

# UltraViolet Light and Its Benefits in Captivity

## What is UltraViolet Light?

There exists what is called the **Electromagnetic Spectrum** which consists of various wavelengths of radiation that spans from gamma rays to radio waves, with ultraviolet (UV,) visible light, and infrared (IR) in between.

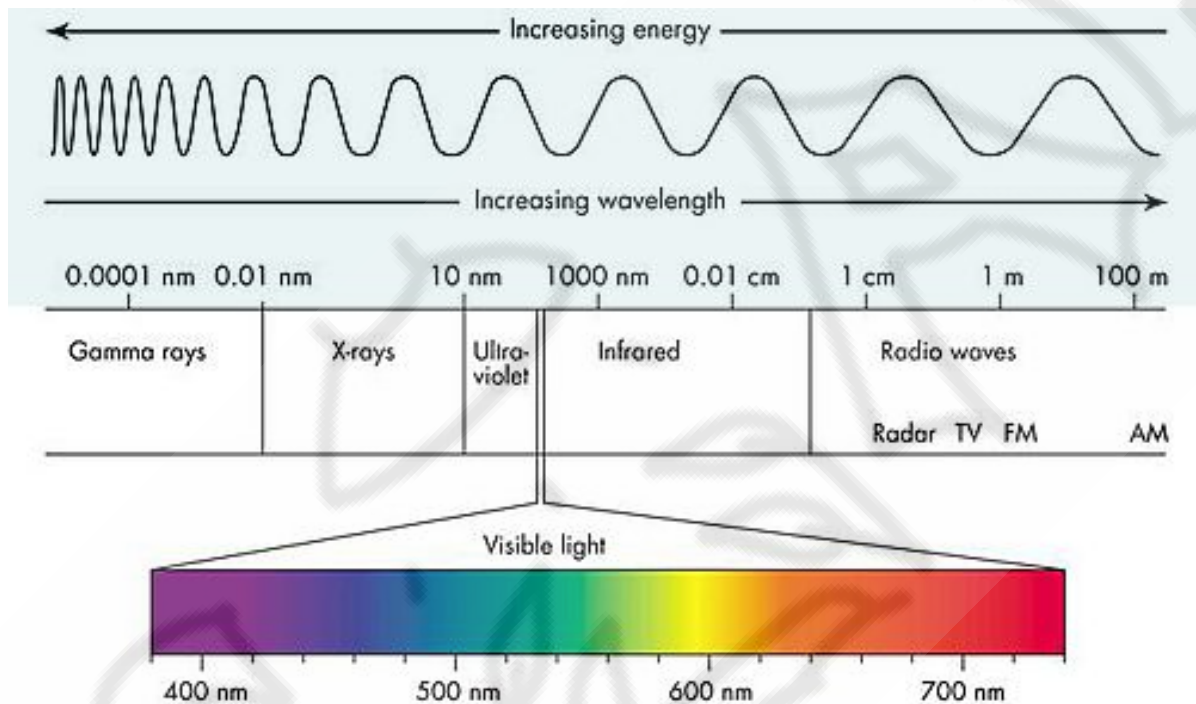


Image source: <https://www.cyberphysics.co.uk/topics/light/emspect.htm>

Ultraviolet light occurs right before visible light, however that is solely in terms of human vision. Every living creature has receptors, known as cones, in their eyes which register different wavelengths and colors. For example, humans have three cones being blue, green, and red. Depending on how these cones are activated we are able to see the colors of visible light. Reptiles on the other hand have a fourth cone that allows them to see colors below 400nm making them able to perceive colors much better than we can as they are able to see colors within the UV range. Humans on the other hand can only see UV with aids, and not of our own doing.

## How Does UV Affect Reptiles Other Than Added Color in Vision?

Similar to IR, UV has three different wavelengths, all of which do different things.

**UV-A:** UV-A is 380nm-315nm and when speaking of human skin, is able to penetrate deep into the subcutaneous tissue. Here it is able to break down collagen which leads to premature aging, and a high risk of melanoma (skin cancer.) Reptiles on the other hand have adapted so that their skin reflects UV-A which aids in them being able to identify one another.

**UV-B:** UV-B is 315nm-280nm and is not deeply penetrating, however is how your skin tans and is the cause of 'sunburns' and promotes carcinoma (another type of skin cancer.) This is why it is important to take into consideration how close the animal is able to get to its UV source when choosing a bulb, this will be touched on again later on. The most important part of UV-B though is how it allows for natural synthesis of D<sub>3</sub> in the animal.

**UV-C:** UV-C is below 280nm and is extremely harmful. UV-C is commonly used for sterilization in sewage plants and some aquariums as it's very good at killing germs.

Reptiles who are provided proper UV light in captivity tend to be more active and healthier overall. This is because the UV-A allows them to maintain their full color vision, allowing them to see things the way they were intended while the UV-B allows them to gain the much needed D<sub>3</sub> vitamin.

While it is possible to use supplementation alone it is hard to gauge exactly how much supplementation is needed, as most keepers just follow the instructions given to them by the manufacturers of the supplements, or they've been given instructions by other more established keepers. Natural synthesis of D<sub>3</sub> ensures that the reptile is able to get everything they need and allows them to self regulate as they would in the wild.

UV-C on the other hand is mostly filtered out by the Earth's atmosphere and is not produced in reptile UV bulbs. The only way UV-C is made and used is if it is a product being manufactured specifically for UV-C use such as the examples above.

## The Importance of Vitamin D<sub>3</sub>

"The **D<sub>3</sub> Cycle** is a chemical and hormonal change in the body of an animal, which goes on to produce vitamin D<sub>3</sub>." - Arcadia Reptile.

When cholesterol is exposed to natural light (UV-B,) it is then turned into pre-vitamin D<sub>3</sub> within the skin's membrane. The pre-vitamin D<sub>3</sub> then gets exposed to heat and turns into D<sub>3</sub> which can then enter the blood plasma, bound to a vitamin D binding protein, and then moves to the liver where it gets converted into a hormone called calcediol.

Calcidiol is then carried all around the body, and reaches the kidneys. The kidneys then convert some of it into another hormone called calcetriol which plays a big part in calcium metabolism by controlling blood calcium levels. Calcetriol also aids the immune and cardiovascular systems.

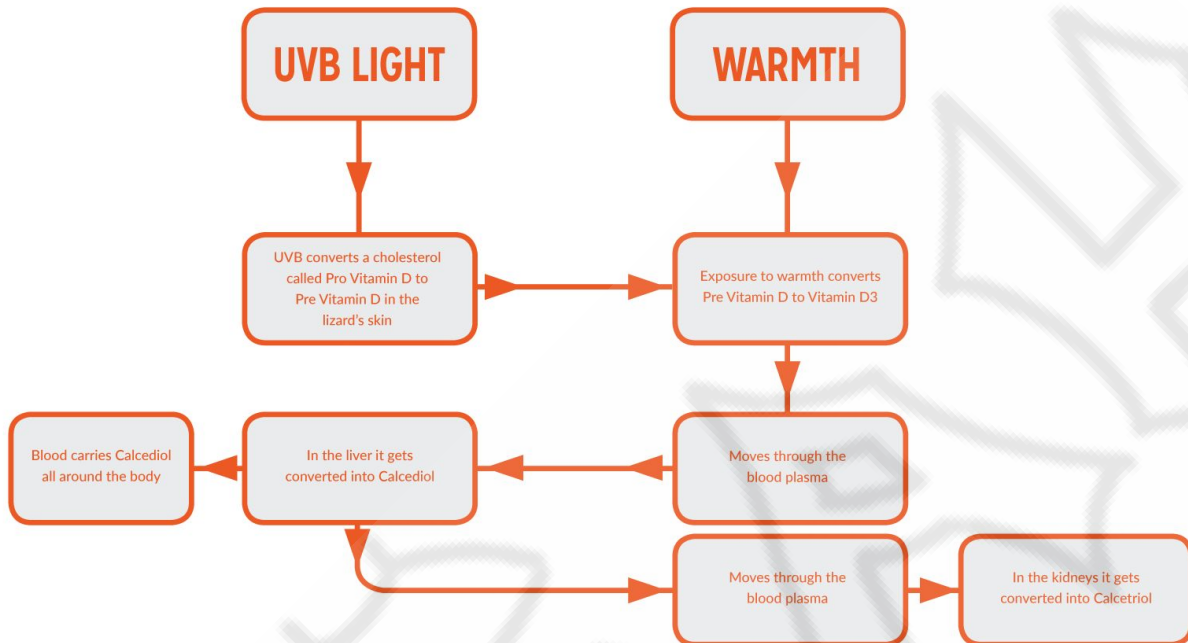


Image and information on the D<sub>3</sub> cycle source: <https://www.arcadiareptile.com/d3-cycle/>

The metabolism of calcium is important as it allows for strong bones and the proper formation of bones. Without proper D<sub>3</sub> or calcium the animal can acquire hypocalcemia which can then very quickly turn into rickets, an early form of **Metabolic Bone Disease** (MBD.)

## Metabolic Bone Disease

MBD is caused by poor diet, poor husbandry, or both. Without D<sub>3</sub> the body is unable to absorb and utilize calcium effectively and instead will pull directly from the bones. This often times causes brittle bones due to a lack of bone density, misshapen limbs due to the bones not developing properly, anorexia, lethargy, an inability to walk properly, swollen limbs and joints including the jaw, cloacal prolapse, elongated bones again due to improper bone development, muscle fasciculations, tetany, maxilla, and spinal fractures.

MBD is normally diagnosed with an x-ray to get a better grasp of the severity by allowing the licensed vet to view the bone density. They are then able to prescribe a form of care to help stop the progression of the disease however in most cases it is not at all reversible.

While MBD can be managed if caught early on, the animal will always have a lower quality of life. MBD is completely avoidable.

## Determining the Amount of UV Needed by Species

A biologist by the name of Dr. Gary Fergusun did a study on voluntary exposure to UV by lizards and snakes in the southern US and Jamaica using 15 different species in their natural habitats. He published a paper on his findings on the behavior of wild reptiles and how they utilized UV. This study helped start a long line of studies into the use of UV with reptiles and how it could be applied to captivity. Eventually it led to the concept of **Ferguson Zones** which is a measure of UV that is deemed appropriate to a species based on its behavior in the wild.

There are four Ferguson Zones which are as follows:

**Zone 1:** Crepuscular or Shadedweller, Thermal Conformer

**Zone 2:** Partial Sun/Occasional Basker, Thermoregulator

**Zone 3:** Open or Partial Sun Basker, Thermoregulator

**Zone 4:** Mid-Day Sun Basker, Thermoregulator

FERGUSON ZONE	SPECIES INCLUDE:	SUGGESTED UVB
<b>Zone 1:</b> Crepuscular or Shade Dweller, Thermal Conformer	Crested Gecko Leopard Gecko Tokay Gecko Burmese Python Green Tree Python Milk Snake Reticulated Python	<b>Shade Method:</b> Gradient UVI 0-0.7
Intermediate between Zones 1 and 2	Fiji Branded Iguana Corn Snake Carpet Python	<b>Shade Method:</b> Gradient UVI 0-0.7
<b>Zone 2:</b> Partial Sun / Occasional Basker, Thermoregulator	Australian Water Dragon Emerald Tree Monitor Green Anole Monkey-Tailed Skink Pygmy Chameleon Ornate Box Turtle Red Foot Tortoise Boa Constrictor Red-Tailed Ratsnake Garter Snake Western Hognose Snake	<b>Shade Method:</b> Gradient UVI 0-1.0  or <b>Sunbeam Method:</b> UVI Maximum 1.1-3.0 in Basking Zone
Intermediate between Zones 2 and 3	Blue-Tongued Skink Chinese Water Dragon Panther Chameleon Common Musk Turtle	<b>Sunbeam Method:</b> UVI Maximum 1.1-3.0 in Basking Zone
<b>Zone 3:</b> Open or Partial Sun Basker, Thermoregulator	Black-and-White Tegu Fringed Lizard Standing's Day Gecko Yemen Chameleon Indian Star Tortoise Leopard Tortoise Spotted Turtle Diamond Python	<b>Sunbeam Method:</b> UVI Maximum 2.9-7.4 in Basking Zone
Intermediate between Zones 3 and 4	Bearded Dragon Bosc or Savannah Monitor Green Iguana Painted Turtle Red Eared Slider Sulcata or African Spurred Tortoise	<b>Sunbeam Method:</b> UVI Maximum 2.9-7.4 in Basking Zone
<b>Zone 4:</b> Mid-Day Sun Basker, Thermoregulator	Chuckwalla Uromastyx Rhinoceros Iguana Texas Horned Lizard	<b>Sunbeam Method:</b> UVI Maximum 4.5-8.0 in Basking Zone

The above chart is an abbreviated version from the January 2016 Journal of Zoo and Aquarium Research, "How much UV-B does my reptile need? The UV-Tool, a guide to the selection of UV lighting for reptiles and amphibians in captivity" by Dr. Frances Baines, Joe Chattell, James Dale, Dan Garrick, Iri Gill, Matt Goetz, Tim Skelton, and Matt Swatman.



Image source: <https://www.solarmeter.com.au/model65R.html>

Using these zones that are based on the time of day, and therefore the amount of UV present, the animal basks we are then able to add them to one of these four categories and then continue on to the amount of UV we would need to provide in captivity to better replicate their natural habitat.

Above is an image going into greater detail of some of the species included in each zone, the respective **UltraViolet Index** (UVi) reading, as well as the recommended light method for each.

UVi can be read using a scientific tool such as a Solarmeter 6.5R which measures UV-B specifically, the 'R' standing for reptile. This is the leading, and most trusted, brand of UVi readers. While there are cheaper alternatives out there the reality of it is that you get what you pay for and if you buy a cheaper model then you risk losing the sensitivity needed to accurately measure UV.

Being a crepuscular reptile, leopard geckos are listed as Zone 1 and therefore require very low levels of UV.

## Using the Shade Method vs Sunbeam Method

The **Shade Method** is used with low level UV species and is meant to give a reading no higher than 1.0 in most cases. This is done by providing low level UV across the entirety of the enclosure, providing lots of cover so that the animal has a gradient ranging from no UV to the maximum UV for that zone. This is done so that the highest point the animal can get to is the highest appropriate level of UV, with everything below being low levels. This creates a gradient from top to bottom that allows the animal to self regulate based on its altitude in the enclosure. Due to their low output, T8 fixtures are commonly recommended for this method.

The **Sunbeam Method** however is much more commonly used and better replicates how UV is in nature. This is a method in which a small portion of the enclosure is covered in higher UV to create a basking area. This is usually done by putting the UV right next to the heat source to better replicate how the sun emits heat, light, and UV all at once. This creates a horizontal gradient where the animal can simply walk over to the designated basking area to receive higher UV. T5 fixtures are necessary for this method as they are significantly more effective than their T8 counterparts and are able to create a wider gradient with a smaller focal point being the basking spot.

## The Different Fixtures and Their Bulbs

UV lights do not emit any meaningful heat. This means that while the bulb may be warm to the touch, it does not actually add to the ambient temperatures of the enclosure. Another important point of UV lighting is that it cannot be dimmed. Not only should you not dim them, but the bulbs themselves are incapable of dimming, so unlike heat sources it is absolutely imperative to get an appropriate strength bulb as there is no external source to adjust the bulb as needed.

Most bulbs are labelled by percentage and output. The percentage indicates how much of the light being emitted is UV-B wavelengths specifically e.g. a 6% UV bulb would emit 6% UV-B while the remaining 94% would be UV-A and visible light. As for output there are two types being **Normal**

**Output** (NO) and **High Output** (HO) with NO bulbs emitting a softer, less intense light than their HO counterparts.

Lastly there are two makes of bulbs. These would be linear bulbs and compact bulbs. Linear bulbs are long tube-like bulbs that require either a T8 or T5 fixture to function, and create a nice flood effect that covers a wide area. Compact bulbs on the other hand are either coil shaped or U-shaped and use a dome fixture to function, these bulbs are not normally recommended as they create a spot light of UV which greatly limits the usable area of UV for the animal. Compact bulbs are also known for having technical issues such as being much stronger or weaker than advertised, and having a noticeably smaller window of perfect UV range before becoming unsafe or ineffective meaning the animal must be a very specific distance from the bulb at any given time.



\*please reference our UVB file for exact recommendations for your viv size

Created by Victoria French

Image courtesy of Victoria French

## Do I Need a T8 or T5?

This depends on the animal, as well as the closest distance the animal can get to the bulb and which method of UV-B is being provided. So long as an appropriate bulb is being used to ensure safe levels of UV-B then really either fixture will do as leopard geckos are crepuscular and do not require high amounts of UV-B.

**T8:** T8 fixtures and bulbs were some of the original bulbs to be marketed for captive use. These tend to be much weaker and require  $\frac{3}{4}$  to the full length of the enclosure to be covered in order to be an effective source of UV-B. It seems as though some brands are actively trying to phase these bulbs and fixtures out of production.

**T5:** T5 fixtures improved upon T8 fixtures and are the current industry standard. T5 fixtures can come in both NO and HO, giving the user more options in regards to available UV-B strength allowing them to provide more accurate UV-B levels to their animals. These fixtures are also 5x more efficient, allowing them to cover a larger area with a smaller fixture, because of this it is recommended to only cover  $\frac{1}{2}$  -  $\frac{1}{3}$  of the length of the enclosure in order to be an effective source of UV-B.

## How Do I Know Which Strength to Get?

Which UV bulb you need is highly dependent on multiple factors being, species, mounting, fixture, and fixture design. Leopard geckos require low level UV-B as they are a crepuscular species, however a low level bulb mounted inside the enclosure will be much stronger than a bulb that is resting over mesh as the mesh will filter out the UV by 30-35% on average. Another factor to keep in mind is whether you are using a T8 model fixture, or a T5 and then even further, does it have a reflector? A fixture with a reflector helps guide the light flood in a downwards direction, because of this it helps the UV-B concentration as it is more focused making it stronger than a bulb that is in a fixture that does not use a reflector.

There are also many different brands available. The two most commonly recommended brands being ZooMed's ReptiSun line, and Arcadia. Other brands such as Exo Terra, Mega Ray, Komodo, Thrive, and so on either have untested bulbs or are known for their bulbs emitting much higher UV than advertised e.g. Exo Terra. Mega Ray is a reputable brand however they focus on higher UV species and aren't suitable for species that require low level. It is important when using UV that your bulbs can be trusted to emit the desired amount of UV-B to avoid burns.

Attached below is a graphic that can be read with interior mounting being the top section, over mesh on the bottom. Without a reflector on the left, and with a reflector on the right. Please keep in mind that the distances listed are the minimum distance that must be maintained at all times between the animal and the light in order to provide a safe UVi, and is not the total height of the enclosure itself.



# LG-AH UVB GUIDE

When deciding what kind of UVB to get, ask and answer these 3 questions:

- 1) How tall is my enclosure?
- 2) Is the UVB going inside the enclosure or on top of a mesh lid?
- 3) How close can the leo get to the UVB light?

There are many options for UVB lighting, please follow the chart below on what kind to get for your setup:

INSIDE THE ENCLOSURE:				
BRAND / MODEL:	*DISTANCE		*DISTANCE	
	w/o Reflector	*UVI	w/ Reflector	*UVI
Arcadia Shadedweller ProT5 Kit	Not Tested	—	10" / 25cm	~ 1.5
*Arcadia 6% T8	Too Weak	—	Too Close	—
*Arcadia 6% T5 (HO)	10" / 25cm	1.4	20" / 50cm	1.4
*Arcadia 12% T8	10" / 25cm	1.2	16" / 40cm	1.3
*Arcadia 12% T5 (HO)	16" / 40cm	1.1-1.4	Too Strong	—
Reptisun 5.0 T8 (by ZooMed)	Too Weak	—	Too Close	—
Reptisun 5.0 T5HO (by ZooMed)	Too Close	—	12" / 30cm	1.4
Reptisun 10.0 T8 (by ZooMed)	Too Close	—	14" / 35cm	1.4
Reptisun 10.0 T5HO (by ZooMed)	18" / 45cm	1.3	Too Strong	—
ON TOP OF MESH LID:				
BRAND / MODEL:	*DISTANCE		*DISTANCE	
	w/o Reflector	*UVI	w/ Reflector	*UVI
Arcadia Shadedweller ProT5 Kit	Not Tested	—	8" / 20cm	~ 1.5
*Arcadia 6% T8	Too Weak	—	Too Weak	—
*Arcadia 6% T5 (HO)	6" / 15cm	1.6	16" / 40cm	1.0-1.4
*Arcadia 12% T8	6" / 15cm	1.4	10" / 25cm	1.6
*Arcadia 12% T5 (HO)	12" / 30cm	1.2-1.4	20" / 50cm	1.3-1.6
Reptisun 5.0 T8 (by ZooMed)	Too Weak	—	6" / 15cm	1.1
Reptisun 5.0 T5HO (by ZooMed)	6" / 15cm	1.1	10" / 25cm	1.3
Reptisun 10.0 T8 (by ZooMed)	6" / 15cm	1.3	10" / 25cm	1.4
Reptisun 10.0 T5HO (by ZooMed)	12" / 30cm	1.6	Too Strong	—

\*DISTANCE - This is the absolute closest your leo should be able to get to the UVB light when directly under it.  
 \*UVI - UltraViolet Index, measurements used to read the intensity of UV rays. Ideal UVI for a leo actively basking under the UVB light is 1-1.5.  
 \*REFLECTORS - This is the shiny material that is often behind the UVB bulb, inside most fixtures, and it makes a massive difference in UVB output.  
 \*ARCADIA 6% & 12% - Please note that the smallest size these bulbs come in are 24" (60cm), so they are typically only ideal for 4ft+ (1.2m+) long enclosures.

CREATED BY JESSICA GORDON PUGLISI using information from ArcadiaReptile.com & "Measured UVI of Popular Fluorescent UVB Tube Configurations"  
 ©F. Baines & R. Bullock June 2015. To see the aforementioned graphic and more information on UV lighting please see the LG-AH UV File.

Image courtesy of Jessica Gordon Puglisi



## Sources:

Reptile Lighting Facebook Group

The Leopard Gecko (German)

<https://www.der-leopardgecko.de>

Arcadia Reptile

<https://www.arcadiareptile.com/d3-cycle/>

Merck Manual Veterinary Manual

<https://www.merckvetmanual.com/exotic-and-laboratory-animals/reptiles/metabolic-and-endocrine-diseases-of-reptiles>

Swell Reptiles (UK)

<https://www.reptiles.swelluk.com/blog/uvb-lighting-part-2-bulbs-set/>