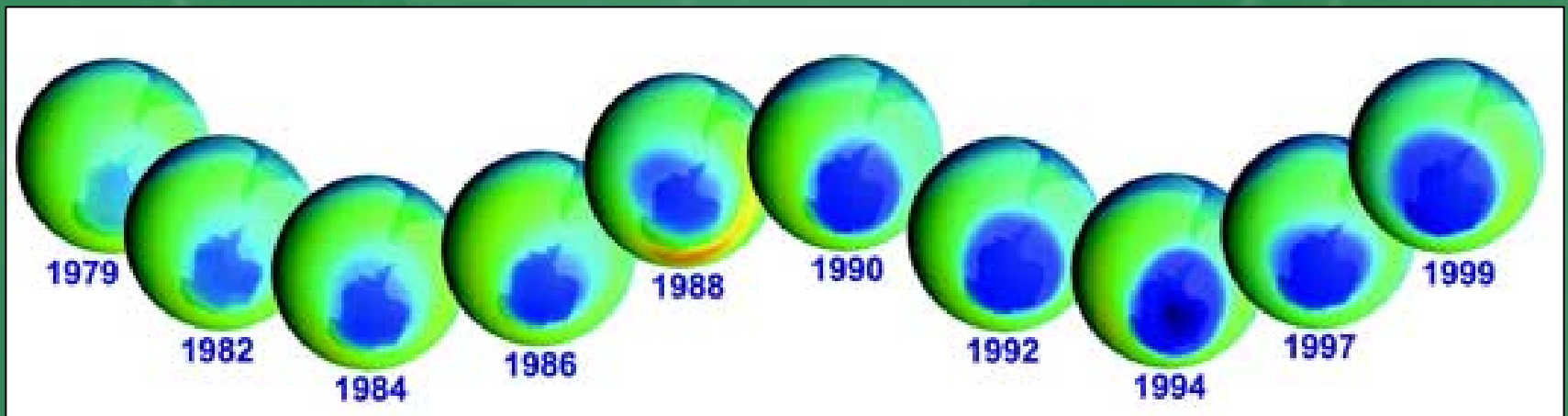


# Eye Diseases Associated with Ultraviolet Light Exposure

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# Introduction

- Ultraviolet light is a form of electromagnetic radiation which has a wavelength of 100nm to 400 nm.
- Much of the ultraviolet light reaching the Earth from the sun is absorbed by the ozone layer in the stratosphere.
- The depletion of the ozone layer by manmade compounds may increase the amount of exposure to UV by humans on the ground and increase the risk of some specific eye diseases.



*Depletion of Ozone*

# Historical Perspectives

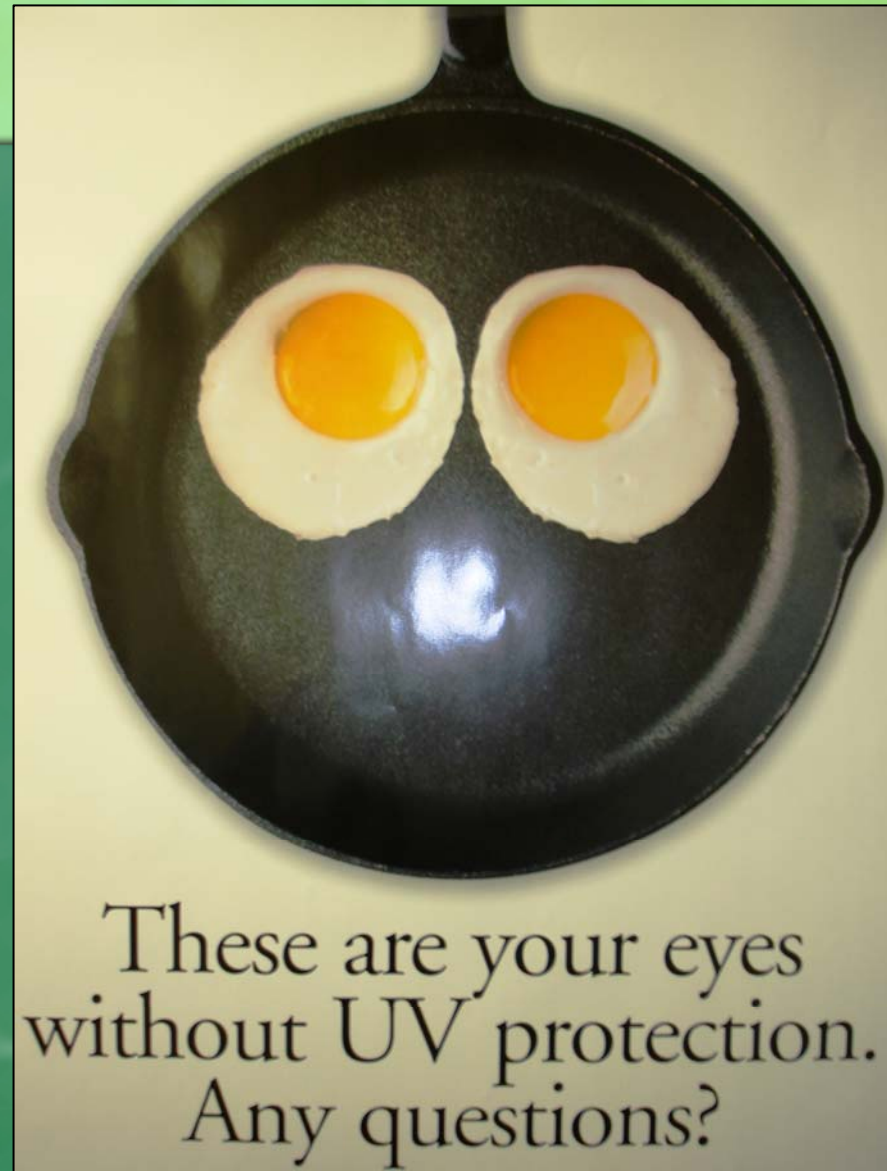


- Chloroflourocarbons (CFCs) are chemicals first formulated in 1928. During the 1950's they became common as coolants for refrigerators and air conditioners.
- They are also used as aerosol propellants, to manufacture foam, as an industrial cleaning agent, and in the manufacture of Styrofoam products.
- Two researchers, Mario Molina and F. Sherwood Rowland discovered in 1974 through their research that CFCs which are stable at ground level become unstable at high altitudes and react with and damage the stratospheric ozone layer.
- Based on these scientific discoveries the United Nations helped to develop the Montreal Protocol in 1987 limiting the production of these harmful industrial gasses.
- The Montreal Protocol was later amended so that these gasses would be totally banned after 1996.
- Despite these moves to improve the situation, the ozone layer is not expected to be fully restored for approximately 100 years.



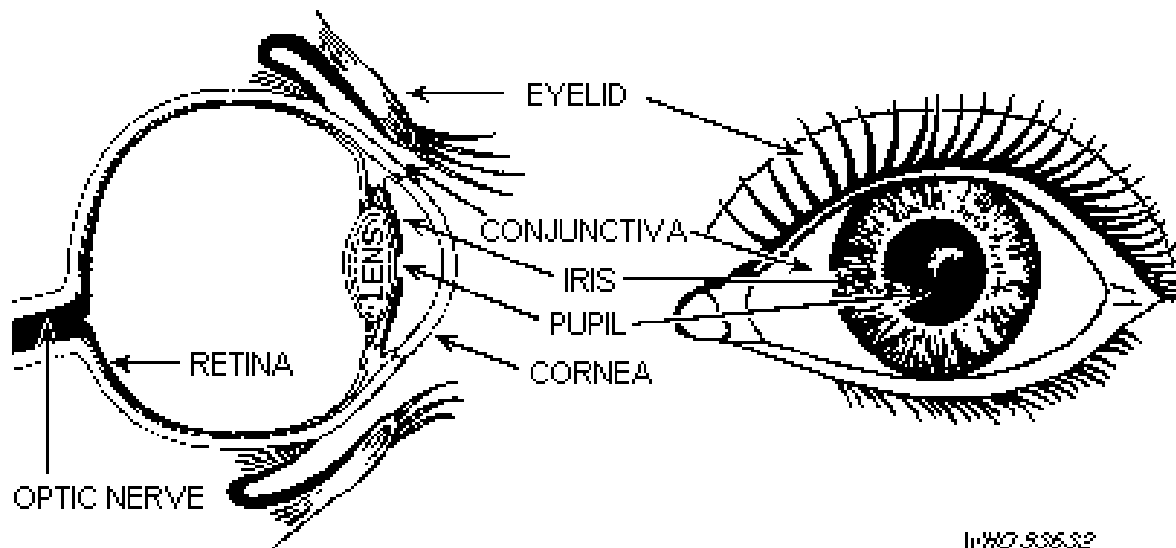
# Description of Health Related Issues

- Ultraviolet light can be subdivided into three categories based on wavelength. UVA (315 - 400 nm), UVB (280 - 315 nm) and UVC (100 - 280 nm).
- UVC is almost completely absorbed by oxygen and ozone in the atmosphere and even with reduced ozone levels still is fully absorbed and thus poses no threat to living things at ground level.
- With reduced ozone levels, UVB at ground level would increase.



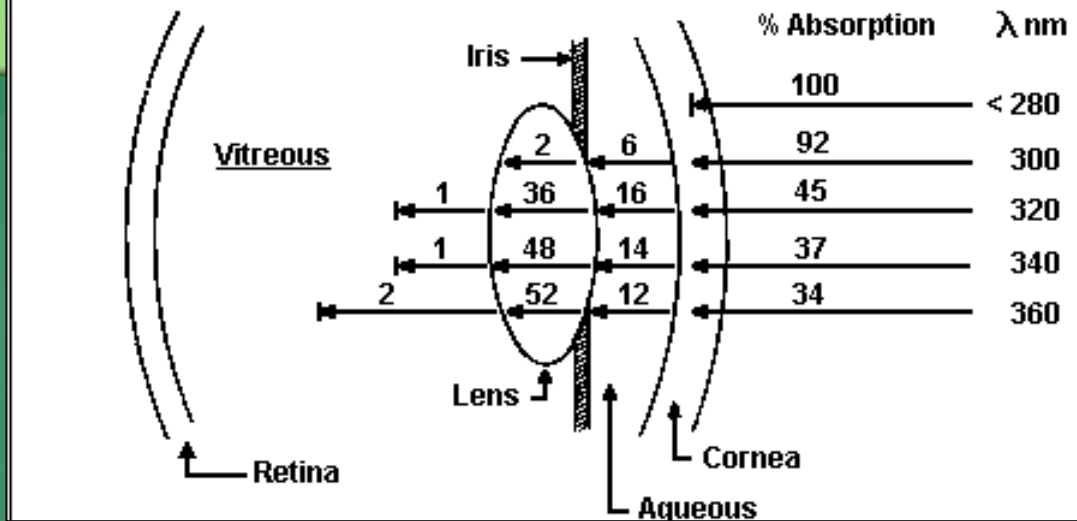
- The eye does have some natural protection from UV radiation.
- These include ocular adnexa such as the eyebrows, orbital rim, eyelashes, eyelids and squint/blink response to bright light.
- Basically, UV light can be absorbed by four structures in the human eye; the cornea, conjunctiva, lens and retina.

**Figure 10.1 Schematic of the human eye**



# Cornea:

Figure 10.2 Schematic of absorption of UV in the ocular media. Values represent the percent of UV incident upon the corneal surface that are absorbed by various layers. From Sliney & Volbarscht (1980), based on data from Boettner & Volter (1962)



# Photokeratitis:

- Also known as snow blindness, eclipse blindness or welder's flash occur between one half to twenty four hours after prolonged or excessive exposure to UVA and UVB particularly in highly reflective environments such as in snow or on the water.
- This over exposure causes a superficial punctate keratopathy which is self healing and resolves within 8 to 12 hours.



## *Pterygium*

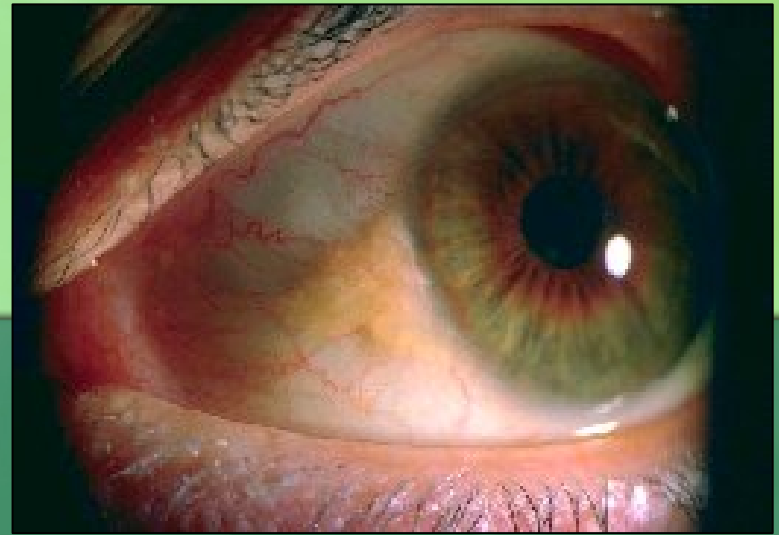
- It is theorized that this chronic irritation causes inflammation increasing the overgrowth of conjunctival tissue.
- The formation of pterygium is often associated with outdoor occupations such as farming, fishing and construction.
- Another possible risk factor for pterygium formation is particulate injury such as from windblown dust, sand, ice and snow.
- This might help to explain the apparent higher prevalence of pterygium among diverse groups such as Australian Aborigines, Pacific Islanders, and Eskimos.
- No incidence rates are available for pterygium, however prevalence rates are between 3% - 10 % in general population worldwide, with onset most common between the ages of 20-30 years of age.



## *Climatic Droplet Keratopathy*

- A degenerative condition of the cornea characterized by the deposition of protein material which looks like “small droplets” in the superficial corneal stroma.
- CDK appears to be more prevalent in areas of persistent snowfall such as Labrador, Greenland, Siberia and Mongolia, and in dry sandy desert areas such as Saudi Arabia, Iran, and Australia.
- In Labrador, CDK accounted for 25% of the bilateral blindness, and 19% of all blind eyes.
- Similar to pterygium, microtrauma via windblown dust, sand or ice may also play a role in the formation of the disease.

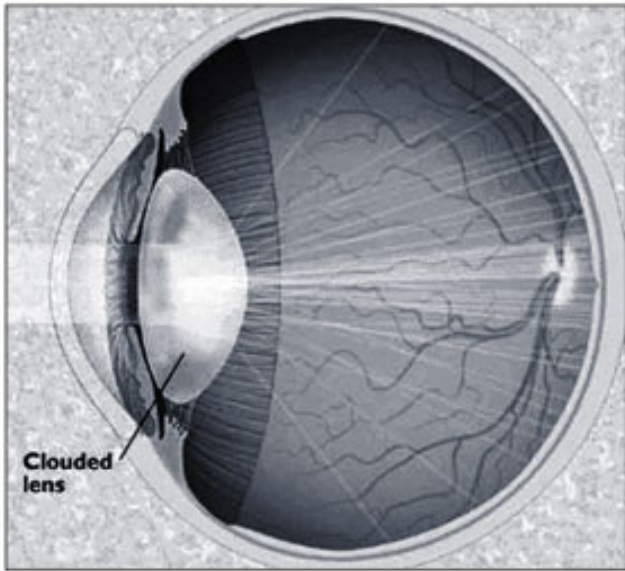
# Conjunctiva:



## *Pinguecula*

- Pingueculae are localized yellowish-green fleshy benign lesions that are near the limbus on either the nasal or temporal bulbar conjunctiva.
- They are similar in appearance to pterygia but do not extend onto the cornea.
- Similar to pterygia, UV exposure and microtrauma are prominent risk factors.
- Little epidemiological data is available, however a study of Chesapeake Bay fisherman shows an odds ratio of 3.06 for those with the highest exposure to annual UVB.

# Lens:

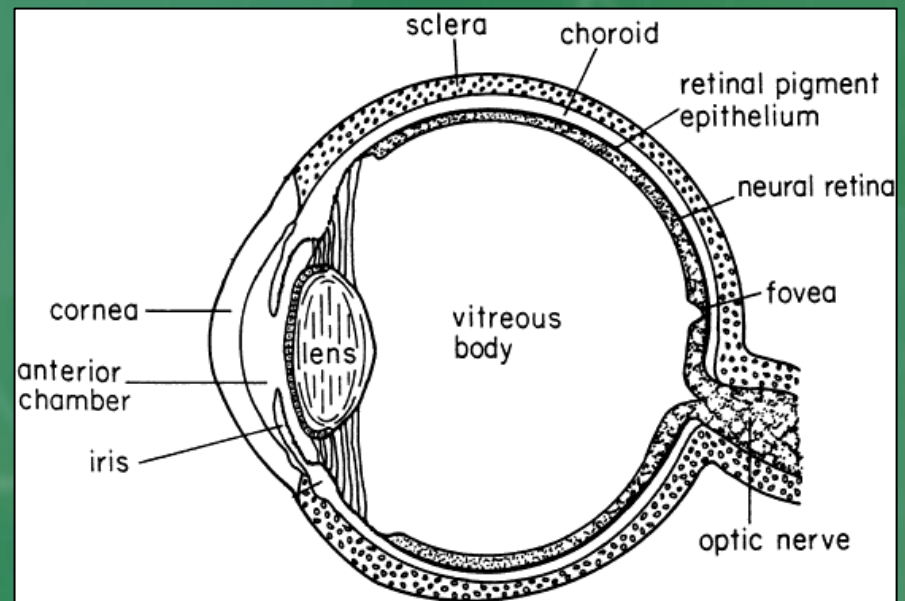


**Fig 1.** Nuclear cataract clouds lens.

- Cataracts are defined as an opacity of the lens which obstructs vision.
- The estimate in 1995 was that cataracts accounted for nearly half of the 38 million bilaterally blind people, and in 2000, about 25 million of the 50 million blind.
- In 1998, the Salisbury Eye Evaluation Project found an association between UVB exposure and cataract formation. The odds ratio was found to be 1.10, 95% confidence interval, 1.02 - 1.20.

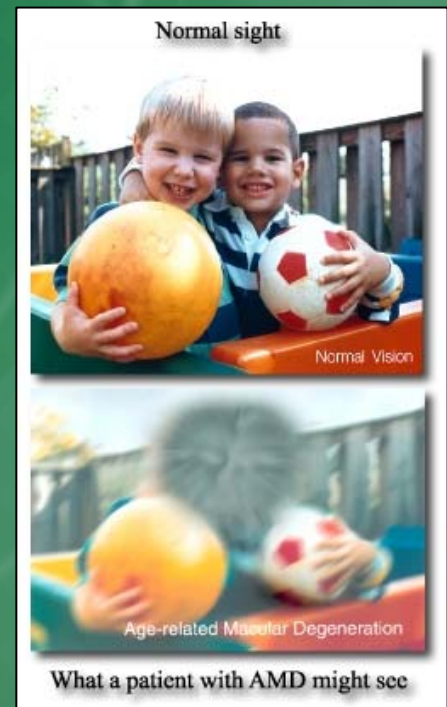
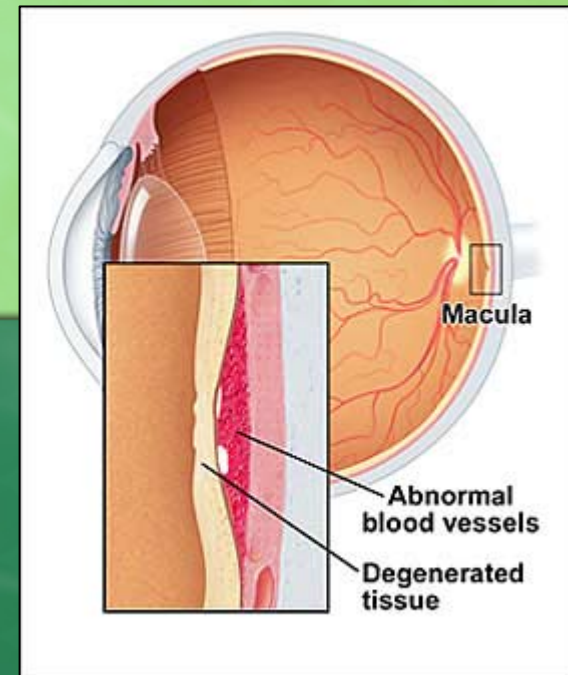
# Cataracts

- A model of risk of cortical cataract in the U.S. population due to increased UV-B exposure from an ozone depletion of 5-20% showed that by 2050, the prevalence of cortical cataract will increase above expected levels by 1.3-6.9%.
- This would mean that an additional 167,000 to 830,000 cases will occur by 2050. Using a 2003 cost of cataract surgery of \$3370 per cataract surgery, the increased health care cost in the U.S. would be between \$563 million to \$2.8 billion dollars.
- Source: Amy J. Epidemiology 2005; 162(11): 1080-1088



# Retina:

- Age related macular degeneration (ARMD) is one of the leading causes of blindness in the industrial world.
- Visual loss in ARMD occurs from degenerative changes in retinal pigment epithelial cells due to direct causes or secondary to vascular change in retinal and sub-retinal tissue.
- It has been suggested that UV exposure may be a factor in the development of ARMD, but in phakic adults, only small amounts of UVA and UVB actually reach the retina, since they are strongly absorbed by the cornea and lens.
- The population based POLA of 2584 residents of Site, France in 2001 found no association between exposure to bright sunlight and ARMD.
- The possible problem with UV exposure and ARMD would be for those individuals undergoing cataract surgery without an intraocular lens implant which blocks UV.
- This problem is most likely to occur in third world countries, where accessibility to UV absorbing intraocular lens implants may be limited.



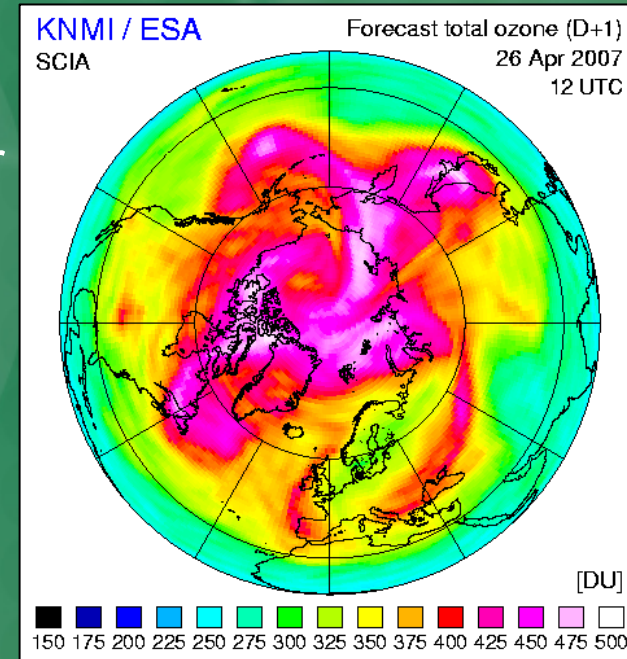
# Current Status

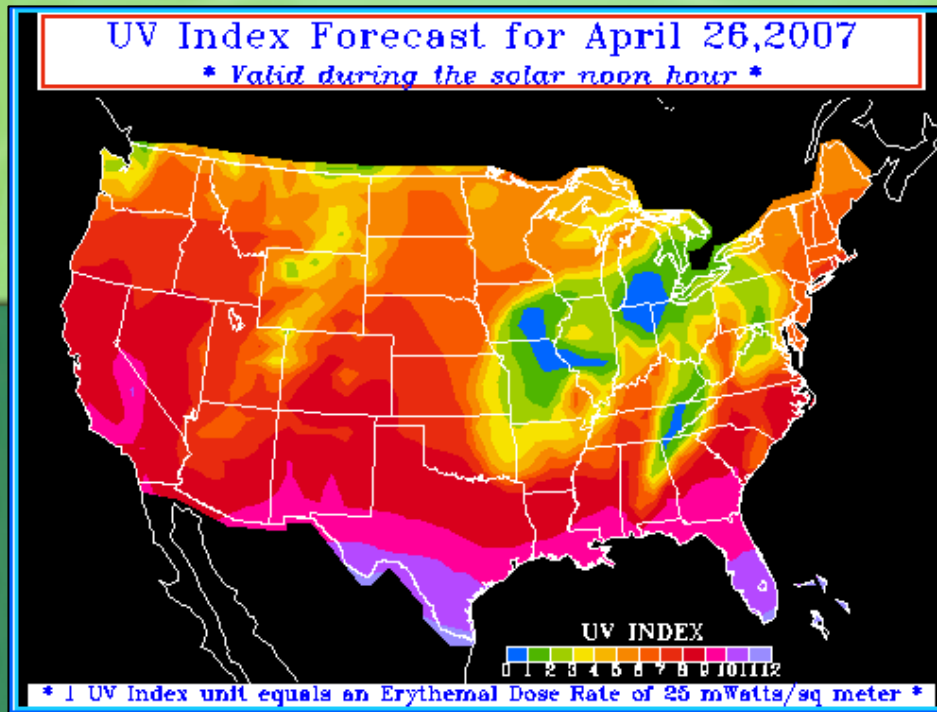


- The United Nations came together to create the Montreal Protocol on Substances that Deplete the Ozone Layer in 1990 to mandate the reduction and gradual elimination of all ozone-depleting CFCs and HCFCs.
- In the U.S. the Clean Air Act was amended in 1990 to include Title VI to help protect the stratospheric ozone layer.
- Estimates are that it will take approximately 100 years for the ozone layer to restore itself.
- The areas of the world most affected by UV exposure related eye diseases are near the equator where the sun's influence is greatest.

# Possible Prevention Measures

- InterSun, the Global UV Project, was created to reduce the burden of disease resulting from exposure to UV radiation.
- This project has 4 basic sections. First, it provides personal sun protection information for individuals.
- Second, it developed the UV index in 1995, a measure of the UV level at the Earth's surface to raise public awareness of UV dangers.
- Third, it promotes UV protection through education programs to the youth of the world, and fourth it promotes consideration of UV protection in the formation of public policy and environmental management.
- The U.S. Environmental Protection Agency has formulated the "Sun Wise Program" as a way of promoting UV protection to the public.



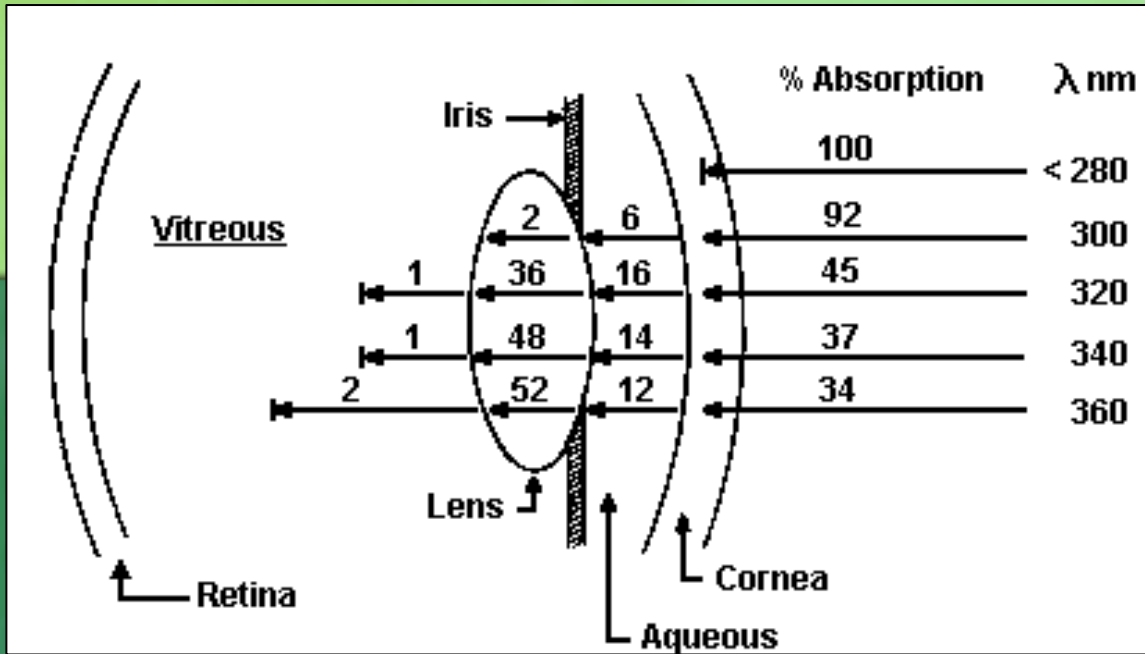


- It also uses the UV index as a way of quantifying UV exposure at ground level.
- The Sun Wise program has suggested 8 Sun Action Safety Steps for the public.
- They are to limit midday sun exposure, to seek shade, to wear a hat, cover up with full-length clothing, wear sunglasses that absorb 99-100% of UVA and UVB, always use sunscreen, avoid sunlamps and tanning parlors, and watch the UV Index.

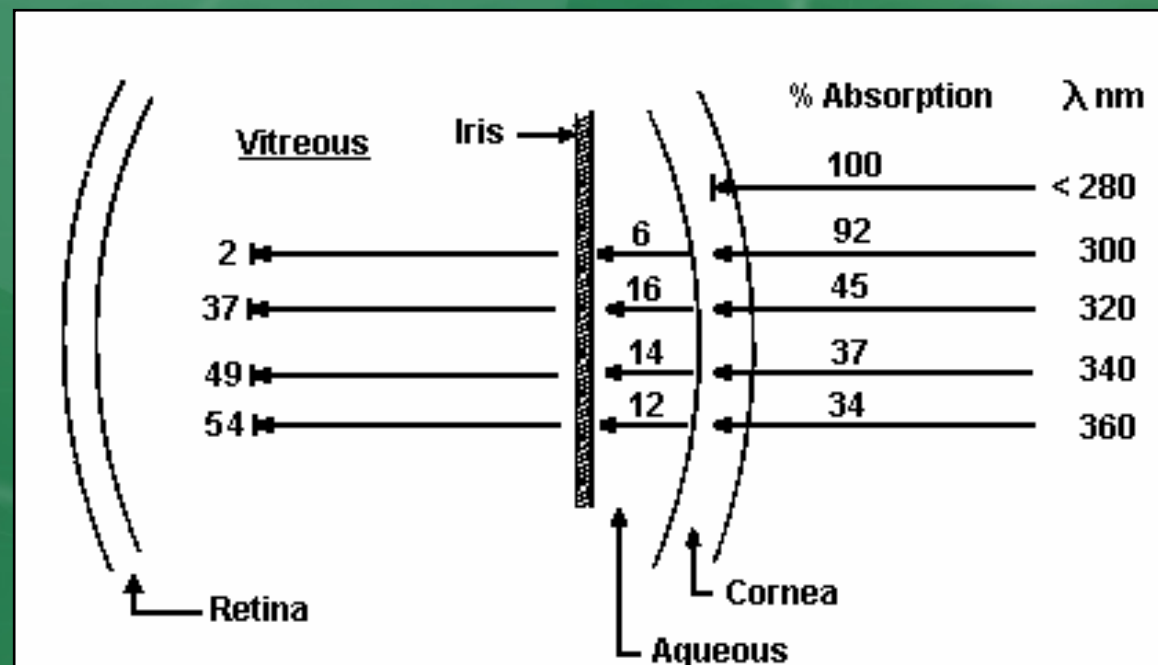
# Political Implications and Public Impact of the Problem

- Worldwide, some 12 to 15 million people are blinded by cataracts annually, of which up to 20% may be caused or enhanced by sun exposure.
- This means that up to 3 million people per year develop cataracts as a result of ultraviolet exposure.
- The cost of 3 million cataract surgeries worldwide is staggering from both a monetary and a man power point of view.
- And if either no intraocular lens or a non-UV absorbing lens is used during surgery, the person now becomes a target for future retinal damage due to UV reaching his macula and increasing his risk of macular degeneration.

Schematic of absorption of UV in ocular media. Values represent the percent of UV incident upon the corneal surface that are absorbed by various layers.



With Lens



Without Lens

# What Remains to Be Done

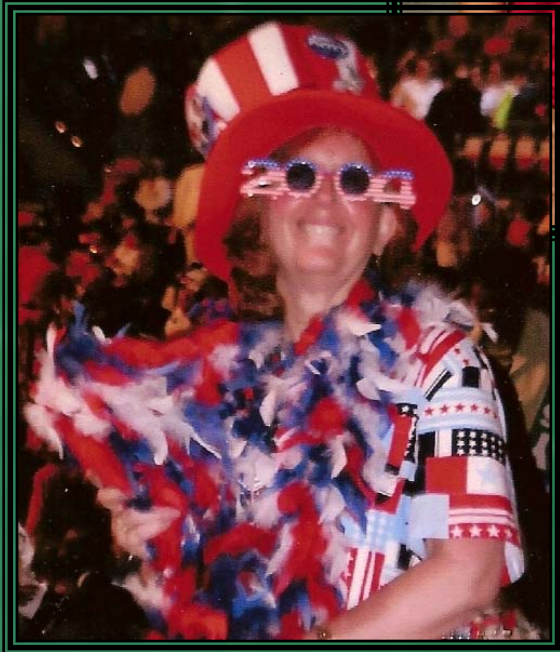
- Further education of the public as to the danger of UV radiation need to take place.
- My experience with VOSH-CT missions in Nicaragua over the last 10 years is that many people there have no idea that UV protection is important.
- People in occupations such as fishing and farming utilize no hat or sunglasses, and the prevalence of problems such as pterygia and inflamed pinguecula is enormous.
- We have made it a point to educate and provide free UV absorbing sunglasses to all our patients.





- Programs such as the “Caps for Kids” program founded by my daughter Rose Blondin has worked to provide brimmed hats to patients on our VOSH missions who work outdoors and to as many children as possible. Unfortunately, on a global scale, these relief efforts are only a drop in the bucket.
- The cost of publicizing these programs is miniscule compared to the potential future health care costs and human misery that will accrue if we fail to educate and help protect the public from over-exposure to UV radiation.

# The End . . .



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