UVC Basics

Ultraviolet light belongs in the electromagnetic spectrum with a wavelength in the range of 200 to 400 nm (nanometers), which is shorter than that of visible light, but longer than X-rays. All UV rays and bands are invisible to the human eye.

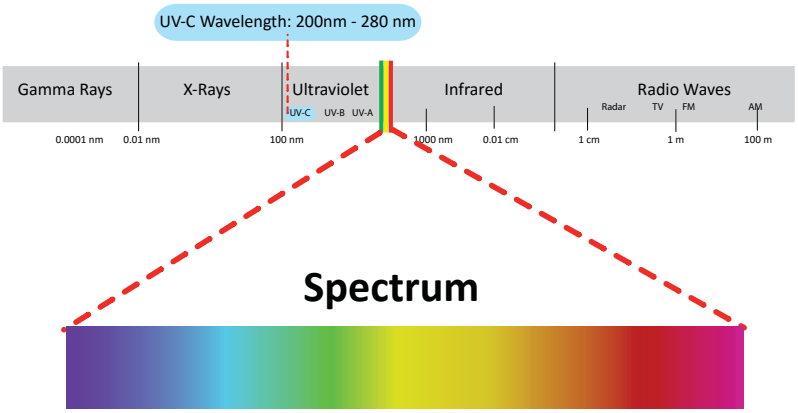
The UV spectrum can be subdivided into the following bands:

UV-A (long-wave; 400 - 315 nm):
used for black lights, skin tanning, ink/resin curing.

UV-B (medium-wave; 315 - 280 nm):
used for psoriasis therapy, can cause sunburn, skin cancer.

UV-C (short-wave; 280 - 200nm):
most effective for germicidal disinfection.

UV-V (vacuum UV, below 200 nm):
can produce ozone in the air.



All wavelengths of UV light are emitted by the sun, but only the longer wavelengths, UV-A and UV-B reach the earth.

The UV-C rays, which are the shortest wavelength, but highest energy is blocked by the ozone layer.

Inactivating Microorganisms

Since UV-C rays are blocked by the ozone layer, microorganisms have not developed a natural defense against UV-C energy. When the DNA of a microorganism absorbs UV-C energy, molecular instability occurs, resulting in the disruption of the DNA sequence. This renders the cell unable to grow or reproduce. Without the ability to reproduce, the cell cannot infect, and it rapidly dies.

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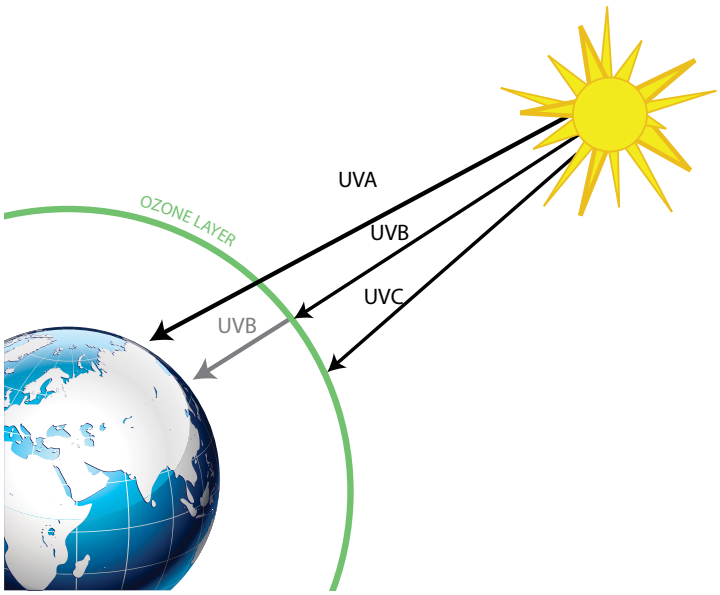
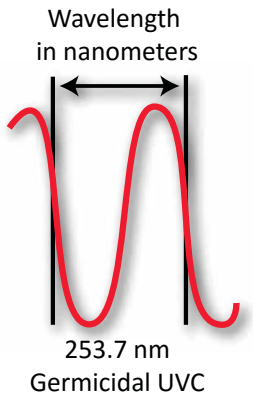
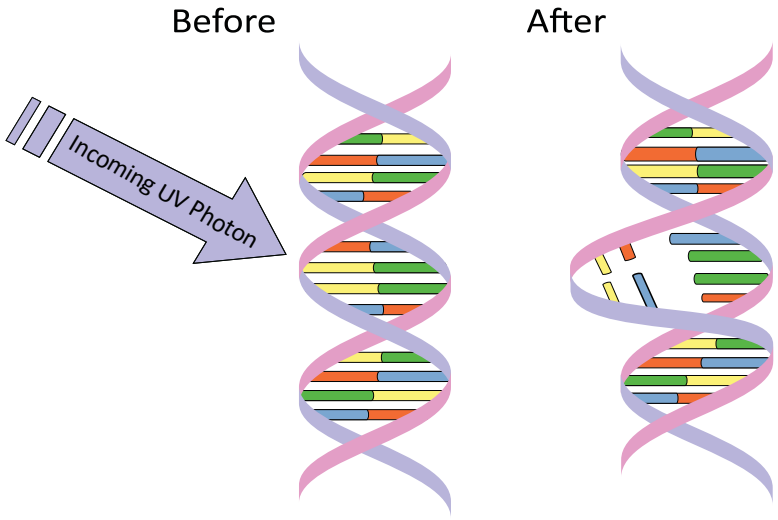
The application of UV-C energy to inactivate microorganisms is known as Germicidal Irradiation or UVGI. It has been used for this purpose since the early 1900s. Artificial UV-C energy is produced in germicidal ultraviolet lamps which produce UV radiation by ionizing low pressure mercury vapor. These lamps are like typical fluorescent household lamps, but do not have the phosphorescent coating which imparts the soft white light. Most commercial UV-C lamps are low pressure mercury lamps that emit UV energy at 253.7 nm, which is an ideal wavelength for disrupting the DNA of microorganisms.





UV-C lamps and devices are being increasingly used all over the world in various configurations and applications to disinfect water, air and surfaces.

The following are incident energies of germicidal ultraviolet radiation at 253.7 nanometers necessary to inhibit colony formation in microorganisms (90%) and for complete destruction:



Organisms:

Energy dosage of Ultraviolet radiation in µWs/cm2 needed for kill factor

Bacteria	90%	100%
Bacillus anthracis - Anthrax	4,520	8,700
Bacillus anthracis spores - Anthrax spores	24,320	46,200
Bacillus magaterium sp. (spores)	2,730	5,200
Bacillus magaterium sp. (veg.)	1,300	2,500
Bacillus paratyphusus	3,200	6,100
Bacillus subtilis spores	11,600	22,000
Bacillus subtilis	5,800	11,000
Clostridium tetani	13,000	22,000
Corynebacterium diphtheriae	3,370	6,510
Ebertelia typhosa	2,140	4,100
Escherichia coli	3,000	6,600
Leptospiracanicola - infectious Jaundice	3,150	6,000
Micrococcus candidus	6,050	12,300
Micrococcus sphaeroides	1,000	15,400
Mycobacterium tuberculosis	6,200	10,000
Neisseria catarrhalis	4,400	8,500
Phytomonas tumefaciens	4,400	8,000
Proteus vulgaris	3,000	6,600
Pseudomonas aeruginosa	5,500	10,500
Pseudomonas fluorescens	3,500	6,600
Salmonella enteritidis	4,000	7,600
Salmonela paratyphi - Enteric fever	3,200	6,100
Salmonella typhosa - Typhoid fever	2,150	4,100
Salmonella typhimurium	8,000	15,200
Sarcina lutea	19,700	26,400
Serratia marcescens	2,420	6,160
Shigella dyseteriae - Dysentery	2,200	4,200
Shigella flexneri - Dysentery	1,700	3,400
Shigella paradysenteriae	1,680	3,400
Spirillum rubrum	4,400	6,160
Staphylococcus albus	1,840	5,720
Staphylococcus aerius	2,600	6,600
Staphylococcus hemolyticus	2,160	5,500
Staphylococcus lactis	6,150	8,800
Streptococcus viridans	2,000	3,800
Vibrio comma - Cholera	3,375	6,500

Organisms:

	Energy dosage of Ultraviolet radiation in µWs/cm2 needed for kill factor	
Molds	90%	100%
Aspergillius flavus	60,000	99,000
Aspergillius glaucus	44,000	88,000
Aspergillius niger	132,000	330,000
Mucor racemosus A	17,000	35,200
Mucor racemosus B	17,000	35,200
Oospora lactis	5,000	11,000
Penicillium expansum	13,000	22,000
Penicillium roqueforti	13,000	26,400
Penicillium digitatum	44,000	88,000
Rhisopus nigricans	111,000	220,000
Protozoa	90%	100%
Chlorella Vulgaris	13,000	22,000
Nematode Eggs	45,000	92,000
Paramecium	11,000	20,000
Virus	90%	100%
Bacteriopfage - E. Coli	2,600	6,600
Infectious Hepatitis	5,800	8,000
Influenza	3,400	6,600
Poliovirus - Poliomyelitis	3,150	6,60
T obacco mosaic	240,000	440,000
Yeast	90%	100%
Brewers yeast	3,300	6,600
Common yeast cake	6,000	13,200
Saccharomyces carevisiae	6,000	13,200
Saccharomyces ellipsoideus	6,000	13,200
Saccharomyces spores	8,000	17,600

Please note that many variables take place in a real-world environment that make actual calculating of the UV dosage very difficult (air flow, humidity, distance of microorganism to the UV light and time). However, it is proven that UV light will kill any DNA-based organism given enough UV dosage and that UV light breaks down DNA on a cumulative basis. Therefore, as air circulates through the ductwork of an HVAC system containing an UV light, the UV light continuously cleanses the air. If a microorganism is not effectively eradicated on the first pass through the ductwork, the UV light will continue to break its DNA down on subsequent passes. In addition, microorganisms typically do not sit in a static environment in HVAC systems except on coils which can be exposed to our lights also. In fact, microorganisms breed microorganisms if not controlled. The UV light helps to reduce incidences of inhaled pathogens for persons who reside or work in indoor environments.