Chapter

15

Reptiles

KEY TERMS

carapace
plastron
scutes
oviparous
viviparous
Jacobson's organ
episodically
pleural cavity
polyphyodontic
hemipenes
ecdysis
dysecdysis
autonomy
ectotherms
POTZ
UV light
heliotherms
slam feeding
stomatitis
caseous
gaping
Mycobacteria
gout
diuretic
oviparous
lavage
septicemia
hematoma
cardiocentesis
parthenogenesis

OBJECTIVES

After completing the chapter, the student should be able to

- properly house common reptile species.
- provide appropriate client education to new reptile owners.
- provide basic nursing care for reptile species.
- demonstrate appropriate restraint techniques with each species of reptile.
- provide appropriate diets for different reptile species kept as pets.
- provide the appropriate temperature and humidity (POTZ) for reptile species.
- identify potential problems with inappropriate housing, restraint, and diet.

Introduction

Reptiles have been kept in captivity for many years, however, the knowledge to keep them healthy was severely lacking. There was no understanding of the importance of UVB lighting, temperature requirements, humidity, and diet. Most, if not all, were wild caught and kept or traded by hobbyists.

Small turtles could be purchased for a quarter and came with flowers painted on their very tiny shells. The habitat was a small plastic bowl with an island and a green topped palm tree. Dried ants and flies were provided in a fish food shaker and the only advice available was to feed raw hamburger and put drops in its swollen eyes.

Today, many of these remarkable and ancient animals are captive bred and protected from being collected in the wild. New information is forthcoming almost on a daily basis and with new information comes improvement in diet and husbandry practices.

Reptile medicine has become a highly skilled, specialized field. Medical diagnostics and procedures are advanced and specific to the uniqueness of reptiles. Specifically designed habitats have become household focal points because of their beauty and appeal, recreating natural habitats that are quickly disappearing. Reptiles are bred for beauty, color variations, and health. The variety seems endless. The attraction to reptiles is in their differences, not their similarities.

Lizards inhabit a wide variety of ecosystems from desert dwelling to tropical rainforests. They are divided geographically between Old World species and New World species. There are approximately 4450 different species. The iguanids include the largest number of New World species. Within this group are the green iguana,

anole, basilisk, horned lizard, and the spiney lizard. The Agamidae family contains the largest of the Old World lizards. Examples from this group include the bearded dragon, agama, frilled lizard, water dragon, and uromastyx (Figure 15-1).

Figure 15-1 A member of the *Agamidae* family is the Chinese water dragon.

Chameleons are within a separate classification of Old World lizards, Chamaeleonidae. There is a great variety of chameleons commonly available. veiled, panther, Jackson's, and Mueller chameleons are all popular and under the right conditions are fairly easy to maintain. Another group includes the geckos, skinks, and monitor lizards. Many of these species are noted for aggressiveness in captivity, especially the monitors and tokay gecko. Care needs to be taken when handling these species.

Lizards have keen eyesight with excellent color vision. Their binocular vision causes them to tilt their heads to one side when focusing. Chameleons are able to focus each eye independently, with one eye on one object and the other eye on another at the same time (Figure 15-2).

Chelonians (turtles and tortoises) are facing many threats to survival. They are used as food, nests are robbed of eggs, and many species are illegally traded by the thousands for use in *traditional medicine.* There are approximately 257 remaining species of turtle and tortoises, divided into 12 families.

In very general terms, tortoises differ from turtles in that tortoises are terrestrial vegetarians while turtles are aquatic, or semiaquatic and omnivorous. Collectively, they are called chelonians. The most common cause of disease in chelonians is poor husbandry. Tortoises and turtles differ in nutritional and husbandry requirements.

All chelonians have an upper shell, the carapace, and a lower shell, the plastron. The two halves are connected by bony bridges. The carapace forms the vertebrae and ribs while the plastron is an approximation of abdominal ribs. The shell is covered in a keratin layer, with distinctively shaped scutes. Scutes are capable of regeneration if damaged (Figure 15-3).

Figure 15-2 Chameleons belong to a separate classification of Old World lizards, *Chameleonidae*. This veiled chameleon has just caught a cricket with a very long and sticky tongue. (*Courtesy of Kathy Nuttall.*)

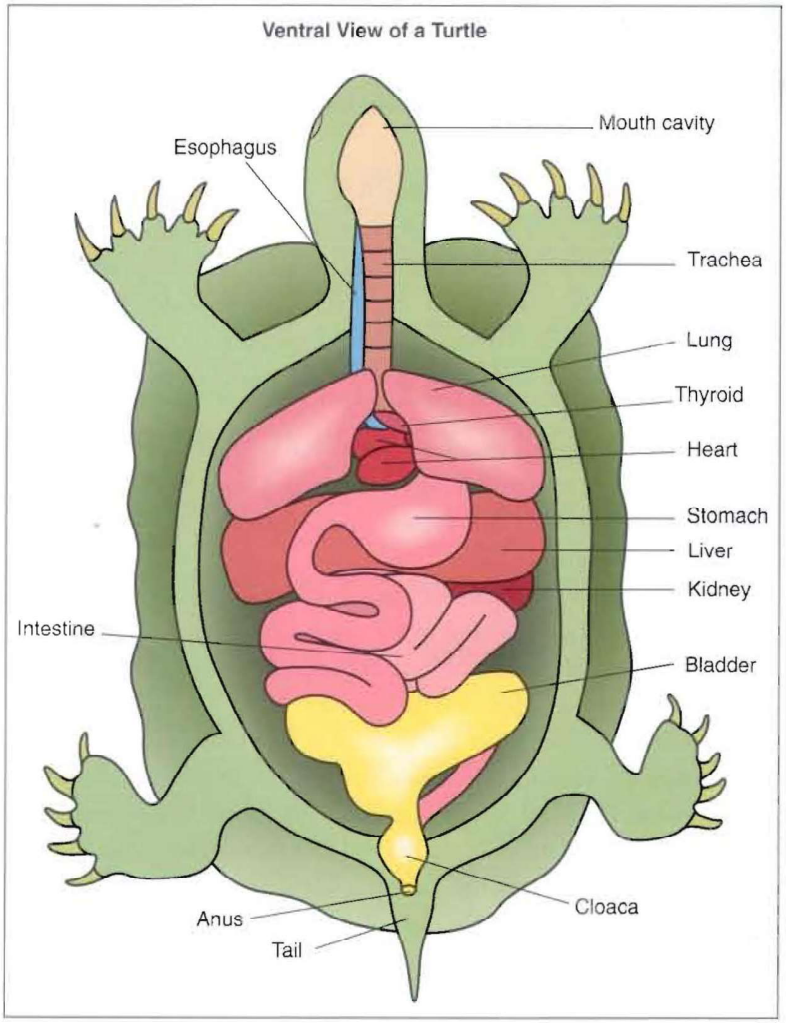

Figure 15-3 Chelonians, turtles and tortoises, are similar in anatomy. Both have an upper and lower shell connected by bony bridges to protect internal organs.

Owners frequently ask if they should allow their turtles and tortoises to hibernate. There are many differing opinions from veterinarians and herpetologists. The most common problem seen by veterinarians is that animals are allowed to hibernate when they are not nutritionally prepared. Posthibernation anorexia can be caused by disease prior to hibernation, poor nutrition, cold weather shortly after coming out of hibernation, and the owner not feeding the chelonian sufficiently during recovery from hibernation. They are usually presented to the veterinary hospital with respiratory problems and a dramatic weight loss. Many Chelonians, doing poorly, die during hibernation. All owners should discuss hibernation options with their veterinarian and have a complete physical exam prior to hibernating a turtle or tortoise.

THERE IS NO TRUTH IN COUNTING THE LINES WITHIN THE SCUTES TO DETERMINE AGE.
Lines and patterns of the scutes are determined by species, diet, overall health, and growth rate.

Sexual determination in chelonians is easier than in other reptiles. In the mature chelonian, the plastron of the male is concave and the plastron of the female is flat. Males have a longer tail than females, which is shorter and not as thick. In aquatic species, males have long claws on the front limbs to stroke the female during copulation. In box turtles, males have a red iris and females a yellow iris.

All chelonians are **oviparous**. Most species of box turtles lay eggs beginning in May and continuing through July. They lay an average of two to eight eggs at one time. Box turtles can store sperm for approximately four years. Female tortoises must be in prime condition before they start egg production.

There are more than 2500 species of snakes. Of these, approximately 1700 are Colubrids. Colubrids are some of the most popular snakes kept in captivity. They include cornsnakes, rat snakes, king snakes, milk snakes, and garter snakes. Colubrids are aquatic, arboreal, or terrestrial.

Another popular group is the Boids, with approximately 63 species. The group includes both boas and pythons. The Boids, native to North, Central, or South America are **viviparous**, giving birth to live young, while the species native to Africa, Asia, and Australia are oviparous, egg layers.

Snakes have poor eyesight and hearing is limited to low frequencies. They rely on olfactory input.to hunt and evaluate their environment. The **Jacobson's organ**, near the tongue, is a highly developed sensory organ. The forked tongue picks up scent that is filtered through pits in the oral cavity. A healthy, active snake is continually flicking its tongue for sensory input. Infrared receptors that sense heat are located between the nostrils and eyes. These sensory adaptations allow the snake to strike with great accuracy.

Snake skulls are very flexible and mobile. Snakes are able to move the top jaw independently from the bottom jaw, which allows them to open their mouths wide enough to swallow prey. Snakes need to be fed prey that will allow the jaws to develop normally and expand with growth. A hungry snake will sometimes yawn widely. Yawning is also seen after swallowing prey and serves to reposition the jaws (Figure 15-4).

Tracheal rings are incomplete in most lizards. In snakes, the trachea does not bifurcate as with most species. Turtles have a long, flexible trachea that bifurcates close to the heart. Most reptiles breathe **episodically**, with periods of apnea. Reptiles do not have a diaphragm to assist with respiration, but instead use intercostal muscles. Snakes and lizards breathe with rib movement while turtles and tortoises breathe by using shoulder muscles to change the pressure in the **pleural cavity**.

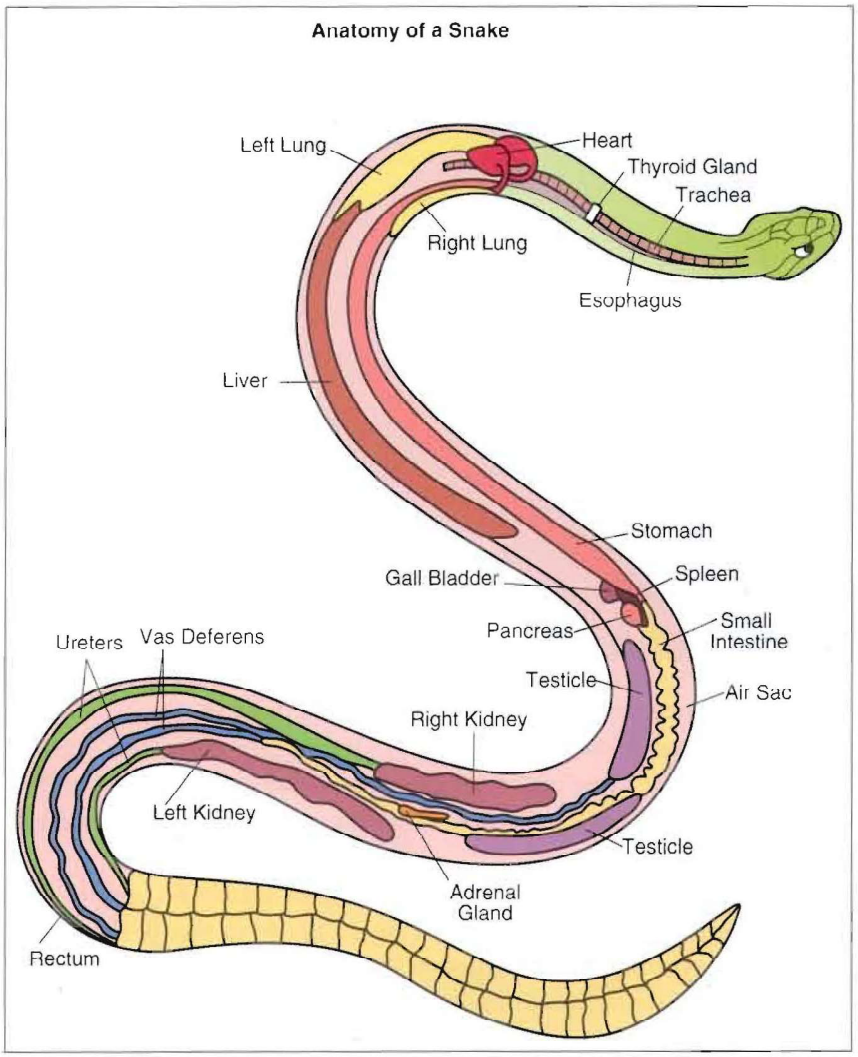

Figure 15-4 The anatomy of a snake, showing the elongation of internal organs.

Reptile teeth are **polyphyodontic**, that is, they are reabsorbed or shed and replaced at a rapid rate throughout life. Not all reptiles have teeth. Some have a hard bony plate along the mandible and maxillary bones.

The digestive tract of reptiles is shorter than that of mammals but slower to digest and assimilate food. Herbivorous reptiles have a slower digestive metabolism than omnivores and insectivores.

Sexing lizards and monitors can be difficult. In some lizard species, males have horns or subtle differences in body build. Males usually have more robust bodies and larger heads than females (Figure 15-5). Many males develop large jaw muscles and more pronounced dorsal spines or crests, depending on species.

DNA sexing in reptiles is not always accurate and many laboratories have abandoned this method. Ultrasound may reveal ovaries in a reproductively active female, but so will a radiograph with the distinctive outline of multiple eggs.

Male reptiles have paired reproductive organs called **hemipenes**. Gender determination of some lizards can be done by locating the hemipene bulge, which is just cranial to the vent. The hemipenes can be everted manually or they may prolapse. Chronic prolapse need to be investigated for a medial cause. In chronic conditions, one or both hemipenes may be surgically removed.

Figure 15-5 Reproductively mature iguanas often undergo dramatic behavioral and color changes during breeding season. This mature male green iguana has turned a deep reddish orange and has become very aggressive towards its owner. (*Courtesy of Eric Klaphake, DVM.*)

The sex of a mature iguana (and many other lizard species) was thought to be determined by femoral pores. If the femoral pores were pronounced, it was assumed to be a male. This is no longer accepted as there are many female lizards with large femoral pores.

Some species of snakes have small spurs, located on either side of the vent. They are short bones covered in keratin. Spurs are used in courtship and mating. Examining the relative size of spurs is not a reliable method for sex determination. Sexual determination in snakes can be performed with the use of a probe.

Probing requires a slender, blunt-ended metal rod that is inserted into the vent caudally and carefully moved along the ventral wall of the tail. A probe that can be passed only two to three scale lengths caudally indicates a female. In a male, the probe can be advanced six to seven scales. The probe should slide in easily and force should not be used. A sterile lubricating jelly is applied to the tip of the probe before insertion into the vent (Figure 15-6).

Figure 15-6 The sex of a snake may be determined with careful use of a probe inserted into the vent. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Reptile reproduction is regulated by the pineal gland, the hypothalamus, and environmental stimuli. These, in turn, stimulate the release of reproductive hormones. Many species of reptiles from the Northern hemisphere will not breed unless they have been in hibernation for a period of time to mimic the natural hibernation period. Most breeding hibernations begin in November and continue through February.

Incubation temperature determines the sex of the offspring in more than 70 species of reptiles, including 90 percent of turtles and some lizards. The exception to this is snakes. With some reptile species, sperm can be stored in the oviduct. Fertilization is triggered when the ova enter the oviduct, which may be months later. In some species, the sperm can be stored for up to six years. The female is able to produce fertile eggs over a period of several years without coming into contact with a male. The majority of reptile eggs are incubated around 28 °C (82 °F) to 32 °C (86 °F). To determine if an egg is viable, an egg candle can be used several days after the egg has been laid. The egg is taken into a dark room and a bright light source is held directly against the shell. One to seven days after the egg has been laid, the yolk drops and a blood spot will appear. During stages of the incubation period, it may be possible to observe development of the fetus and possible movement within the egg (Figure 15-7).

Figure 15-7 A reptile incubation setup. These bearded dragon eggs were all hatched successfully. (*Courtesy of Bev and Dan Ring.*)

Reptiles shed their skin as they grow. A healthy snake sheds its skin in one piece, starting with the head. It should be complete all the way down to the tail. Chelonians shed their skin in small pieces from the limbs, neck, and tail over a short period of time. A chelonian that appears to be constantly shedding needs to be examined for malnutrition or a skin infection. Aquatic turtles shed not only their skin, but layers of growing scutes. Lizards shed their skin in patches, small

pieces over a period of several days. Shedding completed in a healthy reptile is referred to as **ecdysis**. Failure to shed completely can cause problems. As it dries out, the dead skin constricts around toes and the end of the tail, cutting off blood supply. Ecdysis occurs throughout the lifetime of the reptile. Young snakes shed more frequently than adults because of their rapid growth rate. Moisture from the snake's body enters the space between the old and new layers of skin, which aids in loosening and lifting the old skin up and off. Snakes beginning to shed appear opaque and the eyes appear blue (Figure 15-8).

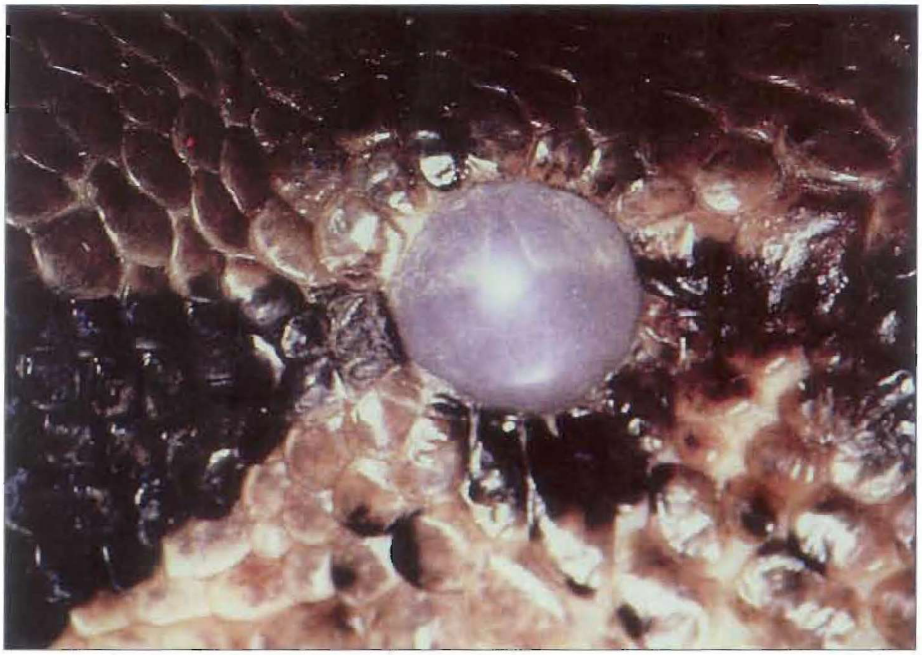

Figure 15-8 The *blue* eye of a snake that is about to shed. (*Courtesy of Kathy Nuttall.*)

Ecdysis takes approximately five to seven days, during which time the snake is unable to see and should be handled carefully or, preferably, not at all. A snake, *in the blue* is more likely to strike. A good, healthy shed comes off in one piece, complete with eye caps. If the eye caps are retained, it could cause ocular damage. Retained eye caps need to be removed very carefully to avoid injury to the eye. A slow trickle of warm water will moisten the eye cap. Using *only* cotton tip swabs or cotton balls, gently and carefully roll the layer of dead skin away from the eye. Never attempt to pull eye caps away with forceps as doing this could also remove the lens of the eye. Difficulty during the shedding process is known as **dysecdysis**. The most common reason for a poor shed is lack of humidity or poor nutrition. If the snake needs assistance it should be soaked in warm water and the old skin pulled off caudally in the direction of the scales, starting from the head and moving toward the tail (Figure 15-9).

Behavior

Several studies have been done on reptile behavior, especially with the green anole. Most of the studies have been related to reproductive behavior. For reptiles in captivity, it is important to know the social structure of each species so as not to stress the reptile. Many reptiles suffer from environmental stress in captivity.

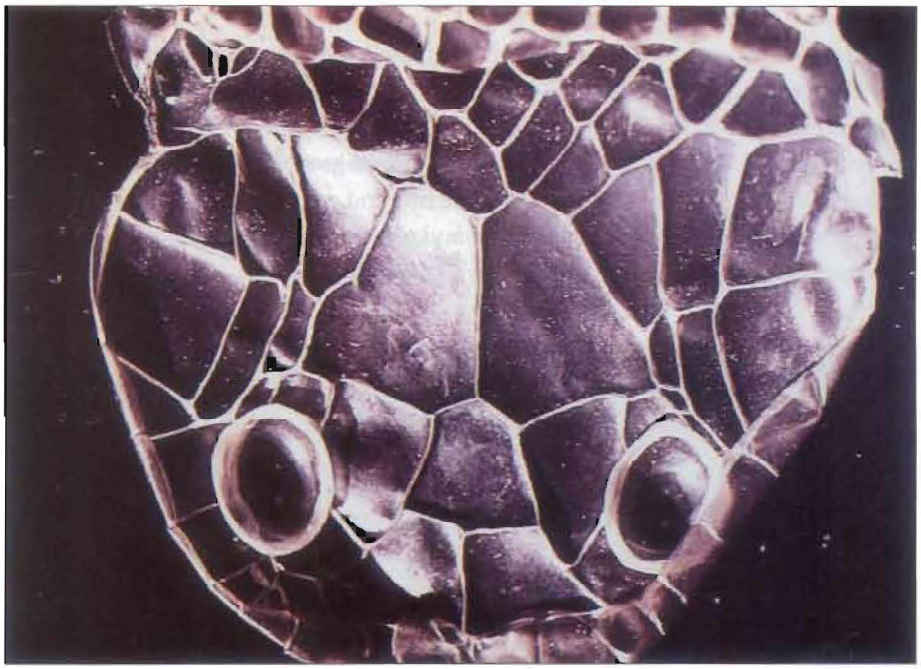

Figure 15-9 The recently shed skin of a healthy snake, complete with eye caps. (*Courtesy of Kathy Nuttall.*)

If danger is near, most reptiles will try to avoid detection by hiding, as this requires the least amount of energy to avoid being detected. If this does not work, some species fake a bite or strike. The Eastern Hog Nose snake, for example, performs a *death display* by turning upside down and lying motionless. While playing dead, this species can produce a bloody, smelly liquid that imitates blood. Other reptile species may self-inflate by taking in air, causing them to appear bigger to a predator, or may wedge tightly into a small space.

Different species of lizards have various ways of protecting themselves in their natural habitats. Many species of lizards have the ability to release their tails and escape unharmed. Species with autonomy, the voluntary release of the tail, also have the ability to regenerate it. The regrown tail has a distinctly different appearance and color. It may take several months to regenerate. The head-bob, a quick up and down movement, is always a warning or a threat and should not be copied by owners. It is not a friendly greeting.

Tail flicking and tail whipping are behaviors that indicate that the reptile is agitated. It is seen in snakes when they vibrate their tails when a predator or threat approaches. Lizards will often use their tails to strike out at the predator or if agitated during an examination in a veterinary hospital.

AGGRESSION IN MALE GREEN IGUANAS IS WELL DOCUMENTED. Women owners need to be especially careful when male iguanas become sexually mature, as they become extremely aggressive towards women during their menstrual cycle. There have been several instances of male iguanas attacking and causing severe lacerations that required emergency room treatment, sutures, and, in some instances, reconstructive plastic surgery. It is foolhardy and dangerous to believe that reptiles, especially iguanas, can be *trained* to be gentle, that aggressive behaviors can be modified, or that they will respond to humans with any degree of affection.

Snakes have the ability to empty their musk glands when provoked or frightened. These glands are located near the cloaca. Milk snakes are known for this behavior. Turtles do not have this gland, but they will urinate often during handling with the same effect.

Chelonians retract their head and legs into their shells for protection against predators. This can pose a problem when trying to examine or medicate them. Several species of lizards, for example, the horned lizard, can spurt blood from their eyes as far as three feet or nearly a meter. They are able to do this by restricting blood flow from the head until the small blood vessels rupture due to the rise in blood pressure around the eyes.

The ability of some reptile species to change colors helps them with camouflage. Color change can also indicate courtship, stress, illness, or interaction with other species. Chameleons are known for their ability to change color. Other species of reptiles have the ability to change according to changes in their environment, including heat, cold, stress, and perceived threats.

Housing

Reptiles are ectotherms and require an environment that provides the heat necessary for metabolic activity and health. Each species requires a different temperature range to achieve optimum ability to digest prey, fight off infection, and perform day-to-day functions. These temperatures are referred to as POTZ (preferred optimum temperature zone). A reptile enclosure should take into consideration all of the variants and provide areas to accommodate reptile movement from one area to another, allowing the reptile to obtain optimum temperature to function. Reptiles that are ill usually seek out the warmest part of the enclosure (see Table 15-1 under Fast Facts). Ambient humidity influences a reptile's ability to eat, to shed normally, and to eliminate waste. Humidity can range from 30 percent to 100 percent, depending upon the natural habitat of the species.

Correct lighting is a critical component in keeping reptiles healthy. Ultraviolet light assists in the assimilation of vitamin D3. Vitamin D3 is necessary for the absorption of dietary calcium. Natural sunlight is the best source of ultraviolet light, but most reptiles are kept indoors. Reptiles should not be housed in direct sunlight from windows. The full spectrum rays of sunlight cannot penetrate through window glass and habitat temperatures will dramatically increase, potentially killing the reptile.

Full spectrum lighting is provided by bulbs and fixtures designed specifically for reptile habitats. There are varying degrees of ultraviolet wavelengths or UV light generated. UVB affects vitamin D3 production and calcium metabolism. UVA bands affect the behavior of reptiles. Full spectrum lights (UVB and UVA) should be changed every six to eight months, or according to the manufacturer recommendation. While the bulb may still produce a light, the ability to produce a *full spectrum* may have dropped dramatically. The lights should cycle for 13 to 15 hours during the summer months, and 9 to 12 hours during the winter months to mimic the natural photoperiod of the species.

Lizard habitats should be spacious enough to allow the lizard to stretch lengthwise and to turn around completely, including the full length of the tail, without touching the sides of the enclosure. Terrestrial lizards require more floor space than height. Aquatic and semiaquatic species need access to an area with

water and a dry area for basking. Adequate ventilation while keeping heat and humidity within the POTZ range needs to be considered. Glass or acrylic habitats help contain appropriate levels of heat and humidity (Figure 15-10).

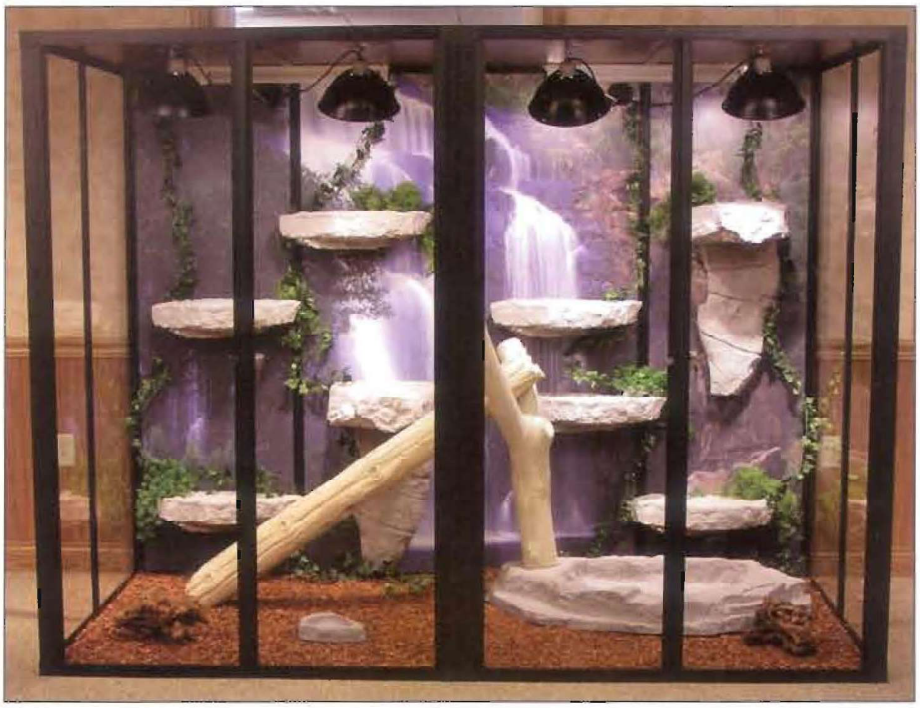

Figure 15-10 When designed correctly, reptile habitats are not only beneficial to the inhabitant, but can become a focal point and an area of great beauty and interest. (*Courtesy of CagesByDesign.*)

Chameleons require a cage that allows for plenty of air circulation, such as a wire mesh or screen, yet maintains temperature and humidity for the species. Chameleons should *not* be housed in aquariums, which do not provide adequate ventilation. Housing chameleons in aquariums, however large, is often a main cause of death.

Humidity is difficult to maintain for some lizards. Tropical species need 80 percent to 100 percent humidity, while the desert species only need around 30 percent to 40 percent. Misting the cage daily will help provide some of the humidity. Adding water falls, water bowls, and live plants can also increase the humidity.

Cage substrates vary for different species. Substrates should mimic the natural environment of the species. There are a variety of commercially prepared substrates that provide for species variation. These include sand, shredded bark, soil, and soft reptile litter. Some are digestible, others are supplemented with calcium, but all are manufactured for specific reptile requirements and feeding behaviors.

Some species inadvertently swallow substrate material when catching prey. This can cause gastrointestinal blockage. Wood shavings of any type, silica sand, corncob, and ground walnut shell should not be used. An example and result of using an incorrect substrate occurs with the leopard gecko, which is frequently kept on sand. Sand impaction is common in this species because of the way they catch crickets, *pounce and swallow*, ingesting sand along with the prey.

Most lizards need climbing objects as a part of the cage furnishings. These include various sized branches, driftwood pieces, cork bark, plastic or live plants, and

rocks. There are also artificial vines, realistically created to mimic jungle vines. All items should be placed at varying levels to provide ease of access to basking areas.

Maintaining the POTZ for each species is very important in keeping reptiles healthy. The basking lamp should be placed at one end of the cage, keeping that area of the enclosure temperature constant. Levels of furnishings provide for temperature gradients. There are several methods and products to provide heat. Heat rocks should not be used for any reptile, especially lizards. There is no way to regulate the amount of heat produced and they can malfunction, either by not producing enough heat or by becoming excessively hot. Iguanas, for example, will lay on a heat rock until it becomes so hot that the skin starts to burn. Normal basking activity is derived from the heat of the sun, dorsally, and reptiles do not have the ability to detect excess heat from the ventral surface.

Basking lights placed outside the cage or enclosed within the habitat at a safe distance from the reptile are more easily monitored and controlled. Any heating elements placed within the environment need to be *caged* so the reptile has no direct access to them. Many species of lizards are excellent at leaping and have been found fatally burned by unprotected heating elements.

If the nighttime temperature drops too low for the reptile, an additional source of heat needs to be provided. This includes ceramic heat bulbs, red incandescent bulbs, or reptile heating pads placed underneath the cage. In the morning, lizards often appear darker than normal. Dark pigments absorb more heat and light. By mid to late afternoon the lizard may be lighter in color because of absorbed heat and light.

Some species of tortoises can grow quite large and require an area that is big enough for exercise and has easy access to a water source for soaking. Tortoises absorb water through their skin and rarely drink water like mammals. Substrates which are digestible include alfalfa rabbit pellets or a layer of grass hay placed over a rubber mat. Rabbit pellets bought in bulk are relatively inexpensive and the area can be cleaned of fecal material similar to cleaning a cat litter tray. Loose grass hay is raked up and disposed of as garden mulch. The mat underneath is simply hosed off and replaced. Nondigestible floor coverings commonly used include indoor/outdoor carpet and reptile soil mixes. If these are swallowed, they can cause intestinal blockage. Tortoises also need a source of UVB light. Many tortoises are housed outdoors during the summer months and allowed to graze and wander at will. Still, they need a shelter and protection from predators, especially curious dogs.

Aquatic turtles need a body of water for swimming and feeding. They need to be provided with a basking platform that allows them to easily climb completely out of the water. Water quality is maintained with an underwater filter system. Water should be dechlorinated, and depending upon the species, the water may need to be heated. Suitable substrates for turtles include peat moss, reptile soil, or cypress mulch. Clay, walnut shell (which is toxic), rocks, and gravel should not be used as they are too abrasive.

Chelonians are ectothermic, meaning that they actively seek out sunlight for heat. In captivity, the POTZ range for tortoises, depending on species, is between 26 °C and 37.7 °C (79 °F to 100 °F). POTZ for turtles is 25 °C to 35 °C (77 °F to 95 °F).

Snake enclosures vary with the species of snake being housed; burrowing, arboreal, or semiaquatic. The minimum length of the enclosure should be as long as the snake. The enclosure should provide good ventilation yet be able to retain heat. Most snakes are housed in glass aquariums or plexiglass tanks.

IN ONE TRAGIC INSTANCE, a newly purchased panther chameleon was left inside a box in the car while the owners stopped for *just a minute* to do some errands. The chameleon turned pure white in an attempt to dissipate excessive heat. It did not survive.

Cages made of wood are not recommended. They are difficult to keep clean and provide the perfect environment for ectoparasites. Habitats need to have a heat source that will maintain the POTZ range for the species. Basking lamps and/or reptile heating pads placed under the cage are the usual and most reliable source. As with other reptiles, heat rocks should be avoided.

Figure 15-11 All snakes should be provided with a water bowl for soaking. This is a juvenile blood python submerged in a deep water bowl. (*Courtesy of Mark's Ark, Taylorsville, UT.*)

Many species of burrowing snakes are native to dry deserts where they burrow into the sand and wait for prey. Commercial reptile sand has been cleaned, is usually biodegradable, and is a suitable substrate for burrowing snakes. Newspaper, indoor/outdoor carpeting (reptile carpet), and reptile litter (similar to wood shavings) can be used as substrate for ground dwelling snakes. Semiaquatic snakes should have a substrate similar to ground dwellers, but a bowl or container large enough for them to enter the water and soak (Figure 15-11).

Every snake, regardless of species, should have a container of water large enough to allow the snake to be totally submerged. Many snakes hydrate in water by soaking rather than gulping water. Snakes that require a higher humidity, such as rainbow boas and rubber boas, need larger bowls of water and a bowl with damp sphagnum moss to help keep ambient humidity elevated.

Arboreal snakes, for example the green tree python and the emerald tree boa, require branches or sturdy perches. Both of theses snakes fold and drape their bodies across branches in the highest part of an enclosure. Arboreal boas and pythons also require a higher humidity level and need to be misted daily. All snakes require a place to hide. Providing a hiding place decreases the chance of the snake having stress-related problems and may, depending on the species, reduce incidences of defensive or aggressive strikes.

Diet

A correct diet is essential to reptile health. As more information becomes available regarding the needs of individual species, diet recommendations are improved and modified. Different species are herbivore, omnivore, or insectivore (see Table 15-3 under Fast Facts). There is no *one diet fits all* easy answer.

Herbivores include the green iguana, uromastyx, and Solomon Island prehensile-tailed skink. Omnivores include bearded dragons, blue-tongued skinks, tegus, certain geckos, and rock iguanas. Old World chameleons, juvenile monitors, tegus, and anoles are insectivores. Juvenile diets are often different from adult diets. Researching each species is essential in order to understand and meet dietary requirements.

The staple herbivore diet consists of fresh dark leafy greens. This includes chard, kale, mustard greens, endive, bok choy, and collard greens. Spinach should be offered in limited quantities as spinach binds with calcium, preventing calcium absorption. Vegetables that can be added to the diet include grated carrots, broccoli, squash, peas, and green beans. Vegetables need to be chopped up in appropriately sized pieces, and should be *tossed* together and fed like a salad to avoid food preference. Iceberg lettuce should not be fed to any reptile. It has no nutritional value and may cause intestinal bloat. If fed a correct diet and provided with UVB lighting, reptiles should not require the addition of supplements to their food.

Herbivorous lizards take in large amounts of potassium salts in their diet. Because of this, they have nasal glands which excrete excess salts. It is normal to see these lizards with a white, crusty substance around their nares.

Lizards that are fed crickets should be fed daily. Crickets should be gut-loaded prior to feeding them to the lizard. Crickets are usually the main diet of omnivores, but they should be alternated with mealworms and wax worms. Omnivorous lizards should be fed a pinky or fuzzy mouse once a week. There is a variety of canned diets available for lizards, including *canned* (dead) crickets. Designed more for human convenience, they should not be considered a complete diet. The best diets are fresh and as close to a natural diet as possible.

Lizards are one of the few reptile species that use their tongues to lap water. Some snakes, turtles, and tortoises immerse their heads in water and gulp. Supplying an appropriate water source is essential in maintaining the health of the lizard.

All tortoises require a diet that is high in calcium and low in protein and fat. They should be fed daily. Dark leafy greens, squashes, carrots, green beans, peas, and a small amount of fruit offer variety and meet nutritional needs. Tortoises also enjoy nibbling on grass hay, growing grass, and weeds. It is very important that tortoises have grazing access only to areas of lawn that have not been treated with fertilizers, weed poisons, or insecticides.

Turtles are omnivorous. The bulk of the diet should be dark leafy greens with small amounts of animal protein. Animal protein includes crickets, mealworms, and earthworms. Aquatic turtles feed only in the water. Commercial floating turtle sticks are available. If wild caught, the turtle may refuse to eat them, not recognizing the pellets as a food source. They should be added gradually and the consumption monitored. Uneaten pellets should be removed to prevent water fouling, bacteria, and mold growth.

Snakes feed on a variety of prey. They hunt and consume mammals, smaller reptiles, amphibians, eggs, fish, chicks, insects, and worms. Mice, rats, and rabbits are commonly offered as prey animals. Semiaquatic snakes also eat small fish.

Feeding on killed prey will prevent serious injuries to the snake. Live prey has the potential to cause serious bite injuries to the snake. Snakes that are chewed on by prey will try to escape, but not fight back. Some snakes will only take live prey. If feeding live prey, the snake should not be left unsupervised. If the snake does not strike within 10 minutes, the prey should be removed. Never leave live prey in the enclosure thinking the snake will eat it later. More often than not, the snake is the victim (Figure 15-12). Stunned or freshly killed prey is recommended to prevent the possibility of injury to the snake.

Some snakes are very picky about the color and type of prey they eat and the time of day they eat. Season also plays a part in the feeding habits of some

CHAMELEONS DO NOT RECOGNIZE OR DRINK FROM STANDING WATER. They need to be supplied with moving water, as they catch water droplets with their tongues. A drip system can be placed on top of the enclosure or a waterfall added to the habitat.

Figure 15-12 Snakes should never be left unsupervised with live prey. This ball python has been severely chewed by a rat. (*Courtesy of Eric Klaphake, DVM.*)

species. During what would normally be a hibernation period in the wild, many snakes stop eating in captivity. Ball pythons are the most difficult species to keep eating on a regular basis and they are usually the most timid about taking prey.

All snakes strike, holding the prey with their teeth. Smaller species often swallow their prey without constriction. Other species strike and constrict, tightly coiling their bodies around the prey and constricting, suffocating it to death before swallowing it whole. Digestion begins in the stomach. It may take up to five or more days to completely digest one prey item. Bones and hair of the prey are compacted in the feces and expelled.

Adult snakes are usually fed one appropriately sized prey once a week or once every two to three weeks, depending on the feeding habits natural to the species. Smaller snakes and young, growing snakes should be fed weekly. The correct size of prey to offer is one that is as large as the largest part of the snake's body, not according to head size.

Some owners attempt to feed a large number of prey items in a short amount of time to increase the growth of their snake. This is called **slam feeding**, and it is not recommended. Slam feeding can cause the intestinal tract to become blocked, slowing down the metabolism and potentially causing regurgitation of the excess food. Victims of slam feeding techniques often require surgery to remove blocked fecal material and partially digested prey in the intestinal tract.

Force feeding (different to slam feeding) is a technique used to ensure that an anorexic snake has an adequate diet. It should not be attempted by inexperienced owners. The esophagus can be easily lacerated. Forceps and tongs used to push prey items into the mouth and down into the esophagus have caused such trauma that the snake has had to be euthanized. Anorectic snakes should receive a comprehensive veterinary exam. There may be an underlying disease causing the anorexia and *force feeding* may only complicate the issue (Figure 15-13).

Figure 15-13 Force feeding a snake may be necessary to provide nutritional support. A red rubber catheter is placed behind the trachea in the initial approach to the esophagus.

Restraint and Handling

Many lizards become stressed with close human contact. Some will flee or find a place to hide, while others become immobile. General restraint of lizards follows the rule of LEAST: the least amount of restraint required to get the job done, the better.

Lizards do not struggle as much when they are held securely, but not forcefully. Lizards are grasped behind the head and around the shoulders with one hand. The other hand should be placed around the pelvis holding the legs caudally and against the body (Figure 15-14).

Figure 15-14 A two-handed method of restraint for a very quick lizard, the basilisk. This holds the reptile securely and secures the tail, protecting it from injury. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Be cautious of a defensive/aggressive tail-whip, especially from an iguana. The tail should be tucked under the same arm that holds the pelvis and rear legs. Once restrained, the lizard can be wrapped up in a towel for an examination or nail trim.

Another effective method of restraint, especially for radiograph and blood draws, is to place cotton balls over both eyes and loosely but securely wrap the head with a self-adhering bandaging material. When correctly applied, this also forms a muzzle and prevents the reptile from biting. This method puts moderate pressure on the vagal nerve and tends to keep even the most aggressive reptile in a subdued state.

Examining a chelonian can be difficult. To avoid internal injury, chelonians should not be held upside down or with the head lower than the body for long periods of time. This can cause respiratory difficulty and is very stressful for the turtle. They should not be turned quickly from side to side as this might cause the intestines to twist. To examine the head on a small turtle, grasp either side of the head behind the jaws and pull the head forward slowly (Figure 15-15).

If the head is retracted inside the shell, a gentle prod with blunt forceps near the back legs will usually encourage the head to come out from inside the shell. When the head starts to come out, it can be grasped quickly. Chelonians are surprisingly quick in their responses and it may take several attempts to grasp the head or a leg. Completely enclosed box turtles can be tempted to open up if submersed in water. If using forceps to encourage the head to extend from the shell, the forceps should *never* be applied to the mandible. The resistance of the turtle can be so strong that it will most likely cause a midline mandibular fracture. Forceps should be used with great care and only applied to the beak. Even then, there is a risk of breaking chips of keratin from the beak.

Figure 15-15 Restraint of a box turtle. Once the foreleg is secured, the turtle will likely extend the neck, making it possible to quickly secure the head. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Large turtles or tortoises are very strong and it is not possible to manually extend the head or legs without anesthesia. In some instances, large tortoises can be encouraged to stay out of their shells with the offer of food during the examination. Fresh strawberries work wonders.

Movement around snakes, especially near the head, should be careful and slow. Quick movements often elicit a strike and possible bite. Some of the more aggressive snakes, for example the emerald tree boa and the Burmese python, are likely to strike and bite the instant visual contact is made. Before attempting restraint, it is important to understand exactly what behaviors are characteristic of the snake. In all snakes, the head should be secured first. Grasp the head gently but firmly from behind, caudal to the jaws. Once the head is secured, the rest of the body can be held loosely, allowing the snake some movement over the support of the handler's body and arms. For safety, any snake over five feet requires two restrainers; one for the head and first third of the body, and the other to control the body to prevent the snake from wrapping around any part of the handler's body.

Snakes should never be placed around anyone's neck. Many people are seen carrying large snakes in this manner. Aside from endangering themselves, this casualness is a sign of ignorance. Should *anything* frighten the snake, it will quickly tighten and constrict in self-defense or in preparation to strike.

Snakes that need to be transported can be placed in a pillow case or some type of cloth bag that can be tied securely at the top. A large snake can be placed in a sports bag or two-handled cooler. The lid should always be secured.

Medical Concerns

A physical exam should be performed on any reptile prior to purchase. The exam begins with the eyes, which should be clear and open. A sick reptile will

typically have an ocular discharge with the eyes partially or completely closed. The eyes should be checked for any swelling that might suggest irritation or an eye infection. The aural openings should also be checked for swelling that might suggest abscesses or inflammation. The aural opening is also a common place for mites to hide (Figure 15-16). The leopard gecko in Figure 15-16 was not fed the correct diet or housed properly. It was rescued from a pet store and nursed back to heath.

Figure 15-16 A critically ill leopard gecko; the eyes are swollen shut and encrusted with sand. It has stomatitis and is very emaciated. With veterinary care and several weeks of dedicated nursing care by the rescuers, the gecko is now reported to be in excellent health. (*Courtesy of Bev and Dan Ring.*)

The rostrum should be examined for trauma or overgrowth of a beak on a chelonian. The nares should be clear from discharge. The oral cavity should be examined for trauma and areas that are abnormal in color. The normal color of the mucous membranes in most reptiles is pale pink to white. In bearded dragons it is normal to see yellow mucous membranes. **Stomatitis**, inflammation of the mouth, ulcers, open mouth breathing, and excessive salivation can indicate poor health. For example, upper respiratory infections in snakes will cause excessive salivation and open mouth breathing. Tongues in snakes and monitor lizards should be constantly flicking in and out of the mouth. Tongue flicking indicates an alert and healthy specimen.

Overall weight and appearance of the reptile needs to be evaluated. Reptiles that are suffering from malnutrition feel *empty* when they are picked up. Their body weight will be substantially less than it should be for the species. In malnourished lizards, pelvic bones become more prominent and the tail appears shriveled or thin. Snakes have a decreased muscle mass with prominent dorsal processes and ribs. Obesity can also be a problem in reptiles, especially due to poor diets. Obese lizards have a distended abdominal cavity with palpable fat pads along the body. The tail base is also enlarged with fat pads. Obese snakes have fat pads along the lower third of the body.

Most reptile hearts are small and located more dorsally than those of mammals. This makes it difficult to place a stethoscope on the thorax to auscultate the heart. Because of their scales and/or solid breast plates, it is more difficult to ausculate the reptilian heart. Wrapping a damp towel around the thorax of a lizard amplifies the sound and decreases interference from scale noise (Figure 15-17).

Figure 15-17 Wrapping a damp towel around the thorax of a lizard amplifies heart sounds and decreases interference from scale noise. (*Courtesy of Kathy Nuttall.*)

Reptiles are often diagnosed with bacterial infections in the joints and limbs. Penetrating wounds from enclosures or wounds caused by cage mates can be a source of infection. Infection begins locally, at the site of the injury, and then becomes systemic. If the infection is treated when localized, reptiles usually recover without complications. Stomatitis, also called Mouth Rot, is common in lizards and snakes. Stomatitis can develop with immunosuppression, an inadequate diet, or an underlying disease. Signs include anorexia, gingivitis, an inability to use the tongue properly, bleeding, and oral discharge.

Rostral (nose) abrasions occur in lizards that are constantly trying to escape from the enclosure and bumping the walls, causing injury to the rostrum. Treatment involves providing the correct enclosure and environment and applying ointments as recommended by the veterinarian to prevent a systemic infection. If the abrasion is severe, surgical debridement may be necessary (Figure 15-18).

Abscesses are common in reptiles and involve a variety of bacteria. Abscess can form in the oral cavity, eyes, ear canal, and skin. There may also be internal abscesses on the liver and lungs. Abscesses in reptiles are different from those found in mammals. The pus found in the abscess is **caseous**, *cheesy* and nonflowing. Subcutaneous abscesses are surgically opened, and the solid pus packet removed. The cavity may be left open or packed with sterile gauze. Internal abscesses are difficult to diagnose, and may be treated with oral antibiotics (Figure 15-19).

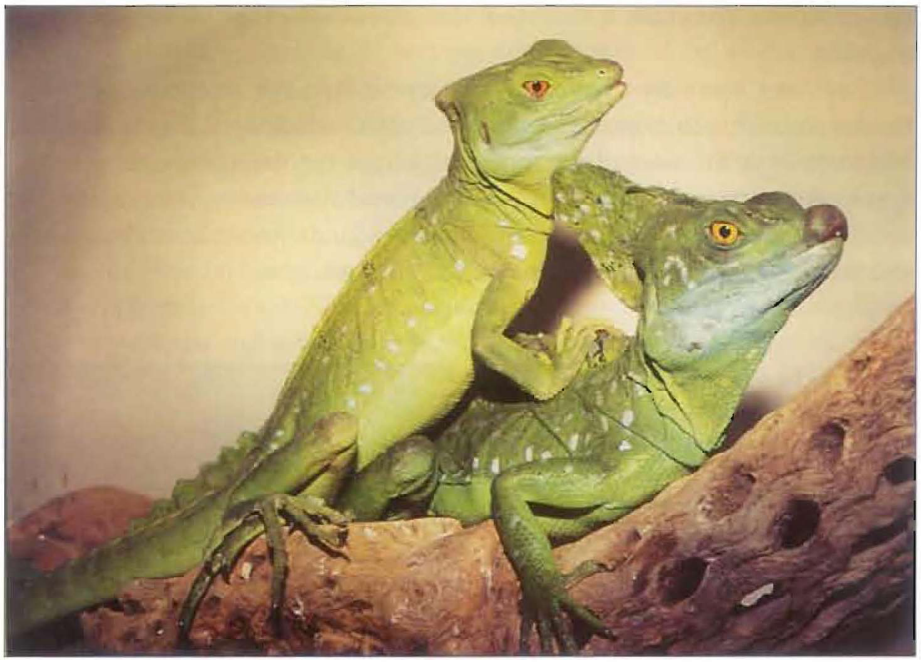

Figure 15-18 A pair of basilisk lizards. The male (lower) has a rostral abrasion.

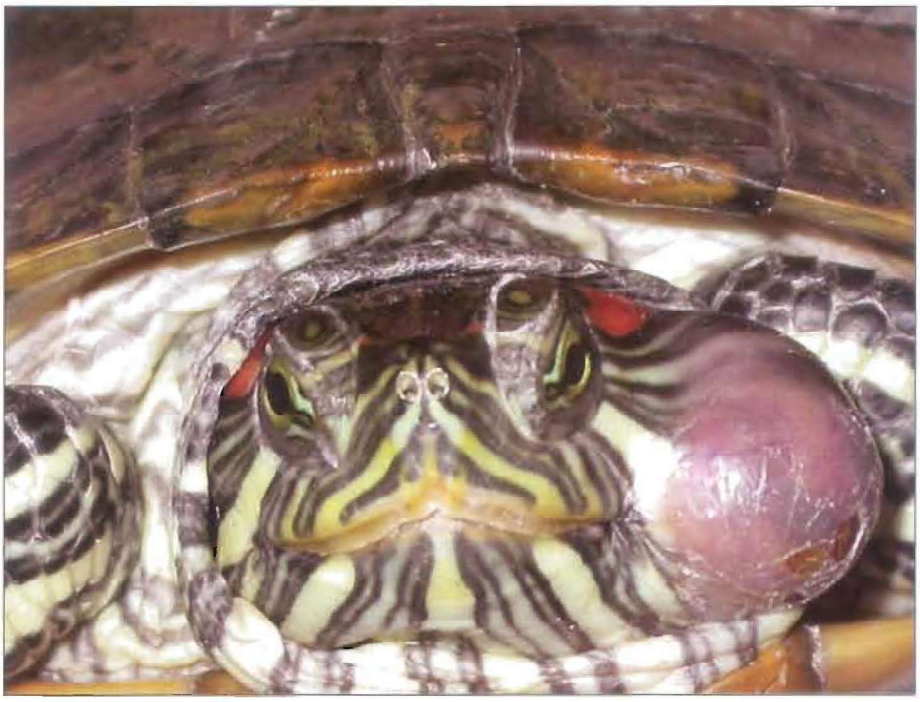

Figure 15-19 Aural (ear) abscesses are fairly common in captive turtles. The abscess on this red-eared slider is so large that it prevents the turtle from retracting its head. (*Courtesy of Eric Klaphake, DVM.*)

Thermal burns are frequently seen by veterinarians. Faulty heat rocks and the close proximity of basking lights are common causes of these burns. Reptiles do not have a withdrawal reflex and cannot perceive that a light or a rock is too hot. Basking reptiles continue to lie on top of a hot item, often burning through the skin and underlying muscle tissue. Treatment depends on the severity of the burn. Sterile saline is used to irrigate the burned tissue. Debridement and possible surgery may be recommended by the veterinarian. Recovery from thermal burns may

take months or years with several sheds that gradually replace the destroyed tissue and skin.

The most common cause of respiratory problems in reptiles is poor husbandry and nutrition. Signs of respiratory distress include open mouth breathing and bubbles at the sides of the mouth and from the nares. Depending on the degree of respiratory distress, there may be abnormal posturing, **gaping** (frequent opening of the mouth), and audible respiratory sounds. Anorexia and lethargy are also seen with respiratory problems (Figure 15-20).

Figure 15-20 Respiratory infections in reptiles are often due to inadequate husbandry practices and not meeting POTZ requirements. This turtle has pneumonia in the left lung. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Stress contributes to illness or a delay in healing. One of the major stress factors in captive reptiles is the environment and the food they are offered. Reptile behaviors that may indicate stress include inflating the body with air, hissing sounds, and open mouth breathing. There may also be immobility, tenseness, a change in color, cautious movement, and evacuation of cloacal contents.

Gastrointestinal Disorders

Gastrointestinal disorders are associated with internal parasites, bacteria or viral infections, and foreign body ingestions. **Mycobacteria** are often diagnosed in reptiles. The invading bacteria cause deterioration and wasting of the whole body. White nodules develop on the viscera, slowly destroying the gastrointestinal tract. Prognosis is grave.

A viral disease of concern in snakes is Inclusion Body Disease or IBD. This virus most commonly affects the boids. There are several strains of IBD that may cause a variety of signs. In young boas, the disease is acute, resulting in paralysis and death. Signs in adult boas include regurgitation one to two days after eating and upper respiratory tract infection. As the disease progresses, neurological signs may be present. In affected pythons, the disease progresses quickly and

involves multiple body systems. There is frequently pneumonia, stomatitis, and neurological signs. The disease was previously referred to as *star gazing* as affected snakes lose the ability to right themselves, with much of the body twisted and upside down due to the loss of muscle control. There is no treatment and it is recommended that any snake testing positive for IBD be euthanized. Diagnosis can be made with biopsies taken from several locations; liver, lungs, skin, and glottis.

Gastrointestinal foreign bodies are more commonly seen in terrestrial reptiles. Some reptiles ingest cage substrate, including sand and gravel. Chelonians sometimes ingest rocks and wood material. Snakes and lizards often ingest inanimate objects. It is not unusual for iguanas to ingest necklaces, earrings, and children's toys (Figure 15-21).

Figure 15-21 This iguana was presented with vague signs, lack of appetite, and lethargy. The radiographs revealed it had swallowed the owner's necklace, complete with the chain. (*Courtesy of Martin G. Orr, DVM, Bird and Exotic Pet Hospital.*)

Gastrointestinal neoplasia is a concern in reptile medicine. Tumors have been reported in all species of reptiles with no apparent age preference. Physical signs of tumors vary, depending on the type of neoplasia and location of the tumor. General signs may include poor growth, anorexia, constipation, melena, and palpable masses. In most cases, the patient does not survive this disease.

Nondigestive Disorders

Metabolic bone disease (MBD) is common in reptiles that have not been fed an adequate diet. It is also seen in reptiles that do not have full spectrum UVB lighting, which is essential for the absorption of calcium. Clinical signs of MBD include muscle tremors, deformed bone structure, stunted growth, spontaneous fractures, and paralysis. Often, the diet has a calcium content that is too low and a phosphorous content that is too high.

Treatment of MBD involves improving the diet, adding calcium supplements or giving calcium injections, and providing correct lighting. The condition may be stabilized, but it cannot be cured or the deformities corrected.

Hypovitaminosis A is caused by an inadequate dietary intake of vitamin A. Signs include respiratory infections, neurological and ocular problems, and difficulty shedding. Supplemental vitamin A is often given by injection.

Oversupplementation of vitamins and minerals can be just as dangerous as a deficiency. Reptile owners need to be aware of the specific dietary needs of a species and provide a suitable and appropriate diet. Many owners are not aware that this may mean twice weekly visits to the grocery store to obtain fresh greens and a lot of time spent in food preparation. Supplements are not a substitute for a correct diet.

Gout is caused by the accumulation of excess urates deposited in the intestinal tract and joints. Gout affects many species including snakes, lizards, and tortoises. Gout is associated with dehydration and poor nutrition. Signs include swollen joints and painful movement. Treatment involves supportive therapy and the use of a **diuretic**, a drug that increases urination and elimination of excess body fluid. Most treatments are ineffective.

Many reproductive problems can occur, especially in green iguanas and chameleons. Most lizards are **oviparous**, egg layers. A common problem occurs when the lizard becomes egg bound. This may occur due to a lack of a suitable site to lay the eggs, stress, poor nutrition, or hormonal problems. Reptile eggs do not have a hard shell like bird's eggs. The shell is soft, rubbery, or leathery, depending on the species. Medical management includes increasing the humidity and temperature, administering calcium gluconate injections, fluid therapy, and providing a suitable substrate for egg laying. The other option is surgical removal of the eggs. Due to the location of the ovaries, the mass of eggs during the preovulatory stage may completely block the GI tract due to their numbers and bulk (Figures 15-22, 15-23, and 15-24).

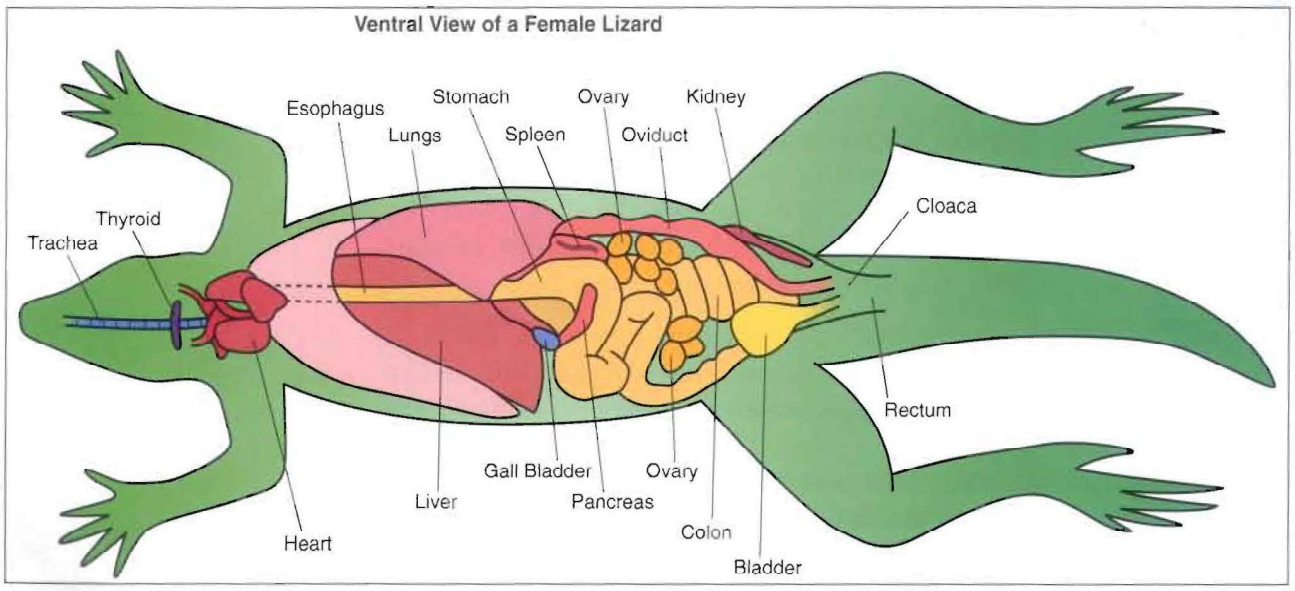

Figure 15-22 The anatomy of a female lizard showing the location of preovulatory eggs.

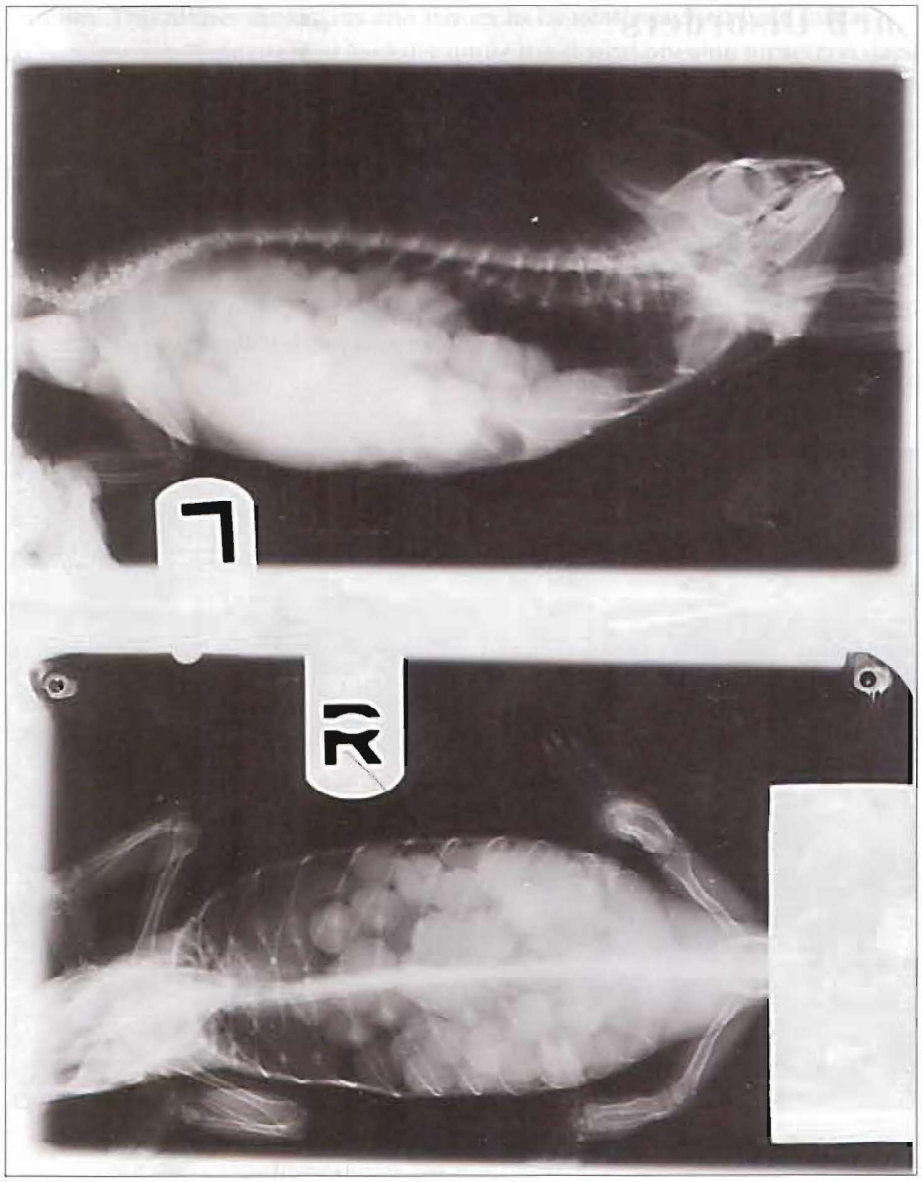

Figure 15-23 A radiograph of an egg-bound female veiled chameleon. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Figure 15-24 Necropsy of a young Senegal chameleon that was found dead. Ten eggs were revealed from the necropsy. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Shell Disorders

Shell repairs in chelonians may be necessary, often due to trauma. Frequent causes are dog bites or being hit by a car. The fractured area of the shell should be debrided to remove any fragments of shell, bone, or contaminants. The area should be lavaged with saline (PSS) to reduce the possibility of an infection, then cleaned with a surgical scrub and flushed again with PSS. Bleeding may be stopped with surgical glue or gelfoam. The damage can be repaired using fiberglass patches, hoof acrylic, or dental material. The patch becomes a permanent addition to the shell. If the injury occurs in a juvenile chelonian, the fiberglass patch will need to be changed to allow for growth (Figure 15-25).

Figure 15-25 A box turtle that has a fiberglass patch to repair a shell injury. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Septicemic cutaneous ulcerative disease (SCUD) is seen in aquatic turtles. This is a bacterial infection of the skin and shell. The condition is common with turtles kept in a dirty environment or not allowed a basking area out of the water. The bacteria cause ulcers of the skin and can cause loss of the scutes. This condition can be life threatening. If the bacteria invade the blood stream it can cause septicemia. Treatment is focused on changing the environment and by keeping the water quality high and well filtered. Affected areas of skin and shell should be cleaned and scrubbed with dilute iodine solution daily until healed.

Overgrown beaks and nails are common in chelonians because their captive environment does not allow for natural wear. Both beak and claws can be trimmed with the use of a dremel tool. Some beak deformities can be the result of an inadequate diet or trauma.

Pericloacal prolapse is common in reptiles. This may involve the penis, hemipenes, cloaca, intestines, oviduct, and bladder. The causes of a pericloacal prolapse include tumors in the cloaca, bladder stones, fecal impactions, MBD, dystocia, internal parasites, trauma, or microbial infection. Most prolapsed organs are cleaned with a surgical scrub, flushed, and reduced with a concentrated sugar

solution. This allows the organs and tissues to be gently pushed back inside the body. Some veterinarians may partially suture the cloacal opening for several days to prevent a reprolapse (Figure 15-26).

Figure 15-26 A cloacal prolapse in a bearded dragon. The vent was partially closed with sutures to prevent its recurrence. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

Clinical Procedures

Intramuscular (IM) injections should be given in the front limbs of lizards and chelonians. If administered in the hind limbs, the renal portal system delivers the agent to the kidneys, where it is quickly filtered out and the effectiveness is lost (Figure 15-27).

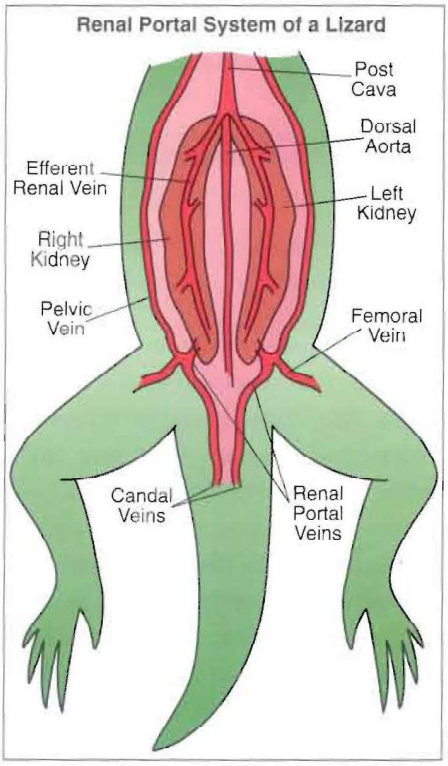

Figure 15-27 A diagram of the renal portal system of reptiles. Because of this system, injections should be given in the front legs. Drugs delivered in the rear limbs are quickly filtered out by the kidneys.

Venipuncture sites in lizards include the ventral coccygeal vein and the ventral abdominal vein. The coccygeal vein is easily accessed in the lizard when restrained in dorsal recumbency. A tuberculin syringe with a 22 to 25 gauge needle is required. The needle is inserted between the scales at the midline of the tail. It should be inserted at least 1/3 of the distance from the vent to avoid penetration of the hemipenes (Figure 15-28).

The ventral abdominal vein is superficial and fragile. The lizard is restrained dorsally and a 22 to 25 gauge needle is used with a shallow approach just lateral to the vein.

Venipuncture sites in chelonians include the jugular vein, the dorsal and ventral coccygeal vein, the heart, the carotid artery, and the subcarapacial vein. The jugular vein is located laterally on the neck, beginning at the tympanic membrane. It follows the angle of the jaw along the length of the neck. This is a common site for blood collection in small turtles and tortoises when the head can be extended and restrained. The vein is held off at the base of the neck and a tuberculin syringe with a 22 to 25

Figure 15-28 The approach to the coccygeal vein for blood collection in a reptile. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

gauge needle is used to collect the sample. Pressure on the vein should be applied for several minutes after blood collection to avoid a hematoma. The dorsal coccygeal vein is superficial and approached midline from the ventral surface of the tail. A 25 gauge needle is angled at 45 to 90 degrees and slowly advanced into the skin until blood enters the needle hub. The subcarapacial vein is found midline, directly under the carapace. The head should be retracted into shell. The approach should be with a 60 degree angle, just caudal to skin attachment to the carapace. In soft shell turtles, cardiocentesis can be performed for blood collection (Figure 15-29).

Figure 15-29 To obtain a blood sample from the subcarapacial vein, the head should be retracted. (*Courtesy of Jordan Applied Technology Center, West Jordan, Utah.*)

The two most commonly used blood collection sites in the snakes are the ventral coccygeal vein and cardiac puncture. The ventral coccygeal vein is located caudal to the vent along the midline of the tail. The snake should be restrained vertically. The appropriate sized needle is inserted midline at a 90 degree angle until coming into contact with the vertebrae. The needle is then slowly backed out until blood enters the hub.

A cardiac puncture requires patience. The snake is restrained dorsally or held aloft by two people. The heart beat can be felt or seen at the distal end of the first third of the length of the snake's body. The heartbeat of a snake is substantially slower than that of mammals and it may take several seconds to locate the heart. Once a heartbeat is visualized, the site can be marked with a nontoxic felt-tipped pen. Using a 25 gauge needle and tuberculin syringe, enter straight into the heart, avoiding a lot of needle movement to prevent further damage or laceration of the heart.

Medications for chelonians can be given orally or by injection. Intramuscular and subcutaneous routes are preferred. Intramuscular injections are given in the front legs due to the function of the renal portal system. Subcutaneous injections are given between the front leg and the neck. This site is the easiest to access. Be aware that even the smallest turtle or tortoise could attempt to bite.

Administering oral medication to a reptile can be difficult if the reptile does not open its mouth easily. To open a reptilian mouth without damaging it requires head restraint. Once the head is restrained, a rubber spatula, a plastic card (credit card), or tongue depressor can be used to gently pry open the mouth. If metal forceps are used, the tissue around the mouth and in the oral cavity could be injured.

Nutritional support in chelonians can be given by placing a metal avian feeding tube into the esophagus with an attached syringe. To best avoid the trachea, the tube is advanced toward the right side of the oral cavity.

When administering fluids or medications, intramuscular injections should be considered as a last option. This is due to the sporadic uptake of medications

when the patient is dehydrated or hypothermic. Several medications can be irritating to the reptile and complicated further by limited muscle mass. Most intramuscular injections are given in the front limbs of lizards and chelonians.

Fluid replacement in reptiles is commonly administered by intravenous or intraosseous routes. Chelonians can soak in and absorb water through the cloaca if they are not severely dehydrated. If the reptile is slightly dehydrated, subcutaneous (SQ) fluids can be administered. Snakes and lizards receive subcutaneous fluids between the lateral scales. Chelonians receive subcutaneous fluids in the inguinal fold or the ventral neck flap.

ICe administration can also be used to give small amounts of fluids to reptiles. In snakes, fluids are given towards the last fourth of the coelomic cavity, injecting between the scales. In the lizard and chelonians, the fluids are given in front of the hind leg. The fluids are directed towards the opposite shoulder. For maintenance, fluids are calculated at 5 to 10 ml/kg daily.

AN ANOREXIC BOX TURTLE CAN BE SOAKED IN DILUTED (1:1) TOMATO OR VEGETABLE JUICE AND WATER FOR 15 TO 20 MINUTES DAILY. The turtle is able to soak up fluids and vitamins. This should be done in conjunction with assisted feedings and recommended veterinary treatment, which may also include antibiotic therapy.

Blood volume for most species is approximately 5 to 8 percent of total body weight. Approximately 10 percent of this can be collected at one time. Blood should be collected in a lithium heparin (green top) tube. Reptile erythrocytes are nucleated and elliptical. Red blood cells are larger in size than mammals and similar to birds. Packed cell volume (PCV) in most reptiles is between 20 percent and 40 percent. A packed cell volume of less than 20 percent may suggest anemia.

Reptiles do not usually regurgitate under anesthesia with the exception of a recently fed snake. The reptile patient does not need to be fasted prior to anesthesia. Because reptiles are ectotherms, they can be slower to induce and more difficult to maintain under anesthesia. Recovery may be prolonged.

Injectable anesthetics lower cardiac output, causing slower blood distribution and resulting in a slower absorption rate. When using injectable anesthetics in reptiles, an increased time for drug effectiveness is expected. Administering a second volume will not shorten induction time and often leads to anesthetic overdose and death. Some injectable anesthetic agents can be very irritating if given ICe and there is a risk of lacerating internal organs. Most injectable anesthetics are administered intravenous or intraosseous in reptiles. This improves induction and recovery time and is less irritating to the reptile.

Recommended inhalants for use in reptiles are isoflurane and sevoflurane. Sevoflurane has a greater variance in reptiles and, occasionally, a surgical plane of anesthesia may be difficult to achieve.

The reptile heart is three chambered, with two atria and one ventricle. The ventricle has three subchambers with shunts that force the blood to the body and lungs. These valve-like shunts can function independently or in unison (Figure 15-30).

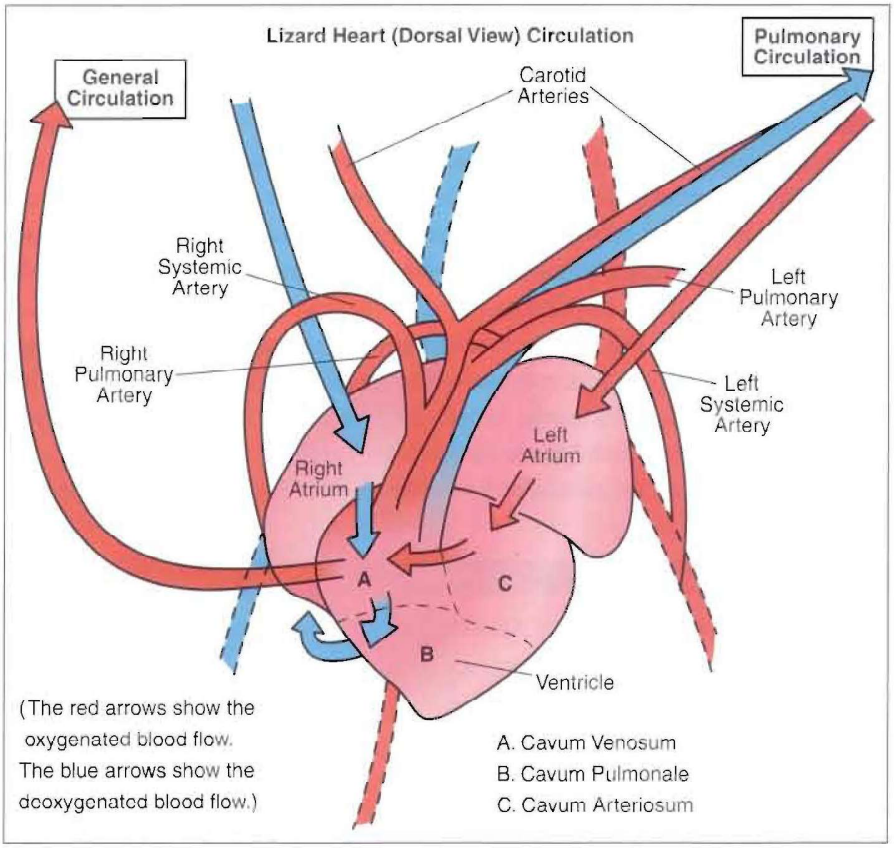

Figure 15-30 Reptiles have a three chambered heart, with two atria and one ventricle. The diagram of a lizard heart illustrates cardiac blood flow.

The cardiac mechanism has a direct affect on oxygen saturation levels and the elimination of anesthetic gas during surgery and recovery.

Reptiles do not have a diaphragm to assist with respiration. Abdominal and intercostal muscles move the air in and out of the lungs (in snakes, only the right lung is inflated). It is common for reptiles to become apnic when completely anesthetized. Reptiles are episodic breathers; they may take a couple of breaths and then stop breathing for a short period of time. When monitoring a reptile under gas anesthesia, the anesthetist should ventilate the patient manually several times in sequence. This inflates the lungs similarly to normal respiration and assists in maintaining the anesthesia level. Normal respiration for an anesthetized reptile is two to four breaths per minute.

It is fairly easy to intubate reptiles as the glottis is easily visualized. Uncuffed endotracheal tubes should be used. If the only appropriate sized endotracheal tube is cuffed, it can be used, but not inflated. Inflation of the cuff can cause trauma to the trachea as reptiles do not have complete tracheal rings to support the cuff. Chelonians have short, bifurcated tracheas. This can pose a problem when intubating for anesthesia. Endotracheal tubes should be placed at the top of the bifurcation to avoid inflating only one lung. When chelonians breathe, the abdominal and neck muscles assist with air flow. When a chelonian retracts its head into the shell, it stops muscle movement and halts respiration. An anesthetized chelonian should have its head and neck fully extended to prevent respiratory compromise.

During anesthesia induction, muscle relaxation starts at the midline of the body and moves cranially, then caudally. The tail is the last part of the body to relax. Assessment of cardiovascular function can be done with the use of a stethoscope, esophageal stethoscope, or a doppler. When placing an esophageal tube,

advance slowly to avoid entering into the stomach. The doppler probe can be placed over the heart, carotid artery, or coccygeal artery. Pulse oximeters are not the most reliable in assessing vital signs in reptiles. The primitive brain stem of reptiles continues to function, producing recognizable sounds of cardiac output when, in fact, the patient may be unrecoverable.

Radiographs can be very helpful in diagnosing problems. High detail film with compatible cassettes or mammography film cassettes, will produce the best radiographic detail. Most radiographs can be taken without anesthesia or chemical restraint, just patience. Normal views for lizards and snakes are dorsal/ventral and lateral. Snakes should be uncoiled for radiographs. Depending on the length of the snake and the area of interest, several may need to be taken in sequence, one length of the body at a time. If it is a large snake, restraint assistance is required. Snakes may also be tempted to enter a length of clear plastic tube, making it easier to obtain a fairly straight position (Figure 15-31).

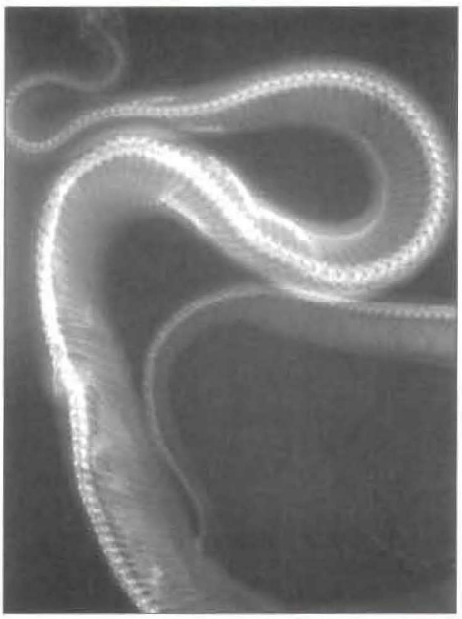

Figure 15-31 A radiograph (D/V) of a snake with a vertebral fracture.

Chelonians are the easiest to position for a radiograph. D/V is the most common view taken. If a lateral or cranial/caudal view is needed, a chelonian can be placed on top of an object with all four legs suspended.

Parasites

Internal parasites are common in wild caught lizards. Parasites may be protozoans in the gastrointestinal tract and circulatory system, and/or nematodes within the GI tract. In the wild, these parasites may not be problematic, but in captivity, when the lizard is exposed to stress, malnutrition, or inadequate husbandry, parasites can become a problem. Signs include anorexia, dehydration, regurgitation, and bloat. If the lizard is already compromised, parasites may become overwhelming and cause death. Parasites can be diagnosed by fecal flotation and are treated with the appropriate anthelmintic as prescribed by the veterinarian.

External parasites, mites, and ticks, are common in wild caught lizards. Red mites, *chiggers*, live under the scales and around the folds of the legs, eyes, and ear openings. Mites feed on blood and can cause anorexia, dehydration, and anemia. Injectable ivermectin is usually prescribed to remove mites from the patient, however, the enclosure needs to be completely disinfected. All natural wood furnishings should be removed and destroyed. Mites hide in wood, moss, and small crevices. Cage furnishings can be bagged and placed in a freezer for 24 to 48 hours, killing free-living mites.

Ticks are usually attached in *hard-to-reach* areas around the head and limbs. All visible ticks need to be carefully and completely removed. Ivermectin injections may also be used in the treatment of a major tick infestation. Soaking the lizard in water, often recommended by pet stores, will not *drown them* (the ticks), nor will a thick coating of petroleum jelly *suffocate them* and solve the problem. Professional veterinary treatment will save an owner much frustration and potential loss of the reptile.

The snake mite, *Ophyionyssus natricis*, is a blood feeding parasite. The mites can cause scales to lift and become necrotic, and cause dehydration, dermatitis, and anemia. They also transmit blood-borne diseases and are a likely vector of IBD. The mites burrow under scales and into crevices in the corners of the mouth and around the eyes.

Because their life cycle is unique, they are very difficult to eradicate. Mated females can lay both fertile and unfertile eggs. The fertile eggs develop as females and the unfertile eggs develop as males. Males are produced asexually, referred to as parthenogenesis.

Eggs hatch within 50 hours of being laid. This species of mites has a 40-day life span that is self-perpetuating. Snake mites have a five-stage life cycle: egg, larva, protonymph, deutonymph, and adult. Only mites in the last two stages of development feed on blood and they must have a blood meal before producing eggs.

The female mite is a voracious feeder, consuming more than 1000 percent of her body weight at each feeding. Mouth parts are similar to those of a tick with a penetrating blood feeding tube.

There may be visual signs of infestation with scale disruption and dermatitis. Infested snakes become agitated and rub on any item in the enclosure. They will also soak in water more often. There are over-the-counter products available, but it is recommended that infected snakes be treated by a veterinarian.

Review Questions

1. **What does POTZ mean and why is this important in housing reptiles?**
2. **Why is it important to provide UV lighting for reptiles?**
3. **Gout is a common disease in reptiles. What are the typical signs seen with this disease?**
4. **What are the common signs of a reptile with respiratory difficulties?**
5. **What is an episodic breather?**

6. What type of habitat is required for chameleons?
7. What are the causes of metabolic bone diseases?
8. What are common blood collection sites for the following species:
   a. lizards
   b. snakesd
   c. chelonians
9. What are the different ways of determining the sex of the following reptiles?
   a. snakes
   b. chelonians
   c. lizards
10. Explain the renal portal system in reptiles.

Reptiles

Table 15-1: Reptile Temperatures and Humidity Levels

REPTILE TEMPERATURES AND HUMIDITY LEVELS		
Lizards	**POTZ**	**Humidity**
African fat tail gecko	78 to 90 °F	20 to 50%
Anole	73 to 84 °F	70 to 80%
Basilisk	73 to 86 °F	80 to 100%
Bearded dragon	84 to 120 °F	30 to 40%
Blue-tongued skink	81 to 90 °F	30 to 60%
Crested gecko	74 to 83 °F	50 to 80%
Dwarf chameleon	70 to 85 °F	70 to 80%
Giant day gecko	80 to 86 °F	50 to 80%
Fischer's chameleon	72 to 85 °F	70 to 80%
Gold dust gecko	80 to 86 °F	50 to 70%
Green Iguana	85 to 103 °F	80 to 100%
Jackson's chameleon	70 to 80 °F	50 to 75%
Leopard gecko	77 to 86 °F	20 to 30%
Panther chameleon	85 to 90 °F	70 to 100%
Savanna monitor	80 to 95 °F	20 to 30%
Tegu	78 to 90 °F	50 to 80%
Veiled chameleon	80 to 95 °F	20 to 30%
Water dragon	77 to 93 °F	50 to 80%
Uromastyx	85 to 110 °F	20 to 30%

Continued

Table 15-1: *Continued*

Snakes	POTZ	Humidity
Ball python	77 to 86 °F	50 to 70%
Blood python	85 to 86 °F	50 to 70%
Boa constrictor	82 to 93 °F	70 to 90%
Red-tailed, Columbian, Burmese python	77 to 86 °F	70 to 90%
Corn snake	78 to 88 °F	20 to 50%
Garter snake	68 to 95 °F	20 to 30%
Green tree python	78 to 85 °F	80 to 100%
Hog Island boa	78 to 90 °F	80 to 100%
Hog-nose	80 to 90 °F	20 to 30%
King snake	73 to 86 °F	50 to 75%
Milk snake	78 to 90 °F	20 to 40%
Rainbow boa	75 to 90 °F	90 to 95%
Reticulated python	78 to 90 °F	80 to 100%
Sand Boa	77 to 86 °F	20 to 30%
Chelonians		
Box turtle	75 to 84 °F	50 to 80%
Leopard tortoise	68 to 86 °F	40 to 50%
Painted turtle	73 to 82 °F	80 to 100%
Red-eared slider	75 to 90 °F	80 to 100%
Red-footed tortoise	80 to 85 °F	70 to 80%
Russian tortoise	78 to 90 °F	20 to 50%
Radiated tortoise (star)	80 to 100 °F	20 to 50%
Sulcata tortoise	80 to 95 °F	20 to 50%

Note: These are recommended average temperature ranges and humidity levels.

Table 15-2: Lifespan in Captivity

LIFESPAN IN CAPTIVITY	
Colubrids	**Age (years)**
Cornsnake	32
Ratsnakes	22
Hog-nose snake	19
Kingsnakes	19 to 44
Northwestern garter snake	15
Boids	
Boa constrictor	40
Solomon Island boa	16
Rubber boa	26
Emerald tree boa	31
Rainbow boa	31
Carpet python	26
Green tree python	19
Burmese python	28
Ball python	20 to 47
Reticulated python	29

Continued

Table 15-2: *Continued*

Box turtle	20
Red-eared slider	20
Red-foot tortoise	20 to 30
Softshell	12 to 15

Table 15-3: Reptile Diets

REPTILE DIETS

Species	Diet	Recommended Feedings
Pythons	Rodents, small mammals, chicks	2 to 3 weeks
Boas—larger species	Rodents, small mammals, chicks	2 to 3 weeks
Boas—smaller species	Rodents	1 to 2 weeks
Ratsnakes	Rodents, chicks	2 to 3 weeks
Cornsnakes	Rodents, checks	1 to 2 weeks
Gopher snakes	Rodents, chicks	1 to 2 weeks
Pinesnakes	Rodents, chicks	1 to 2 weeks
Kingsnakes	Amphibians, rodents, fish, small lizards	1 to 2 weeks
Watersnakes	Amphibians, rodents, fish, small lizards	1 to 2 weeks
Garter snakes	Amphibians, rodents, fish, small lizards	1 to 2 weeks
Hog-nosed snake	Amphibians, rodents, fish, small lizards	1 to 2 weeks
Anoles	Insects	Daily
Chameleons	Insects, limited greens, small lizards	Daily
Geckos	insects	Daily
Water dragons	Insects, pinkies	Daily
Most skinks	Insects	Daily
Swifts	Insects	Daily
Ameivas	Insects	Daily
Lacertas	Insects	Daily
Small monitors	Insects, pinkies	Daily
Tegus	Insects, pinkies	Daily
Day geckos	Invertebrates, insects	Daily
Large monitors	Vertebrates	Weekly
Large tegus	Vertebrates, fruit	Weekly
Bearded dragons	Greens, invertebrates	Daily
Blue-tongued skinks	Greens, invertebrates	Daily
Uromastyx	Greens, invertebrates, seed	Daily
Green iguana	Greens	Daily
Prehensile-tail skink	Greens	Daily
Softshell turtles	Carnivores	Daily
Box turtles	Earthworms, fruits, veggies, crickets	Daily
Wood turtles	Earthworms, fruits, veggies, crickets	Daily
Sulcata tortoise	Grasses, greens, fruits	Daily
Leopard tortoise	Grasses, greens	Daily
Radiated tortoise (star)	Grasses, greens	Daily

Table 15-4: Reproductive (Status) of Reptiles

REPRODUCTIVE (STATUS) OF REPTILES		
Species	**Oviparous**	**Viviparous**
Chelonians	x	
Monitors	x	
Iguanas	x	
Water dragons	x	
Geckos	x	
Veiled chameleon	x	
Panther chameleon	x	
Jackson chameleon		x
Python-snakes	x	
King snakes	x	
Milk snakes	x	
Rat snakes	x	
Corn snakes	x	
Most boas		x
Most vipers (rattlesnake)		x
Colubrids—some		x
Garter snake		x
American water snake		x

Further Reading

Donoghue, Susan (2002). Assist-Feeding Sick Lizards. *Exotic DVM*, 4 (2), 38–39.

Exotic Companion Medicine Handbook. Edited by Johnson-Delaney, Cathy. (Zoological Education Network. 2000, Florida)

Garner, Michael M. (2005). *Common and Emerging Diseases of Reptiles: Bacterial.* North American Veterinary Conference, Orlando, FL, January 2005.

Girling, Simon (2003). *Veterinary Nursing of Exotic Pets.* Blackwell Publishing.

Heard, Darryl, Fleming, Greg, Lock, Brad & Jacobson, Elliott (2002). Lizards. In *BSAVA Manual of Exotic Pets, 4th Edition* (pp. 223–240). British Small Animal Veterinary Association.

Hernandez-Divers, Stephen J. & Cooper, John E. (2001). *Reptile Hepatic Lipidosis* (pp. 193–199). Association of Reptilian and Amphibian 2001 Proceedings.

Mader, Douglas R. (2006). *Reptile Medicine and Surgery, 2nd Edition.* Saunders/Elsevier.

Mayer, Jorg, & Bays, Teresa Bradley (2006). *Exotic Pet Behavior.* Elsevier.

McArthur, Stuart D. J., Wilkinson, Roger J. & Barrows, Michelle G. (2002). Tortoises and Turtles. In *BSAVA Manual of Exotic Pets, 4th Edition* (pp. 208–222). British Small Animal Veterinary Association.

Mosley, Craig A. E. (2005). ACVA. Anesthesia and Analgesia in Reptiles. *Seminars in Avian and Exotic Pet Medicine,* 14 (4), 243–262.

Raiti, Paul (2002). Snakes. In *BSAVA Manual of Exotic Pets, 4th Edition* (pp. 241–256). British Small Animal Veterinary Association.

Stahl, Scott J. (1999). *Medical Management of Bearded Dragons.* North American Veterinary Conference, January 1999.

Wright, Kevin, DVM (2005). Beyond POTZ: Environmental Influences on Reptile Healing. *Exotic DVM,* 7 (4), 11–15.

Wyneken, Jeanette (2001). Respiratory Anatomy—Form and Function in Reptiles. *Exotic DVM,* 3 (2), 17–22.