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Lighting, and its use in Herpetology.

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This article is adapted from a series of pages written by the author.
These are available on the website Reptiles Down Under:
http://www.reptilesdownunder.com

Introduction:

Light is all around us, and all around reptiles and amphibians in their natural environment. Consequently, most people add light of some form to their enclosure. This article focuses on the use of artificial light within an enclosure. Obviously, the best form of lighting is the type found in an animal's natural environment - unfiltered sunlight. Where possible, and in circumstances that allow it, this is the type of lighting that should be used for an enclosure (or "aviary"). However, in a large number of circumstances this is impossible or impractical, and so some form of artificial lighting must be used.

The term "light" is normally used to describe the visible part of the Electromagnetic Radiation (EMR) spectrum, which also contains X-rays, Ultraviolet light, Infrared light, and Microwave and radio waves:

In a reptile or amphibian enclosure, three components of this spectrum are commonly used:

1.The visible part of the spectrum (i.e. Red, Orange, Yellow, Green, Blue, Indigo and Violet which, when combined, produce white light). This is so we can see the animals - let's face it, there isn't much point to keeping them if you can't see them! Also, this allows us to replicate the natural day/night cycle the animal would be subjected to in the wild.

2.The Infrared part of the spectrum, which is basically "heat".

3.The Ultraviolet, or UV, part of the spectrum is commonly used for dragons, turtles, and some snakes (such as Diamond Pythons *Morelia spilota spilota*) as the UV is used by the animal to produce the vitamin D3.

Anyway, that's enough of the science and physics - all you really need to know is that there are three main light types used in enclosures. They will be discussed in this article, in the order Visible light, Infrared light Ultraviolet (UV) light.

Visible light (or light so you and your animal can see!):

This type of light is used for two main purposes:
(i) So we can see our animals, and they can see us.
(ii) To mimic the real world situation in which there is day and night (i.e. to provide a naturalistic photoperiod).

The two standard forms of this lighting is by either a fluorescent tube, or by incandescent or halogen bulbs.

If you choose a fluorescent tube, you can either use a standard "office" tube (either white, or daylight), or an UV tube. As far as incandescent bulbs go, a standard household globe will do fine. You can also use a reflector bulb, which gives more intense light, and allows you to use the lamp for both lighting and providing a warm basking spot. This will be discussed in more detail in the Infrared light section.

Halogen bulbs come in two main types - either wide angle or spot angle globes, giving either a well-dispersed or tightly-focused beam. These can look quite elegant, and produce a nice coloured light, as anyone going into a display room/jeweler's window will know.

Whatever the choice of light, it is best to have it on a 24 hour automated timer, so that it is only on for part of the day. In summer, you should aim for 10 - 14 hours of light, and in winter 6 - 10 hours, depending where the species comes from. The best thing to do is mimic the daylight hours of the locality the species is naturally found in. Also, all lights produce heat, so it may be wise to enclose the light source with a mesh screen to prevent the animal touching the bulb/electrical wiring and burning themselves.

Infrared light (or using lights as a heat source):

There are three main types of light that can be used as a heat source:
(i) a standard incandescent bulb, either coloured (party) or standard (household) globes.
(ii) an infrared heat spotlight.
(iii) a ceramic heat globe.

Fluorescent and halogen bulbs themselves emit very little heat, but the transformer (or ballast) can emit quite a lot of heat. When setting up the enclosure, it may pay to consider placing the transformer/ballast in a position that maximises the use of this heat. This shouldn't be considered as a heat source, rather as a heat supplement. Also, please remember not to allow the animal access to the transformer/ballast or any associated wiring!

Standard incandescent bulbs produce a fair amount of heat - just put your hand near a lamp to see how much! A standard bulb can be used during normal daylight hours, but it has been suggested that 'white' light during the night will disturb an animal's "biorhythm", or internal clock. If you need to heat the enclosure at night, you can still use an incandescent bulb, it just needs to be a coloured party globe. Red and blue are the best colours, as reptiles' eyes do not respond to these wavelengths of visible light effectively, and so to them the enclosure will seem 'dark'. It is important that the globes are coloured all the way down the neck, otherwise the globes will still emit white visible light (you can use automotive paint to colour the necks of bulbs that have a clear section around the base). The beauty of coloured globes is that it also allows you to observe your animals' nocturnal activities, albeit in a strange light!

An infrared heat spotlight is great as a day and night heat source. Because the light emitted is infrared, the animals can't see it, but it does heat the enclosure. These lights typically emit a large amount of heat, so require a ceramic fitting to prevent the heat from damaging the enclosure. These bulbs also emit red light, so these also can be used for night observation of your animals.

Ceramic heat globes consist of an element encased in ceramics. These are true infrared emitters, emitting only heat, and no visible light. These are great for heating enclosures day and night, and also in cooler climates, as they produce quite a lot of heat. These also require a ceramic globe holder, as they will melt plastic fittings. The downside to these bulbs is that they are fairly expensive, and emit no light so you can't see your animals at night, or easily tell if the light is working.

All heat bulbs should be attached to a thermostat to prevent over heating (i.e. cooking!!) of you animals. Also, because they are emitting HEAT, animals can burn themselves if they touch/wrap around the bulb. (If you don' t believe this, try touching a 100 watt bulb after it's been on for just a couple of minutes! Not recommended!). For this reason, all heat bulbs should have a mesh screen covering which prevents the animal from contact with the globe. Make sure the mesh is not too close to the bulb, otherwise the mesh itself will also heat up, and could cause burns.

Ultraviolet (UV) Lighting:

Ultraviolet (or UV) light is represented in the EMR spectrum (light) as light with a wavelength of 200nm to 400nm. The UV spectrum is broken up into three parts: UVA, UVB and UVC, all of which are present in natural sunlight:

UV light is required by most animals and plants, and each of the three types of UV light are used for different purposes by reptiles and amphibians:

UVA is in the visible range, and is responsible for normal behaviors such as feeding, diurnal movement, mating and others.
UVB is a non-visible wavelength, and allows the synthesis of vitamin D3, which helps to process calcium and prevent metabolic bone disease. Most snakes DO NOT have high UVB requirements, as they get the vitamin D3 from the liver of their prey. Amphibians also do not seem to require UVB lighting. Diamond pythons, Lizards and turtles REQUIRE UVB lighting, otherwise they will develop metabolic bone disease and turtles can also have soft shell problems.
UVC is also a non-visible wavelength, and does not seem to be required by reptiles, although little is know about it at this stage. UVC is often used as the light source for UV sterilisation for killing bacteria, and at high levels of exposure can be harmful to most animals.

UV light is usually added to the enclosure by the addition of a tube that emits either UVA, UVB, or both.

Tube manufacturers recommended that you replace the tube at least every 12 months (sometimes sooner), as UV output decreases with time, and after 12 months the tube is no different from a standard fluorescent tube in terms of UV output. A good way to ensure that you change your bulb regularly is to write the date it was first used on the end of the tube in a permanent marker. This way it doesn't matter if you move the tube, change setups or whatever, as you'll always know when it's time to change the tube.

UV wavelengths are filtered by glass and plastic, so it is important that you have the UV bulb within the enclosure, not shining through the top or side. A sheet of glass filters out 95% of UVB light. Aluminium fly screen filters out 30% of UVB light, so it's also important to have wide mesh screens over the tubes if you need to protect the animal from burns. In a lizard enclosure, you might get away with not covering the bulb, especially if the lizards you're keeping aren't good climbers. If you're housing a snake, a wide mesh screen such as 'mouse wire' is best, which should allow at least 95% of the light through.

UV light levels also decrease as you move away from the bulb's surface, so it's important that you position the bulb and your cage's furnishings so that your animals can get as close as possible to the bulb - a basking spot 300mm (12") from the bulb is ideal.

Given the variation in prices of the tube, a number of comparisons have been made. Following are the summary results of two studies which comparable UV output of commonly used tubes.

Test results from SA Fish and Reptile:

Conducted by UVP - Ultra Violet Products
Registered Laboratory, South Australia

Test results of UVA and UVB output of UV emitting tubes with output measured at various distances from the tube surface, and also on tubes of different ages and dual tube combinations. The following UV tubes were tested:

- Philips TL
- NEC Blacklight T10
- Sylvania Reptistar
- Zoo Med Reptisun 5.0
- Zoo Med Reptisun 2.0
- ESU Desert 7%
- ESU Super Day Light
- Dura-lite Power Twist

Thanks to SA Fish And Reptiles who arranged for the tests to occur, and who kindly gave permission to publish the results here, and Ultimate Reptile Supplies who pointed us in the direction of these results.

Comparison of UVA output from fluorescent tubes used in Herpetology.

The tests were conducted by placing a UVA meter at different distances from the tubes face (0 inches to 36 inches). The output is measured in microwatts per cm2 (µW/cm2).

Outside on a sunny day, UVA readings are around 2690 µW/cm2.

UVA	Phillips TL *see note*	NEC Black light T10	Sylvania Repti-star	Zoo-Med Reptisun 5.0	Esu desert 7%	Dura-lite power twist	Zoo-med Reptisun 2.0	Esu Super Day Light
Tube face	300	4820	600	N/A	1550	220	54	140
3 inches	70	960	100	110	300	50	100	30
6 inches	40	550	60	60	180	30	50	20
12 inches	20	270	30	30	90	20	20	10
18 inches	10	160	20	20	50	10	10	-
24 inches	5	100	10	10	30	10	10	-
30 inches	-	70	10	10	20	5	5	-
36 inches	-	50	-	-	15	-	-	-

NOTE: The Philips TL is a medical grade tube and should not be closer than 6 inches from any reptile as it will cause eye damage!!

Comparison of UVB output from fluorescent tubes used in Herpetology.

The tests were conducted by placing a UVB meter at different distances from the tubes face (0 inches to 36 inches). The output is measured in microwatts per cm2 (µW/cm2).

Outside on a sunny day, UVB readings are around 250 µW/cm2.

UVB	Phillips TL *see note*	NEC Black light T10	Sylvania Repti-star	Zoo-Med Reptisun 5.0	Esu desert 7%	Dura-lite power twist	Zoo-med Reptisun 2.0	Esu Super Day Light
Tube face	1780	250	160	85	80	20	45	30
3 inches	430	50	30	20	20	-	10	5
6 inches	250	30	15	10	10	-	-	-
12 inches	120	10	5	10	-	-	-	-
18 inches	70	5	-	-	-	-	-	-
24 inches	40	-	-	-	-	-	-	-
30 inches	30	-	-	-	-	-	-	-
36 inches	20	-	-	-	-	-	-	-

NOTE: The Philips TL is a medical grade tube and should not be closer than 6 inches from any reptile as it will cause eye damage!!

Comparison of UVA output from fluorescent tubes used in Herpetology. Supplementary tests

The tests were conducted by placing a UVA meter at different distances from the tubes face (0 inches to 36 inches). The output is measured in microwatts per cm2 (µW/cm2).

Outside on a sunny day, UVA readings are around 2690 µW/cm2.

These are supplementary test done on:
a) Paired tubes - i.e. Two tube running at once (Zoo-med Reptisun 2.0 and 5.0; ESU Desert 7% and Super Day light)
b) Tubes through glass, showing UV loss due to glass (Zoo-med Reptisun)
c) 12 month old tubes (Dura lite Power twist; Zoo-med Reptisun 5.0)

UVA	Zoo-med Reptisun 2.0 and Reptisun 5.0 pair	ESU Desert 7% and Super day light pair	Zoo-med Reptisun 5.0 through 6mm glass	Dura-lit Power twist 12 mth old	Zoo-med Reptisun 5.0 12 mth old
Tube face	N/A	N/A	270	130	300
3 inches	170	240	60	30	70
6 inches	100	180	40	10	40
12 inches	50	100	20	10	20
18 inches	20	60	10	-	10
24 inches	20	55	-	-	10
30 inches	10	30	-	-	-
36 inches	10	20	-	-	-

Comparison of UVB output from fluorescent tubes used in Herpetology. Supplementary tests

The tests were conducted by placing a UVB meter at different distances from the tubes face (0 inches to 36 inches). The output is measured in microwatts per cm2 (µW/cm2).

Outside on a sunny day, UVB readings are around 250 µW/cm2.

These are supplementary test done on:
a) Paired tubes - i.e. Two tube running at once (Zoo-med Reptisun 2.0 and 5.0; ESU Desert 7% and Super Day light)
b) Tubes through glass, showing UV loss due to glass (Zoo-med Reptisun)
c) 12 month old tubes (Dura lite Power twist; Zoo-med Reptisun 5.0)

UVB	Zoo-med Reptisun 2.0 and Reptisun 5.0 pair	ESU Desert 7% and Super day light pair	Zoo-med Reptisun 5.0 through 6mm glass	Dura-lit Power twist 12 mth old	Zoo-med Reptisun 5.0 12 mth old
Tube face	N/A	N/A	10	10	50
3 inches	25	15	-	-	10
6 inches	10	10	-	-	10
12 inches	5	-	-	-	-
18 inches	-	-	-	-	-
24 inches	-	-	-	-	-
30 inches	-	-	-	-	-
36 inches	-	-	-	-	-

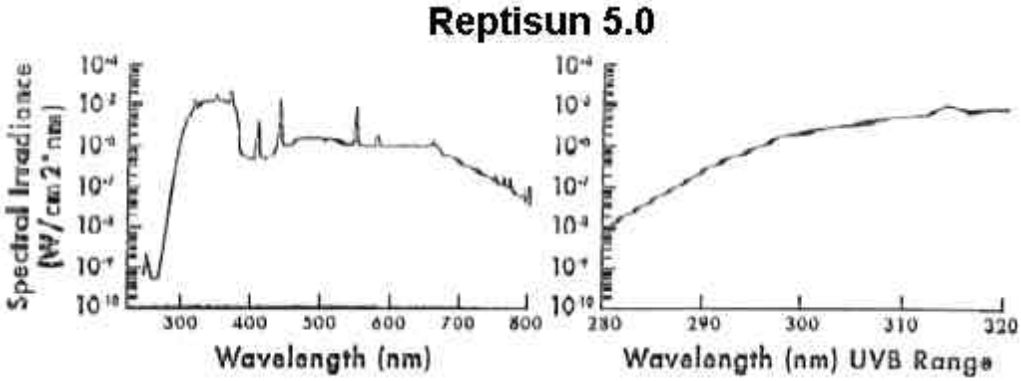
Test results from Independent Boston University School of Medicine:

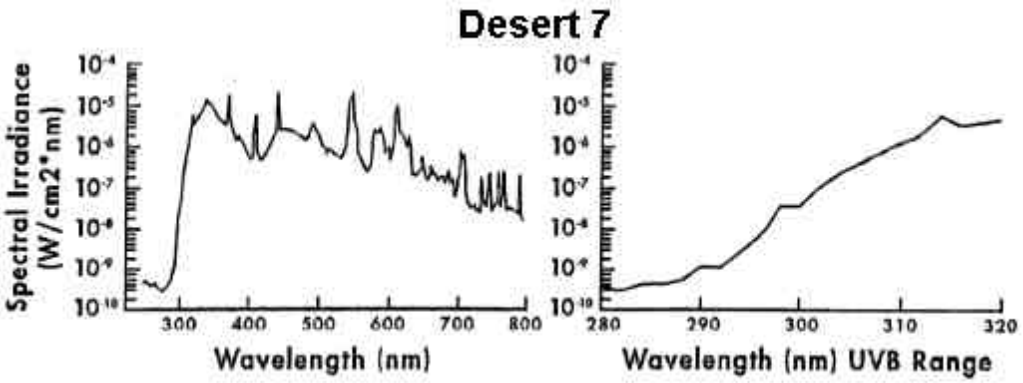
UVB fluorescent tube test results (Supplied by Zoo-Med).

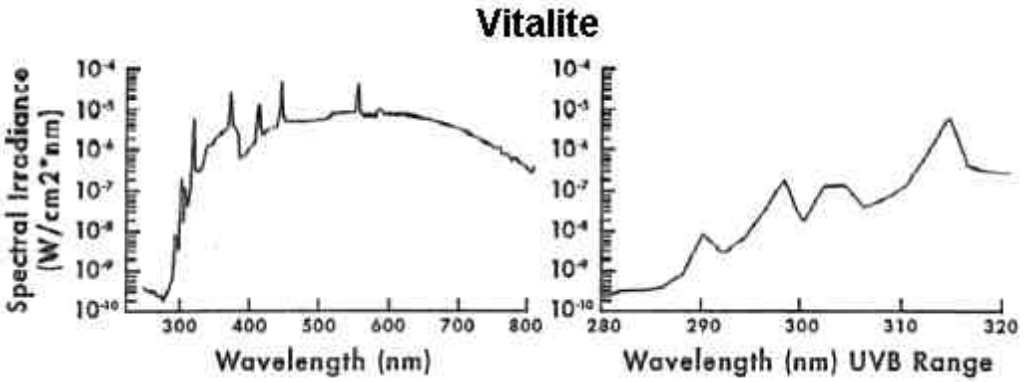
Test results of the spectral irradiance of UV emitting tubes over the full spectral range (100 - 800nm) as well as specifically over the UV spectral range (280 - 320nm). The following UV tubes were tested:

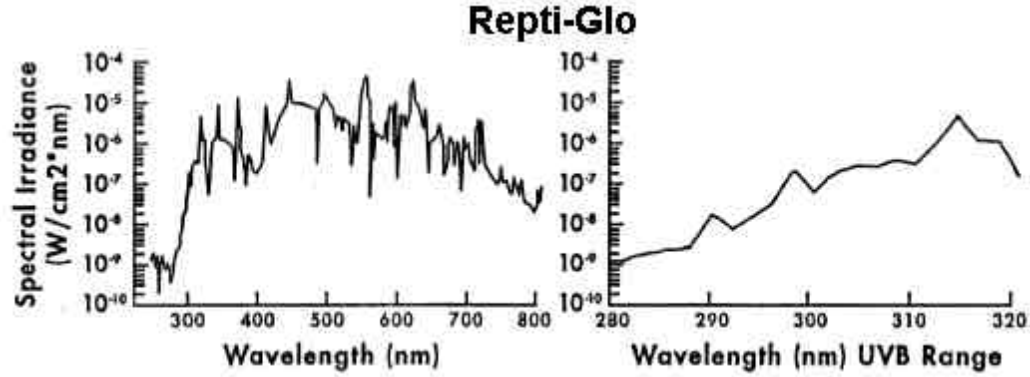
- Reptisun 5.0
- ESU Desert 7
- Vitalite
- Hagen Repti-Glo
- GE Coolwhite

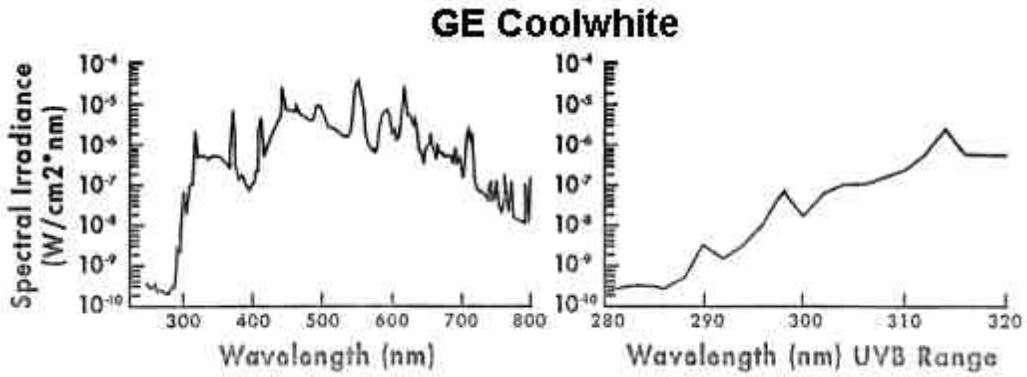
Here are the spectral analyses done on a variety of fluorescent tubes done independently by the Boston University School of Medicine. While the tests were completed independently, the results shown here were supplied by Zoo Med, who make the ReptiSun UV tubes. The actual report has not been cited.











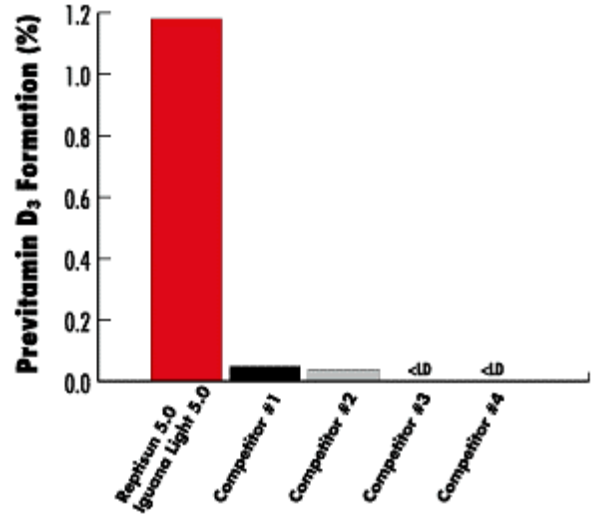


Figure 1 & Table 1
Conversion of 7-DHC to preD3 induced by different light sources. <LD denotes conversion below the limit of detection.

You can see the conclusions made by Zoo-Med at their website:
Reptile fluorescent tube test results from the Boston University School of Medicine
Test results from comparison of leading reptile fluorescent tubes. On the Zoo Med website.
"Recent tests at the Boston University School of Medicine show that Zoo Med's Reptisun 5.0 UVB and Iguana Light 5.0 UVB bulbs induce 7-DHC conversion to Previtamin D3 at a rate 23 times greater than the next leading UVB reptile bulb!"

Links to other UV lighting info:

Arcadia D3 Reptile Lamp
http://www.arcadia-uk.com/d3lamp.htm
Information on the Arcadia D3 Reptiles Lamp. Company hype - "5% UVB, Full-spectrum lamp, excellent colours."

Reptistar (Sylvania) Reptile lighting
http://www.aquanet.de/sylvania/English/repti.htm
Information on the Sylvania Reptistar fluro tubes. Company hype - "Promotes Vitamin D3 and thus increases your reptile's health, growth and well-being through a high content of UVB (up to 5%) and UVA (up to 30%). Improves the natural colours of your reptiles by a 6500 Kelvin full spectrum light with a high colour-rendering index (group 1A)."

Reptisun Fluorescent Tubes (from Zoo - Med)
http://www.zoomed.com/html/fluorescent_lamps.html
Information on the Reptisun 5.0 and Reptisun 2.0 fluorescent tubes. Company hype - "Reptisun 5.0 contains the highest amounts of both UVB and UVA wavelengths (according to an independent laboratory spectral analysis), wavelength penetrates a full 10-12" from the bulb's surface, made from pure quartz glass sleeves. The bulb's UVA/UVB wavelength remains effective for 1 to 1-1/2 years. (Replace bulbs yearly).

Questions and answers about full spectrum lights (from the Hagen website)
http://www.hagen.com/canada/english/reptiles/info_sheet.cfm?CAT=31&INFO=34
Information on reptile lighting. Includes: What are "full spectrum" lights?; What is important about UVB?; How is ultraviolet light measured and compared?; What is "black light"?; What is a sunlamp?; What kind of light do infrared and "neodymium" bulbs produce?; Can too much ultraviolet radiation be harmful?; How close do reptiles have to be to a full spectrum fluorescent lamp to gain any benefit?; How long do effective emissions last?; Can't I just put my reptile outside or in a window when it is sunny?

Discrepancies associated with UVA and UVB meters
http://www.hagen.com/canada/english/reptiles/info_sheet.cfm?CAT=31&INFO=35
Comparison of UVA and UVB irradiance measurements made on solar simulators using spectroradiometric and broadband meter instrumentation indicates that wide discrepancies can occur between the two methods of measurement. With a xenon arc lamp filtered as a solar simulator producing UVA and UVB radiation, the meter can either over or under estimate the irradiance of the source when different cut-off filters are used. The most severe discrepancies occurred with UVB meters although the UVA meters also had significant errors.