM	0.1 mg/kg or	Pharmaceutical, Inc.
	For more sedation		Atipamezole	A = Farmos, Finland
	add Torbugesic		0.2 mg/kg given IM	B = Fort Dodge Labs
Butorphanol tartrate	Torbugesic	10 mg/adult given IV	Naltrexone 2 mg/mg of B given IM	N = Wildlife Pharm.
Okapi				
Xylazine	Rompun	1–1.3 mg/kg	Yohimbine 0.16 mg/kg IM	X = Bayer Corporation
Giraffe Immobilizing Agents/Combinations				
Medetomidine	Domitor/ Medetomidine Vetalar	M = 150 µg/cm of Shoulder Height (SH) K = 3 mg/cm SH	Atipamezole for M 340 µg/cm SH given IM	M = Farmos, Finland M = Wildlife, Pharm.
Ketamine				
Etorphine/ Xylazine	M99 Rompun	X = 70 to 100 mg for adult X = 30 to 40 mg for yearling E (narcotizing dose) Adult = 1.5–2.5 mg Yearling = 0.5–1.3 mg E (supplement) Adult = 0.5 to 1 mg Yearling = 0.3–0.7 mg	Naltrexone 125 mg per mg of E given $\frac{1}{4}$ IM and $\frac{3}{4}$ IV Atipamezole 50 to 100 mg/animal $\frac{1}{4}$ IM ond $\frac{3}{4}$ IV	E = Wildlife Pharm. X = Bayer Corporation
Carfentanil Xylazine (Free-ranging adult animals)	Wildnil Rompun	C = 8 mg X = 100–150 mg	Naltrexone 125 mg per mg of C given $\frac{1}{4}$ IM and $\frac{3}{4}$ IV Atipamezole 50 to 100 mg/animal $\frac{1}{4}$ IM and $\frac{3}{4}$ IV	C = Wildlife Pharm.
Okapi Immobilizing Agents/Combinations				
Medetomidine	Domitor/ Medetomidine Vetalar	M = 60–90 µg/kg IM K = 1–3 mg/kg IM	Atipamezole 5 mg/mg of M given IM	M = Farmos, Finland M = Wildlife, Pharm.
Ketamine				
Etorphine/	M99	E Adult = 4–4.5 mg Total dose IM	Naltrexone 100 mg/mg of E given IM	E = Wildlife Pharm.
Xylazine	Rompun	X Adult = 48–50 mg Total dose	Yohimbine 0.16 mg/kg IM	X = Bayer Corporation
Xylazine	Rompun	X = 110–130 µg/kg IM 30 min before C	Atipamezole 50–100 mg/animal given IM	
Carfentanil	Wildnil	C = 2.7–2.9 µg/kg IM	Naltrexone 100 mg per mg of C given IM	C = Wildlife Pharm. N = Wildlife Pharm.

chest auscultation and palpation of the auricular or mandibular arteries. Pulse oximetry is useful but may not function properly in some animals, especially when an α_2-agonist (medetomidine) is part of anesthetic protocol. Indirect systolic blood pressure is measured with a blood pressure cuff placed above the carpus and a standard sphygmomanometer. The cuff is inflated to 250 mm Hg, and the pressure is released slowly to the point the sphygmomanometer needle deflections are synchronized with the heart rate, which is systolic pressure. Rectal temperature is monitored because hyperthermia can be a problem that needs immediate treatment by cooling with water and shortening the time of anesthesia. The depth of anesthesia is evaluated by the animal's reaction to various stimuli from blood sampling, hoof-trimming, or minor surgery. If the anesthesia is inadequate, the giraffe may respond by movement or an increased heart rate.

Problems encountered with opioids (etorphine or carfentanil) in giraffes include: (1) vomiting or passive regurgitation that may lead to fatal aspiration pneumonia; (2) respiratory and cardiac depression; and (3) prolonged induction and/or stormy recovery that results in secondary self-induced trauma, hyperthermia, and/or capture myopathy. The historical high morbidity and mortality (>10%) encountered with field anesthetic use of opioids has resulted in a hesitancy to anesthetize this species.

In a captive situation, a staged anesthetic protocol with a combination of xylazine and etorphine has been successful when analgesia is indicated. Initial sedation is accomplished with xylazine. Giraffes are sensitive to this drug and require 70 to 100 mg/adult or 30 to 40 mg/yearling given IM. Atropine (7–8 mg/adult and 2–3 mg/yearling) is given simultaneously to prevent xylazine-induced bradycardia. Five to 10 minutes after xylazine, signs of sedation include stargazing, ataxia, and tongue protrusion with slight salivation. Manipulation at this time is contraindicated because most animals react defensively, are uncoordinated, and can fall, and although they appear sedated, they are able to strike out effectively at ground staff. About 15 to 20 minutes after the xylazine, a narcotizing dose of etorphine (1.5 to 2.5 mg/adult and 0.5 to 1.25/yearling) is administered IM. This dose may induce recumbency within 15 to 20 minutes. Ideally a head halter, placed when the animal is narcotized, is used to help control the head and assist the animal to the ground, without allowing it to tumble over backwards. Minor short procedures (e.g., blood sampling, tuberculin testing) can be performed on the standing narcotized animal with etorphine and xylazine antagonists given IV before the animal falls. In a captive situation if the narcotizing dose does not put the giraffe down, alternatives include a second dose of etorphine (0.5–1 mg) or physically bringing the giraffe down by casting it before or after the supplemental anesthetic. To bring a giraffe off its feet, several techniques are effective and can preclude the use of additional drugs that can further depress respiration. Physical restraint to prevent its pacing for a few minutes sometimes is followed by collapse. A second casting method is to halter the animal and physically turn it in a tight circle so it stumbles and collapses. Tripping the animal with a rope around one front foot as it is turned can also facilitate this approach. Administering IV 5% glyceral glycolate to a narcotized animal will induce recumbency. Once down, additional relaxation and sedation is maintained by IV infusion to effect. Once a giraffe is recumbent with blindfolds and earplugs in place the level of anesthesia seems to deepen. During a 30- to 40-minute procedure 30 to 50 gm of glyceral glycolate may be required, and it can be given up to the time of antagonist administration.

Intravenous naltrexone is given to reverse the etorphine (100 mg of naltrexone/mg of etorphine), plus an additional IM dose (25 mg/mg of etorphine). Xylazine is reversed with atipamezole (50 to 100 mg/ animal with 1/4 given IV and 3/4 IM). Additionally, IV doxapram HCl (200 mg) or yohimbine (75 mg) is given IV or IM to help antagonize xylazine in adults.

When anesthetic drugs are reversed with an antagonist, two people support and elevate the head and neck, with the nose pointed downward to prevent the animal from rising before it is adequately recovered. The earplugs are removed, and the blindfold is removed after the animal begins to respond. To assist the recovering giraffe, a rope—held by a minimum of three people on each end—is placed around the animal's shoulders so that as the animal attempts to stand, pulling on the rope helps the giraffe into a sternal position. When the giraffe has recovered sufficient strength and is resisting the head restraint by lifting one person off the ground, the head is manually elevated and the rope is pulled to assist the giraffe to a sternal position. Once the animal stands, the rope is released, and the giraffe walks over it. The interval from antagonist until standing can vary from 10 to 20 minutes, depending on the antagonist and the route given. Subjective supportive therapy given before the antagonist includes 500 mg of flunixin meglumine, a nonsteroidal antiinflammatory drug (Banamine, Schering Corporation; Kenilworth, NJ) plus 1000 mg of methacarbamol, a muscle relaxant (Robaxin-V, A-H Robbins; Richmond, VA).

Standing narcotization is used in field capture with high doses of only etorphine (6 to 10 mg/adult), which stops the animal for blindfolding, and ropes positioned so it can be directed into the trailer. The antagonist is given as soon as the ropes and blindfold are in place.

A combination of medetomidine (MED) and ketamine (KET) has been used successfully in giraffes with dosages correlated to the giraffe's shoulder height (SH). In calm animals (150 µg MED plus 3 mg KET/cm of SH) provided a rapid and relatively uneventful induction, no relationship emerged between the various related dosages to induction time, but an inverse relationship was observed to the level of excitement with the quality of the immobilization. Initial signs with ataxia were noted at about 2 minutes and progressed with the animal sitting before lateral recumbency at 6 to 8 minutes. Atipamezole administration IM (350 µg/cm of SH) resulted in a rapid and complete reversal. A combination of MED and KET is an alternative to opioids for giraffe immobilization. It works best on calm animals, and at these doses, it does not produce adequate analgesia for major procedures. Larger giraffes experienced a less desirable immobilization, which may indicate the dosage correlation to shoulder height may not be appropriate in the larger animals. Physiological monitoring found elevated respiration rates, initial mild acidosis, and slight hypoxia with end-tidal CO_2 within normal ranges. There was no regurgitation or excessive salivation.

Anesthesia of okapi comes with a high anxiety factor for the veterinarian; however, complications are usually minimal. The one problem noted is a stormy induction. The fasted okapi is anesthetized with a combination of xylazine and either etorphine or carfentanil (see Table 61-2). The preferred method is similar to that for the giraffe, where xylazine (45 to 55 mg/adult) is given first and followed in 15 minutes with one of the opioids (etorphine 4 mg/adult or carfentanil 1.5 to 2.5 mg/adult). This staged technique requires less opioid and causes less excitement; the induction period is slightly longer and produces better muscle relaxation than occurs with combining the xylazine with the opioid in the same dart. The narcotized animal should be restrained to prevent self-trauma and flipping over backwards during induction. Once down, the animal is placed sternal with blindfolds and earplugs and given nasal oxygen. The same precautions are in place to prevent aspiration pneumonia as the giraffe, but the okapi is easier to intubate. The reversal drugs include naltrexone (100 mg/mg of opioids) and yohimbine, atipamezole, and/or tolazoline HCl to reverse the xylazine. The animal is supported until it regains its feet

and is monitored closely for 24 hours for renarcotization, especially when carfentanil is used. Initial reports indicate that the MED/KET combination also works well in the okapi.

SURGERY[19]

Because of the giraffe's size and anatomy indications for surgery are limited, except in the distal limbs; hoof-trimming is the major procedure. Minor fracture repairs with equine splinting and casting techniques have been reported.[12] Dystocia occurs, and the major problem is to decide when to intervene.[7] Parturition is fairly rapid in giraffes, and if it proceeds longer than 3 hours, a potential dystocia should be suspected. Because of the dense skin and tucked-up abdomen, a vaginal approach is indicated. Fatal urolithiasis has been reported recently in giraffes, which, if diagnosed early, might be corrected with a perineal urethrostomy.[25] With the increasing giraffe populations in zoos, castration and vasectomy have been used to control reproduction.

Surgery in the okapi is performed for hoof-trimming and for other orthopedic problems, including fractures and limb and joint abnormalities caused by improper diets. The smaller size of the okapi makes it easier to operate on, such as the reported inguinal hernias in calves and problems in the rectal area with prolapses and strictures.

DIAGNOSTICS

Giraffes are best approached in a confinement area, and the examination on the okapi is accomplished with a mutual trust and understanding by the animal and the veterinarian. In both cases additional sedation and/or tranquilizers may assist the procedure. Auscultation would be comparable to other large patients, and abdominal palpation is restricted. In well-trained animals rectal and vaginal exams are possible.

Blood samples are collected from the jugular vein with better access proximally (Table 61-3 and 61-4). Arterial access is via the auricular or mandibular arteries. Urine is usually collected "free-catch" because catherization in the male is complicated by the extensive urethral process and sigmoid flexure of the penis. Other sample collections are similar to that of domestic species.

DISEASES[2,19]

Infectious Diseases

Table 61-5 discusses infectious diseases. The infectious diseases in giraffidae are fortunately limited, with both species being susceptible to the common diseases seen in domestic hoofstock. The bacterial diseases include salmonellosis, anthrax, colibacillosis, and tuberculosis. The viral disease of giraffe includes rinderpest, malignant catarrhal fever, cutaneous viral papillomas, and lumpy skin disease. In okapi, viral diseases of importance include okapi pox and rotavirus.[20] The latter affects young calves and causes severe diarrhea. It was the major reason for hand-rearing in the 1980s and 1990s. Fortunately, the disease seems to have abated with improved preventative medical programs. Corona virus has been isolated from feces

Table 61-3

Reference Ranges for Hematological Parameters for Giraffadae

PARAMETER	GIRAFFE (MEAN ± ST. DEV.)	OKAPI (MEAN ± ST. DEV.)
Erythrocytes × $10^3/\mu\phi L$	10.4 ± 2.5	10.4 ± 2.4
PCV (%)	34 ± 6	36 ± 8
Hemoglobin (g/dl)	11.7 ± 1.8	12.7 ± 2.7
MCV (fl)	34.3 ± 9.3	36.4 ± 4.1
MCH (pg)	11.8 ± 3.0	12.7 ± 1.6
MCHC (g/dl)	34.9 ± 3.5	35.0 ±2.8
Leukocytes × $10^6/\phi L$	12.7 ± 5.0	8.4 ± 2.7
Neutrophils × $10^3/\phi L$	9.21 ± 4.43	5.51 ± 2.39
Band Neutrophils × $10^3/\phi L$	0.92 ± 1.31	0.12 ± 0.08
Lymphocytes × $10^3/\phi L$	2.32 ± 1.49	2.42 ± 1.11
Eosinophils × $10^3/\phi L$	0.37 ± 0.38	0.166 ± 0.09
Monocytes × $10^3/\phi L$	0.40 ± 0.37	0.31 ± 0.36
Basophils × $10^3/\phi L$	0.25 ± 0.24	0.21 ± 0.09
Platelets × $10^3/\phi L$	427 ± 179	405 ± 124
Reticulocytes %	0.0 ± 0.0	
Nucleated RBC/100 WBC	1 ± 1	1 ± 1
Fibrinogen (mg/dl)	191 ± 167	47 ± 15

Table 61-4

Reference Ranges for Serum Biochemical Parameters for Giraffidae

PARAMETER	GIRAFFE (MEAN ± ST. DEV.)	OKAPI (MEAN ± ST. DEV.)
Total protein (g/dl)	7.4 ± 1.3	7.1 ± 1.0
Albumin (g/dl)	3.1 ± 0.5	3.0 ± 0.7
Globulin (g/dl)	4.3 ± 1.3	3.0 ± 0.7
A:G ratio	0.721	1.0
Calcium (mg/dl)	9.9 ± 1.8	10.4 ± 1.7
Phosphorous (mg/dl)	9.5 ± 2.6	8.0 ± 2.3
Sodium (mEq/L)	145 ± 4	142 ± 5
Potassium (mEq/L)	4.8 ± 0.6	5.0 ± 0.6
Chloride (mEq/L)	105 ± 6	104 ± 7
Creatinine (mg/dl)	1.8 ± 0.4	2.4 ± 0.8
Urea nitrogen (mg/dl)	20 ± 7	22 ± 9
Cholesterol (mg/dl)	34 ± 16	9 ± 9
Glucose (mg/dl)	135 ± 61	126 ± 41
Total CO_2 (mEq/L)	21 ± 4.2	41.1 ± 18
Plasma iron (µg/dl)	103 ± 35	125 ± 34
Creatine phosphokinase	1328 ± 1654	865 ± 1018
Lactate dehydrogenase	869 ± 658	548 ± 324
Alkaline phosphatase	505 ± 484	488 ± 647
Alanine aminotransferase	13 ± 11	23 ± 49
Aspartate aminotransferase	95 ± 53	85 ± 65
Gamma glutamyltransferase	64 ± 92	98 ± 170
Amylase (IU/L)	59 ± 78	275 ± 295
Lipase (IU/L)	123 ± 281	20 ± 9

Table **61-5**

Selected Infectious Diseases of Giraffidae

DISEASE	ETIOLOGY	EPIZOOTIOLOGY	SIGNS	DIAGNOSIS	MANAGEMENT
Viral					
Rinderpest	Morbillivirus	Acute disease and highly contagious via nasopharynx	Fever, erosive to hemorrhagic lesion of all mucous membranes and lymphatic tissue High mortality	Serology, virus isolation, and ELISA for viral antigens	Giraffes are highly susceptible. Vaccination, slaughter, and quarantine
Malignant Catarrhal Fever	Herpesvirus	Infects the lymphocytes with natural killer activity and causes an autoimmune phenomenon	Erosive and ulcerative disease of GI tract with four forms: Peracute Intestinal Head and eye Mild	Virus isolation, histopathology, and PCR to detect viral DNA	Not associated with sheep or alcelaphine antelope
Okapi Pox	Poxvirus	Mechanical transmission	Papules, vesicles, and pustules on skin and mucosa	Histopathology and viral isolation	Supportive and separate infected animals
Lumpy skin disease	Poxvirus	Infective and eruptive disease occasionally fatal	Circumscribed painful nodules of skin and mucosa of GI, respiratory, and genital tracts, which can become secondarily infected	Virus isolation and identification serology	Supportive Rx with antibiotics to prevent secondary infections. Vaccine
Viral Diarrhea	Rotavirus	Acute disease complicated by pathogenic bacteria	Anorexia, depression, diarrhea, fever	Electron microscopic examination of feces	Supportive Rx with antibiotics and fluids
Bacterial					
Bovine TB	*M. bovis*	Inhalation and ingestion of *M. bovis*	Granulomatous disease acute to chronic disease course	Tuberculin test, Gamma interferon, and/or culture	Euthanize Possible Rx if valuable animal
Anthrax	*Bacillus anthracis*	Ingestion of spores	Acute febrile disease with rapid death, bloody discharge from body openings	Blood smear for gram-positive organisms	Vaccination, quarantine, antibiotic Rx
Salmonellosis	*Salmonella* spp.	Fecal contamination of food and water	Septicemia Acute enteritis Chronic enteritis	Signs, pathology findings, and culture	Antibiotic in septicemia, but questionable in other forms. Eliminate carrier animals

of okapi with soft stools, but the significance is still under study.

Parasitic Diseases

Both species are susceptible to the common intestinal parasites seen in domestic hoofstock and respond well to similar treatments. Parasitic disease of the liver and gastrointestinal tract were the major cause of death of the first okapi transported to zoological parks. Fortunately standard preventative medical programs that include routine fecal sampling and treatment with appropriate anthelmintics can now control these parasites.

A hematological parasite of potential concern is *Cowdria ruminantium*, the cause of "heartwater" in Africa.[18] Giraffes live in the endemic area and are hosts to the tick that is the vector. Experimental infection in the giraffe was transmitted to naïve species by the tick vector. Cytauxzoonosis was reported in a giraffe that died with anemia, hemoglobinuria, and extensive hemorrhages and focal necrosis of numerous organs.[16]

Giraffe and okapi can harbor the same ectoparasites seen in domestic species, but with comprehensive screening of newly arrived animals and appropriate treatments, they should pose no problems.

Noninfectious Diseases

The peracute mortality syndrome of giraffe is a nutrition-based problem caused by feeding a diet deficient in protein.[13] The dietary protein for a free-ranging giraffe is 18% and it is therefore recommended that a captive diet contain at least 15% protein. This syndrome is characterized by acute death, sometimes after a stressful incident. The pathological findings include serous atrophy of fat, pulmonary edema, petechial serosal hemorrhages, and ulcers in the gastrointestinal tract.

Age-related problems include nephritis and atherosclerosis.[2] Dental problems also occur with uneven molar surfaces and worn and missing teeth leading to debilitation of the animal. Floating of the teeth will help treat this problem but usually requires immobilization.

Proper hoof care is important to the overall health because overgrown hooves lead to debilitating chronic lameness and secondary arthritis. Corrective trimming can be accomplished with animals accustomed to a chute but may require immobilization/anesthesia. The hooves of a giraffe are extremely hard, and the cautious use of a grinder aids in the corrective trimming. Early intervention is indicated because once a hoof begins to overgrow, it can reach a stage in which trimming becomes palliative rather than curative. With improper footing, injury to pelvic tendons and adductor muscles can also occur. Another problem includes hoof rot, which is treated as in domestic species.

The control of stereotypical behavior is important to the well-being of the animal and the visitors' experiences.[1] One major problem of excessive licking may be improved by feeding small amount several times a day to mimic the normal almost continuous browsing of the animals in the wild. Incorporating natural browse several times a day and giving the animal access to the outside as much as possible is advisable. The other behavior of excessive pacing may be improved by environmental changes to the exhibit and small feedings. The social density and interaction of the herd are also factors that can influence this activity.

REPRODUCTION[6,8,19,21]

The basic reproductive information is listed in Table 61-6 for both species. The placenta is cotyledonary and epitheliochorial; therefore calves of both species require colostrum for maternal antibodies.

Breeding behavior in giraffes results from solitary bulls with overlapping home ranges entering female herds and checking the urine of females for estrus. The male will follow the usually passive female stimulating her to stop by touching her hind leg with his front leg. Copulation is very rapid and without aggressive behaviors.

The home ranges of the okapi are much more rigid than giraffes. Breeding behavior in the okapi is more aggressive; the larger female displays the aggression before and after copulation. After birth, the females of both species are usually good

Table 61-6

Reproductive Characteristics of Giraffids

PARAMETER	GIRAFFE	OKAPI
Karyotype (2n)	30	44, 45, or 46
Puberty, age (years)	Female at 3–4	Females at 2.5
	Male at 4–5	Males at 2–4
Estrus cycle (days)	14	15
Receptivity detection	24 hours	
Duration of copulation	Few seconds	Few seconds
Gestation	420–468	414–491
Pregnancy determination	Urinary PdG	Urinary PdG
Placentation	Cotyledonary placentation	Cotyledonary placentation
Pregnanediol-s-glucuronide Pdg (ng/ml)		
Nongravid		
Follicular	3.6 ± 7 PdG/mg Cr	1.9 ± 0.1 PdG/mg Cr
luteal	30.9 ± 1.7 PdG/mg Cr	27.2 ± 3.9 PdG/mg Cr
Gravid	Persistent luteal levels	Persistent luteal levels
	Levels 10 x late gestation	With levels >100
Semen Volume	4–6 ml	

mothers but can become aggressive. The okapi calves usually do not defecate for 10 to 13 days. Some mothers may overgroom the calves and cause irritation and injury to the perineal area.

PREVENTIVE MEDICINE

All newly arrived animals should be quarantined to protect resident animals. During this time, the animal is monitored for disease, and fecal examinations, blood samples, and vaccinations are done. Vaccinations should include killed rabies vaccine in a rabies endemic area and clostridial bacterins, including tetanus. Routine fecal examinations are indicated and are followed by appropriate therapy for parasites. Sanitation, especially for okapi, is important in combating parasitic, bacterial, and fungal disease that ravaged the captive population in the past. Specific vaccination for okapi include a combination rotavirus/corona virus–killed vaccine that is given to the dam 1 month before birth and to the calves at birth and 30 and 60 days later.

Because many problems are associated with diets low in protein, the diet should be continually evaluated. The animals should receive ample browse to aid in their diet and enrichment.

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