ULTRAVIOLET RADIATION: HOW IT AFFECTS LIFE ON EARTH

By Jeannie Allen • September 6, 2001

The sun radiates energy in a wide range of wavelengths, most of which are invisible to human eyes. The shorter the wavelength, the more energetic the radiation, and the greater the potential for harm. Ultraviolet (UV) radiation that reaches the Earth's surface is in wavelengths between 290 and 400 nm (nanometers, or billionths of a meter). This is shorter than wavelengths of visible light, which are 400 to 700 nm.

People and plants live with both helpful and harmful effects of ultraviolet (UV) radiation from the sun. (Photograph courtesy Jeannie Allen)

UV radiation from the sun has always played important roles in our environment, and affects nearly all living organisms. Biological actions of many kinds have evolved to deal with it. Yet UV radiation at different wavelengths differs in its effects, and we have to live with the harmful effects as well as the helpful ones. Radiation at the longer UV wavelengths of 320-400 nm, designated as UV-A, plays a harmful role in that it causes sunburn on human skin and cataracts in our eyes. Radiation at shorter wavelengths of 290-320 nm, designated as UV-B, plays a helpful (essential) role in formation of Vitamin D by the skin, but it also causes damage at the molecular level to the fundamental building block of life—

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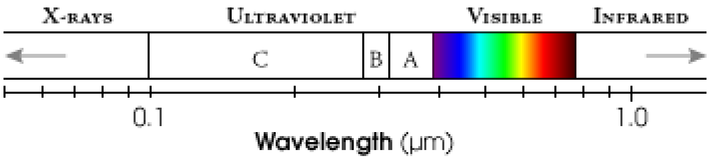
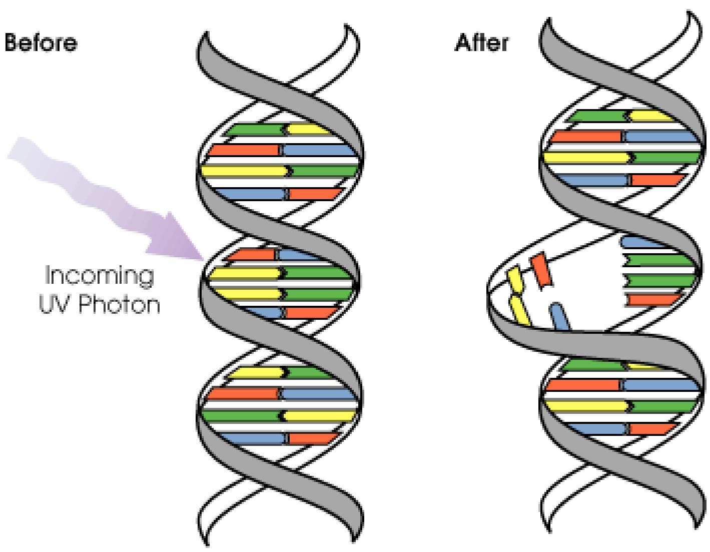
Ultraviolet Radiation

deoxyribonucleic acid (DNA).



Electromagnetic radiation exists in a range of wavelengths, which are delineated into major divisions for our convenience. Ultraviolet B radiation, harmful to living organisms, represents a small portion of the spectrum, from 290 to 320 nanometer wavelengths. (Illustration by Robert Simmon)

DNA readily absorbs UV-B radiation, which commonly changes the shape of the molecule in one of several ways. The illustration below illustrates one such change in shape due to exposure to UV-B radiation. Changes in the DNA molecule often mean that protein-building enzymes cannot "read" the DNA code at that point on the molecule. As a result, distorted proteins can be made, or cells can die.



Ultraviolet (UV) photons harm the DNA molecules of living organisms in different ways. In one common damage event, adjacent bases bond with each other, instead of across the "ladder." This makes a bulge, and the distorted DNA molecule does not function properly. (Illustration by David Herring)

But living cells are "smart." Over millions of years of evolving in the presence of UV-B radiation, cells have developed the ability to repair DNA. A special enzyme arrives at the damage site, removes the damaged section of DNA, and replaces it with the proper components (based on information elsewhere on the DNA molecule). This makes DNA somewhat resilient to damage by UV-B.

In addition to their own resiliency, living things and the cells they are made of are protected from excessive amounts of UV radiation by a chemical called ozone. A layer of ozone in the upper atmosphere absorbs UV radiation and prevents most of it from reaching the Earth. Yet since the mid-1970s, human activities have been changing the chemistry of the atmosphere in a way that reduces the amount of ozone in the stratosphere (the layer of atmosphere ranging from about 11 to 50 km in altitude). This means that more ultraviolet radiation can pass through the atmosphere to the Earth’s surface, particularly at the poles and nearby regions during certain times of the year.

Without the layer of ozone in the stratosphere to protect us from excessive amounts of UV-B radiation, life as we know it would not exist. Scientific concern over ozone depletion in the upper atmosphere has prompted extensive efforts to assess the potential damage to life on Earth due to increased levels of UV-B radiation. Some effects have been studied, but much remains to be learned.

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