

Companion Animal Hospital Exotic Animal Care



Pond sliders, genus *Trachemys*, are a popular group of pet turtles. They are native to the Americas, although most species found as pets are North American, such as the Red-eared Slider (*Trachemys scripta elegans*) and the Yellow-bellied Slider (*Trachemys scripta scripta*). These semiaquatic turtles can be found in various ponds, slow-moving rivers, and other bodies of fresh water. Juvenile turtles are brightly coloured and these colours fade as they mature, with a few exceptions (such as the bright red head stripes of the Red-eared Slider). As fully-grown adults, they average 15-20 cm (6-8") in size although they may grow to over 40 cm (16") long. Females are larger-bodied than males.

When properly cared for, these turtles will easily live 30-50 years, so prospective owners should be prepared for a long commitment. Like with all reptiles, good husbandry and preventative health care are important for a long and healthy life.

1. Environment: Enclosure

There is a very common myth that reptiles will only grow to the size of their enclosure. This is absolutely **false**. Reptile growth rates are only stunted by poor care, poor nutrition, and disease. We do not recommend sacrificing your pet's health with the intention of stunting his growth as this is not ethical and will only lead to a sick and eventually dead pet.

Providing an adequate environment is one of the greatest challenges with pet pond sliders. A minimum guideline for enclosure size using the turtle's carapace (shell) length ensures that the turtle has adequate space to move around for both thermoregulation (see Environment: heating) and exercise, as well as mental well-being:

- Water depth: At least 1.5 to 2x (one and a half to twice) as deep as the carapace length. Please note that an additional 10-15 cm (4-6") above the water level is necessary to accommodate a land area with the basking spot.
- Enclosure length: At least 4-5x the carapace length.
- Enclosure width: At least 2-3x the carapace length.

With the above minimum guidelines in mind, a standard 76 L (20 gallon) aquarium that measures approximately 61 cm long by 30 cm wide by 46 cm tall (24" long by 12" wide by 18" tall) will only house up to a 12 cm (4.7") turtle!

Please note that these guidelines are for a single turtle. Despite many sources debating otherwise, these animals are absolutely not social, and interactions with other turtles are inherently stressful. Reptiles see each other as either predators, competitors, or potential

mates (under the right conditions). The stress of having a competitor in an enclosure will nearly always cause one animal to be subtly “bullied” out of eating and/or basking, and the presence of a larger animal can even cause immune system suppression from stress. If you would like to keep more than one turtle together, we recommend doubling the enclosure size and its important resources (e.g. more than one land area with a basking spot) to avoid competition.

Juveniles are easily housed in aquariums with a secure screen top (baby turtles are stronger than they look, and can climb out of an unsecured aquarium). Larger turtles require very large aquariums, although other water-tight tubs such as rigid pond liners or the Turtle Tub by Zoo Med can also be modified to use safely with sliders.

Aquatic turtles require a dry land area to bask on, at least at large as the turtle’s body so that they may rest completely out of the water. This is not only important for their ability to bask under a heat lamp, but periodically drying off is important for skin and shell health. A dry land area may be created with any combination of floating turtle docks, bricks stacked out of the water, custom ramps, etc. We recommend looking at examples of turtle enclosures online for ideas that may work with your setup.

We do not recommend housing turtles outdoors without ensuring that you have a predator-proof enclosure, and the ability to bring turtles indoors to a suitable enclosure during unsuitable weather.

2. Environment: Heating

Reptiles are ectothermic: They rely on external heat to maintain their bodies at a preferred temperature. All reptiles need an external heat source so that they may thermoregulate by shuttling within a heat gradient in their enclosure. Basically, when a reptile is too cool he will move to somewhere warm, and when he is too warm he will move somewhere cooler. Reptiles will move around in the gradient throughout the day to try to stay at a target body temperature.

To create a thermal gradient in the enclosure, a primary heating device should be placed over the basking spot, which may be left on during the day to mimic sunlight. A secondary device to heat the water is necessary, and there are many suitable water heaters available. These heaters generally have an internal thermostat and can be set at a specific temperature. Please ensure that the water heater has an appropriate plastic guard, or is located somewhere in the enclosure where the turtle cannot smash it against rocks or the aquarium wall (breaking the electric heater in the water could result in a dangerous shock) or burn themselves by touching it.

The temperatures required by pond sliders at the land basking spot are 30-32 °C (86-90 °F) at the basking spot, and the water temperature should range from 24-30 °C (75-86 °F). At night, the entire enclosure should ideally not drop below 20 °C (68 °F).

Monitoring the basking spot and water temperatures are critical: It is not only important to ensure that your pet can get warm enough based on the species' preferred body temperature, but also that the cool end allows for proper cooling when needed. Hyperthermia, or an excessively high body temperature, can kill a reptile or amphibian within minutes, and ensuring that your thermal gradient is appropriate at both ends is critical. For monitoring the basking spot, we recommend the usage of either a digital thermometer with a probe that may be placed at the appropriate spot, or a noncontact infrared temperature "gun" that can be pointed at any location in the enclosure. To monitor the water temperature, a variety of digital thermometers are available. Glass thermometers must be placed somewhere in the enclosure where they cannot be broken by a curious turtle. Note that some thermometers are not very accurate and may be misleading when monitoring temperatures. "Stick-on" LCD and dial thermometers are generally quite inaccurate and we do not recommend their use.

Note that some thermometers are not very accurate and may be misleading when monitoring temperatures. For the basking spot, we recommend a digital probe thermometer where the probe may be placed under the basking lamp. To monitor water temperatures, probe thermometers may also work, as do glass-encased thermometers intended for aquarium use. "Stick-on" LCD and dial thermometers are generally quite inaccurate and we do not recommend their use.

3. Environment: Lighting

These turtles need a broad spectrum light source that provides UV-B radiation to allow for normal calcium metabolism, and UV-A to help with food identification. Please see our handout on lighting for reptiles for more information.

4. Environment: Substrate and cage furnishings

Substrate is the medium covering the floor of the enclosure. Substrate along the bottom of the water must be large enough not to be eaten, as turtles may sometimes try to ingest items that are inedible which can lead to a fatal digestive tract impaction. Large gravel or polished "river stones" can be effective, and some owners have success with various soil and sand mixes used to plant live foliage. Any substrate must be cleaned regularly (either using an aquarium siphon to "vacuum" or removing the substrate to be rinsed), as substrate will easily trap organic material and promote harmful bacterial growth. Healthy bacterial growth can be encouraged in systems with a naturalistic substrate and live plants, but in small enclosures this can be very difficult to achieve.

Reptiles need hiding spots so that they may hide to feel secure. These aquatic turtles will appreciate foliage to use as cover, as they do in the wild. There are many attractive plastic aquarium plants available that can be used to create cover, but monitor your turtle closely to ensure that he or she is not trying to eat them (ingesting plastic can lead to a digestive tract

impaction). Live plants can be used in enclosures, but take note that they must be safe for your turtle to eat (as turtles will generally try to eat live plants), they require a specific substrate to allow them to survive, and even if the turtle does not try to eat them they will likely need to replace frequently due to wear and tear from a large-bodied turtle moving around.

Safe live plants to use in an aquatic turtle habitat include:

- Anacharis, *Egeria densa*
- Anubias, *Anubias barteri*
- Amazon Sword Plants, *Echinodorus sp.*
- Duckweed, *Lemna sp.*
- Java Fern, *Microsorium pteropus*

Other cage furnishings such as rocks and suitable driftwood may be used to add visual interest and further hiding spots for your turtle. Please ensure that rocks are heavy enough to rest in place, and if they are stacked that they cannot be toppled. Turtles can seriously injure themselves, trap themselves so they cannot surface (turtles can drown if trapped), or even be crushed to death in an enclosure with inappropriately placed rocks.

5. Environment: Water quality and filtration

Providing appropriate filtration in an aquatic turtle enclosure is a challenge. Most aquatic turtles are messy eaters, leaving a lot of food debris in the water, and produce a significant amount of waste. Regular water changes and large (expensive) filters are a must in these captive habitats.

Filtration helps to remove physical and chemical waste from the water, and is made up of three parts:

- **Mechanical filtration** removes large waste from the water. This needs to be physically removed from the filter regularly, as organic waste will continue to degrade.
- **Biological filtration** uses healthy bacteria (grown on filter media like ceramic rings or plastic “bio-balls” over about 4 to 6 weeks) to convert ammonia to less toxic by-products. These filter media should not be sanitized during filter maintenance to avoid killing the healthy bacteria.
- **Chemical filtration** helps to remove excessive organic waste in the water. Activated carbon is a common filter media used to help remove ammonia from the water. Other media can be used to alter pH and hardness.

Small enclosures for young turtles may use any type of internal canister filter, hang-over-top power filter, or submersible filter. For large enclosures, external canister filters are probably the most effective in keeping the water clean. Because turtles produce so much waste compared to fish, we recommend purchasing a filter that is double the capacity of your enclosure. For

example, for use in a 280 L (approximately 75 gallon) aquarium, the minimum recommended filter rating should be for a 560 L (approximately 150 gallon) aquarium.

Water quality parameters should be monitored regularly (weekly to every few weeks, or more often if there has been any major change to the enclosure) to ensure that there are no invisible hazards in the water. Clear water does not always mean that the water is healthy. The following parameters are especially important in aquatic turtles:

Parameter	Description	Target for enclosure
Ammonia	Waste product of turtles, and produced by bacteria that break down organic waste in the environment. It is toxic, and in quantities that are dangerous enough for your turtle it is odourless. Regular water changes and efficient biological filtration help to reduce ammonia concentrations.	Ammonia should be undetectable with commercial tests. Any level of detectable ammonia is dangerous for your turtle.
Nitrites and nitrates	Healthy bacteria convert ammonia to less toxic nitrites, then nitrites to the even less dangerous nitrates.	In a healthy aquatic habitat with good biological filtration, nitrites will be low to undetectable, and nitrates will be detected. The presence of nitrites without nitrates suggests that the water system has not been effectively "cycled."
pH	pH is a measure of the acidity or alkalinity of the aquarium water.	pH = 6-8

Chlorine and chloramine are both potentially harmful to not only small turtles, but also the healthy bacteria growing in your turtle’s home. While these water additives are not dangerous for people, and may not even be harmful to a large turtle, because they can damage the bacterial balance in your aquatic system we recommend using dechlorinated water. Check with your municipality to see what type of additives are in your water supply. Aquarium dechlorinators (that remove chlorine, chloramine, and heavy metals) are generally regarded as safe for turtles and fish, and are found in most pet shops with an aquarium section. Water with chlorine only may be left out in a bucket for a minimum of 24 hours to allow the chlorine to evaporate.

6. Nutrition

Pond sliders are omnivores: They eat a combination of plant and animal matter. The animal part of their diet is mostly invertebrates and small fish, and the plant portion should be mostly nutritious leafy greens. These turtles’ appetite preferences change from primarily meat-eating to mostly plant-eating as they age; this is called an ontogenetic diet change. It is important to introduce young turtles to healthy plant matter so that they will continue to eat them as adults.

Generally, a combination of the following food groups will result in a healthy turtle:

- Commercial pelleted diet (33% of the diet for young turtles, 25% of the diet for mature turtles): A good quality pelleted diet is important to ensure that your turtle is eating good quality protein and a range of vitamins and minerals that may be difficult to balance with whole foods. Because pellets are nutritionally more dense than whole foods, they should be offered in limited amounts avoid overfeeding.
- Animal matter (33% of the diet for young turtles, 25% or less of the diet for mature turtles): See our handout on turtle nutrition.
- Plant matter: (33% of the diet for young turtles, 50% or more for mature turtles): See our handout on turtle nutrition.

Young, growing turtles should be fed daily. A rule of thumb is to allow the turtle to eat as much as they can within a few minutes, then remove the rest. Adult turtles may be fed every 2 to 3 days. Some keepers feed their turtles in separate, smaller tubs filled with water to avoid soiling the water in the main enclosure, as turtles can be very messy eaters.

7. Health

Good husbandry helps prevent most health problems in reptiles. As ectotherms, their immune system function is directly affected by both stress and their ability to thermoregulate, so proper environmental temperatures are critical. There are some other common health problems that you can avoid with the right precautions.

Signs of illness can be very subtle in reptiles as these animals tend to be stoic and will hide or mask symptoms to the best of their ability. Any abnormal behaviour should be considered suspicious, as often a change in an animal's routine or how they interact with you can be an early warning sign that something is wrong.

Metabolic bone disease (MBD) is unfortunately very common in growing turtles with inadequate nutrition or other husbandry problems. If you think that your turtle is not growing as he or she should or the shell appears deformed, please contact our staff. In the early stages of this syndrome, most pets are treatable and the condition can be reversed. If left untreated, it is fatal.

Diseases involving ulcers, discolouration, or other defects of the shell are often a result of some generalized infection (or septicemia). While turtles will often survive with these shell defects and sometimes even appear completely healthy otherwise, we strongly recommend investigating the cause as it is a serious sign that something is wrong with the turtle's general health.

Trauma to the shell is serious and can happen many ways: Accidentally dropping your turtle, accidental mishaps with other pets such as dogs, or even accidents in the enclosure involving heavy cage furnishings like rocks. We recommend taking these injuries very seriously as they

can lead to lethal complications. A turtle's shell is living bone, and any damage to the surface leaves the body open to infection.

8. Further reading

Our caresheet has only scratched the surface of pond slider care. We strongly recommend that turtle owners continue learning about their companion animal as they are a complex species.

- **Red Ear Slider.com:** <<http://www.redearslider.com/>>
A hobbyist website with lots of details on Red-eared Slider care, most of which is applicable to all pond slider species.
- **Tortoise Trust:** <<http://www.tortoisetrust.org/>>
A nonprofit organization dedicated to providing top quality care information for tortoises and turtles to hobbyists. They are frequently involved in research projects involving turtle and tortoise captive welfare.
- **World Chelonian Trust:** <<http://www.chelonia.org/>>
Another nonprofit organization dedicated to chelonian (turtle and tortoise) conservation and welfare.

Companion Animal Hospital Exotic Animal Care



Lighting for Reptiles and Amphibians

Some reptiles and amphibians require broad spectrum lighting that includes ultraviolet A and ultraviolet B radiation (wavelengths found in natural sunlight). Providing this special lighting in captivity is critical for the health of many common companion species.

1. What is ultraviolet light?

Ultraviolet light is invisible to the human eye, but important to many members of the animal kingdom. There are three classifications of ultraviolet light:

- **Ultraviolet A:** UVA is also called long wave or "black light" ultraviolet radiation. This class of UV is important in regulating natural cycles in some reptiles, such as brumation ("hibernation") and reproduction.

Many species of reptile (Fleishman et al. 1993), insects (Salcedo et al. 2003) and birds (Cuthill et al. 2000) can see UVA light. It is important in helping to see members of the same species or even prey. It has been demonstrated that reptiles provided with UVA light

generally do better in captivity, with increased levels of natural activities, greater reproductive success, and better appetites (Klaphake et al. 2004).

UVA is produced by the sun, by broad spectrum fluorescent bulbs and black lights (Gehrmann 2006).

UVA is definitely beneficial to diurnal species (species active during daylight hours). It may be most important in visually-oriented species, like members of the iguana (Iguanidae), agama or dragon (Agamidae) and true chameleon (Chamaeleonidae) families of lizards, as well as in turtle and tortoise species.

- **Ultraviolet B:** UVB is also called medium wave ultraviolet radiation, and is essential in vitamin D₃ production (the “sunshine vitamin”). Vitamin D₃ allows the body to use calcium from the diet. Some species can use vitamin D₃ from dietary sources (animal matter), but many species either cannot absorb dietary D₃ or do not encounter vitamin D₃ in their natural diet.

It is uncertain whether reptiles can see or detect UVB. It is produced by the sun, and by some broad spectrum artificial lighting (Gehrmann 2006).

UVB is important to provide for most diurnal lizards, chelonians and some amphibians. Herbivorous (plant-eating) animals absolutely need UVB lighting as they cannot use dietary vitamin D₃. Without UVB lighting, calcium deficiency occurs and manifests as many health problems, including the metabolic bone diseases (a group of pathologies related to calcium metabolism).

There is a growing amount of research suggesting that species that we have not traditionally recommended UV-B lighting for can benefit from exposure. For example, some studies (Acierno et al 2008, Hedley and Eatwell 2013) have demonstrated that snakes can certainly use UV-B lighting. More investigation is needed to determine the health benefits of providing broad spectrum lighting to these species, however in the meantime it may be safest to allow for lighting that is as natural as possible for these captive snakes.

- **Ultraviolet C:** UVC, or short wave ultraviolet radiation, is produced by the sun but filtered by our atmosphere. Some lights will produce UVC radiation very close to the bulb surface. It is germicidal and used in air and water disinfection systems. Exposure to UVC radiation is harmful to the skin and eyes, and does not need to be provided to reptiles or amphibians in captivity.

2. Types of broad-spectrum lights

There are several types of commercial bulb available to provide your companion animal with broad spectrum lighting. Select a bulb according to the animal you have, and the type of enclosure you are using.

- Linear fluorescents are suitable for enclosures with a lot of floor space, as well as for long animals that have a large body area that needs UV exposure. Examples of brands include: **Exo Terra Repti Glo** by Hagen, **Iguana Light** and **Reptisun** by Zoo Med, **Desert Series 50** and **Tropical Series 25** by Zilla.



- Compact fluorescents are limited in their "spread" (place them horizontally towards the basking area, to increase surface area exposed) but have a greater relative irradiance closer to the bulb, so they are more suitable for small enclosures. Examples of brands include: **Exo Terra Repti Glo** by Hagen, **Reptisun** by Zoo Med, **Desert Series 50** and **Tropical Series 25** by Zilla.



- Mercury vapour lamps are only suitable for very large enclosures. They produce a large amount of heat as well as visible light, UVA and UVB (Baines et al. 2006). Users must be very careful to avoid thermal burns, always test the environmental temperatures before introducing your pet to the enclosure when using a mercury vapour lamp. Examples of brands include: **PowerSun UV** by Zoo Med, **Exo Terra Solar Glo** by Hagen.



3. Using broad-spectrum lighting

Keep the following points in consideration when lighting reptile or amphibian enclosure:

- Always research recent current care information about what kind of lighting your species needs. Reptile and amphibian care and medicine is a field that is constantly evolving.
- Never allow a glass or plastic barrier to occlude your broad spectrum light. Glass and plastic filter 99-100% of UVB radiation, even if visible light may pass through (Baines et al. 2006).
- The amount of UV produced decreases with distance from the bulb. Most bulbs are effective at a distance of less than 30 cm (12") from the basking spot (but read the manufacturer's recommendations). However, because bulbs may also produce small amounts of harmful UVC radiation near the bulb's surface, keep a minimum distance of 10 cm (4") (Baines et al. 2006).
- Screen or mesh covers or enclosures will physically block some UV from reaching the animal (Baines et al. 2006). If you have mesh or screen between your broad spectrum bulb and the animal, ensure that your pet can get relatively close to the bulb, or add a reflector to increase how much UV is projected to the basking spot.
- Reptiles and amphibians are never in direct sunlight for the entire day. Always ensure that your pet can choose a location as a shelter from UV light exposure.
- Replace the light every 6-12 months, or according to the manufacturer's recommendations. The UV output of a bulb decreases over time, even if the light is still producing visible light (Klaphake et al. 2003).
- Consider using "high output" bulbs (with an 8.0 or 10.0 rating) with species that would be exposed to a lot of UV light (like desert animals) or in large enclosures, and mid-range output bulbs (5.0) with other species or in smaller enclosures. Low output bulbs (2.0) are probably useless in terms of UVB output.

Thank you for your trust in taking care of your reptile companion. If you have any questions or concerns about his or her care at home, please call the hospital to speak with our staff.

4. Sources and further reading

- Acierno, MJ, MA Mitchell, TT Zachariah, MK Roundtree, MS Kirchgessner, D Sanchez-Migallon Guzman. 2008. Effects of ultraviolet radiation on plasma 25-hydroxyvitamin D3 concentrations in corn snakes (*Elaphe guttata*). *American Journal of Veterinary Research*, 69(2):294-297.
- Baines, F, A Beveridge, R Hitch and R Lane. 2006. UVGuide.co.uk. <<http://www.uvguide.co.uk>>
- Cuthill, IC, JC Partridge, ATD Bennett, ST Church, NS Hart and S Hunt. 2000. Ultraviolet Vision in Birds. In JBP Slater (ed.), *Advances in the Study of Behavior*. Vol. 29. Saunders Elsevier, St. Louis, U.S.A.
- Fleishman, LJ, ER Loew and M Leal. 1993. Ultraviolet vision in lizards. *Nature*, 365:39.
- Gehrmann, WH . 2006. Artificial Lighting. In DR Mader (ed.), *Reptile Medicine and Surgery*. 2nd ed. Saunders Elsevier, St. Louis, U.S.A.
- Hedley, J and K Eatwell. 2013. The effects of UV light on calcium metabolism in ball pythons (*Python regius*). *Veterinary Record*, 173:345.
- Klaphake, E, E Adkins, T Driggers, G Ferguson, W Gehrmann, Z Gyimesi, E May, M Ogle and T Owens. 2003. Roundtable: Ultraviolet Light and Reptiles, Amphibians. *Journal of Herpetological Medicine and Surgery*, 13:27-37.
- Salcedo, E, L Zheng, M Phistry, EE Bagg and SG Britt. 2003. Molecular Basis for Ultraviolet Vision in Invertebrates. *The Journal of Neuroscience*, 23:10873-10878.

Companion Animal Hospital Exotic Animal Care



Aquatic turtles have specialized nutritional needs that must be catered to in captivity to ensure that your pet stays healthy. Different turtle species, and even different age groups in the same species require specific types of diets.

9. Pellets and their role in balanced nutrition

A good quality pelleted diet is important to ensure that your turtle is eating good quality protein and a range of vitamins and minerals that may be difficult to balance with whole foods. It is extremely difficult to replace the prey variety that wild turtles encounter, so pellets will help to fill in that gap in nutrition in captive animals. Because pellets are nutritionally more dense than whole foods, they should be offered in limited amounts avoid overfeeding.

There exists many brands of pelleted diets that cater to different life stages and species of turtle. "Growth" formulas tend to have more protein and calcium than "maintenance" or "mature" formulas, meant to imitate a change in dietary preference from animal to plant matter as some turtle species mature (such as in pond sliders, family Emydidae). For species with a more carnivorous diets throughout their lives, they may often be kept growth formulas for their entire life.

Talk to our staff about the food brands that we recommend for your pet turtle. We do not recommend any food that contains dried ant eggs or larvae, shrimp, or mealworms. These diets are very imbalanced, particularly in their calcium content, and are poor contributors to any turtle's diet.

10. Animal matter in the captive diet

Most turtle species need some kind of animal matter in their diet, with some species remaining mostly carnivorous for their entire lives and others transitioning to a mostly plant-based diet as they age.

There are many invertebrates commercially available as fish and turtle food:

- Earthworms: Suitable feeder earthworms include Canadian Nightcrawlers (*Lumbricus terrestris*) and Red Wigglers, sometimes called "compost worms" (*Eisenia foetida*). We recommend using only worms intended for feeding pet reptiles, as bait worms may be contaminated with detergents or other irritants used to collect them from soil.
- Bloodworms are the larvae of chironomid flies (nonbiting midge flies) and are a common frozen food found in pet stores.
- Glass worms are mosquito larvae that can be found seasonally in the frozen fish food section of the pet shop. They are high in fat and should not be fed as a staple prey item, but can be fed occasionally to add variety to the diet.

Fish can contribute to the captive turtle's diet by providing a balanced prey item, and live fish (although ethically questionable) can be a source of environmental enrichment. Not all fish species are suitable as prey. We recommend feeding whole fish wherever possible, as offering only muscle meat is imbalanced.

- Recommended feeder fish species include Guppies (*Poecilia reticulata*), platies and swordtails (*Xiphophorus sp.*).
- Cyprinid fish, such as minnows (various species) and Goldfish (*Carassius auratus*) contain an enzyme called thiaminase that can lead to a vitamin B deficiency when fed in excess.
- Oily fish including tuna, whitefish, sardines, mackerel, herring, etc., contain excessive amounts of unsaturated fatty acids and are deficient in vitamin E. Feeding these fish in excess leads to serious health conditions.

We do not recommend feeding insects in the diet unless they can be gut-loaded with a high-calcium feed just prior to feeding them to your turtle. Most insect species commonly fed as prey (including crickets, mealworms, superworms, and others) have very poor calcium content, and an inverted calcium-to-phosphorus ratio (Ca:P). This is the proportion of calcium and phosphorus in any food, an important value to consider as these two mineral nutrients have a close relationship. The target dietary Ca:P for insectivores is 1.5-2.0:1 (one and a half to twice as much calcium compared to phosphorus). Few commercial insects naturally have this calcium content, so supplements are necessary. Powdered supplements used for land-dwelling reptiles and amphibians are ineffective in an aquatic habitat as they tend to immediately disperse in the water.

We also do not recommend feeding sections of beef or chicken meat, as they are severely deficient in various nutrients. Feeding raw meats lead to unsanitary conditions in the enclosure, and historically may have contributed to turtles carrying *Salmonella* bacteria.

11. Plant matter in the captive diet

Many aquatic turtle species have a dietary shift as they age and become primarily plant-eaters. Although live aquatic plants in the enclosure can be a source of some nutrition, they tend to be quite expensive to replace and may not offer a balanced diet. Many fruits and vegetables that are popular in the grocery store produce section are not suitable for feeding reptiles.

There are many naturally-occurring plant chemicals (phytochemicals) that interfere with normal absorption or use of nutrients. In small quantities, these are not harmful, but when anti-nutrient dense foods make up the bulk of an animal's diet there can be serious health consequences. Some notable "anti-nutrient" phytochemicals include the following:

Glucosinolates: Several chemicals in this group interfere with the metabolism of dietary iodine, acting as goitrogens. Goitrogens suppress thyroid gland function, and are named for an enlargement of the thyroid gland in some affected species called "goiter." Glucosinolates are found in particularly high concentrations in many cruciferous vegetables (plants in the genus *Brassica*). Foods that contain significant amounts of glucosinolates include bok-choy (Chinese cabbage), broccoli, Brussels sprouts, cabbage, cauliflower, kale, rutabaga, spinach, and turnip.

Oxalates: Oxalates are found in many plants, particularly of the genus *Oxalis*. They bind to dietary calcium, inhibiting it from being absorbed. Foods high in oxalates include beets and beet greens, broccoli, carrot, cilantro, kale, pears, spinach, strawberries, Swiss chard and tomatoes. Note that oxalates found in plants that are commonly considered irritating oral tissue (and toxic to some animals) contain oxalates in a specific structure, called raphide crystals. Some herbivores can eat these plants, however always verify with the veterinary team before introducing plants to your lizard's enclosure.

Phytates: A phosphorus-storing compound in plants, phytates will bind to calcium, zinc, iron and other minerals so that the body cannot use them, and also interferes with protein digestion. Legumes and grains are typically high in phytates.

Tannins: These phytochemicals chemicals render protein unusable to the body. Foods containing significant levels of tannins include bananas, carrots, grapes, onions and spinach.

To create a balanced plant-based diet, we separate different fruits and vegetables into functional groups based on what they provide in the diet.

Staple food items that provide important nutrients are marked with an asterisk (*). Every category of the diet needs at least one staple vegetable (two or three per category is better). Ideally, feed 2-4 items from each category, daily (except fruit).

Leafy Green Vegetables (66-75%): Dark, leafy green vegetables that are high in calcium should be the bulk of the diet.

*Arugula, bok choy, *collard greens, *dandelion greens, endive, *escarole (chicory), kale, *mustard greens, nappa cabbage, parsley, Swiss chard, rapini, romaine lettuce, *turnip greens, *water cress.*

Other vegetables (25-33%): Other vegetables help round out the nutritional content of the diet. Pick at least one green vegetable and one red, orange or yellow vegetable to feed regularly. These vegetables should be chopped or shredded so that they float to be easily grabbed by your turtle.

**Acorn squash, *butternut squash, *cassava (yucca root), carrot, *green beans, *kabocha squash, parsnip, pumpkin, *okra, spaghetti squash, *snap peas, *snow peas, sweet potato, *wax beans, zucchini.*

Fruits: Fruit availability is often seasonal in the wild, and should not be a large part of the captive diet. It may be offered rarely as a treat and does not need to be fed daily.

Apple, bell pepper (any colour), berries, cherries (pitted), kiwi, melon, papaya, pears, plum, prickly pear cactus pads (de-spined and skinned).