BIOMEDICINE

Joanne Silberner reports from Rockville, Md., at the Bureau of Radiological Health Symposium on Biological Effects of Light Sources

Let there be fluorescent light?

The ultraviolet rays of the sun have been implicated in skin cancer, rapid skin aging and cataracts. F. Alan Andersen, a biophysicist at the Food and Drug Administration's Bureau of Radiological Health, believes there may be another potentially damaging source of UV light to consider — artificial lighting. He told Science News, "Five percent of an office worker's total UV exposure can come from fluorescent lighting. That number is not trivial when you consider how prevalent skin cancer is."

The intensity of sunlight is far greater than that of fluorescent lighting, but the Bureau's studies show fluorescent lighting to be more effective than sunlight in causing mutation in mammalian cells. When effectiveness and intensity are combined, sunlight is still a greater source of UV radiation, but, Andersen notes, for every increment of exposure there's probably an incremental increase in risk. "I think if we could eliminate the non-sunlight exposure to UV, we'd see a drop in skin cancer incidence," he says.

Should office workers go to work in caftans and dark glasses? No, says Andersen, it's more a question of identifying people who are ultra-sensitive to UV, including those who use photosensitizing medications, and eliminating UV where it isn't needed. We don't need UV to see, he points out, and a fluorescent light's UV rays can easily be blocked by commercially available plastic sheaths.

Shedding light on immune diseases

Ultraviolet light and abnormal immune responses have both been blamed for causing different types of cancer. Now, evidence is mounting for a direct relationship between UV exposure and immune deficiencies. Georgia Schuller, immunologist at the Bureau of Radiological Health, has found one mechanism by which light can affect the immune response. She exposed mouse macrophages to strong UV light, and found that cell viability and function dropped off at a rate proportionate to the exposure.

The model system is relevant, she says, because there are macrophage-like cells in the outer layer of human skin. Dermatologists have reported that skin exposed to UV light shows less of a response to irritants than does protected skin. Symposium participant Kiki Hellman of the BRH says that the relationship between UV and the immune system is a two-way street — many immune diseases are marked by light sensitivity.

Eyes and butter

Light free of ultraviolet radiation is not without its problems. Animal testing at the Bureau of Radiological Health has shown that monkeys with dilated pupils exposed for 12 hours to 500 foot-candles of light — about the brightness outdoors on a cloudy day — suffer damage to the color receptors in the retina. Though the effect of this exposure on vision is not known, the morphological damage to the retina lasts six months or longer. Some scientists have proposed that the damage is caused by chemical oxidation in the retina.

According to the theory, light does to the eye what it will, with time, do to butter — makes it rancid by oxidizing the lipids. But Stephen Sykes of the Bureau of Radiological Health reports his failure to halt retinal damage by giving the monkeys vitamin E, an anti-oxidant, casting doubt on oxidation as the mechanism at work. Other anti-oxidants have also proved unable to prevent damage, Sykes notes.

So it's back to the drawing board to find out how white light causes injury, a finding that may take on increased importance if the conviction of some photobiologists that many retinal diseases are initiated by light damage is found to be true.

SPACE SCIENCES

Saturn's straight-up magnetic field

One of the most surprising results of the Pioneer 11 spacecraft's close encounter with Saturn last September was the finding that the axis of the planet's dipole magnetic field is aligned to within 1° of its axis of rotation. The dipole axes of the other planets known to have intrinsic magnetic fields — earth, Mercury and Jupiter — all are tilted on the order of 10° from their planets' rotation axes, and although planetary magnetic field theory is far from clearly understood, scientists had assumed that Saturn's dipole would show a similar inclination.

Now D.J. Stevenson of the University of California at Los Angeles has offered a possible explanation, which, he reports in the May 16 Science, could also explain why the field is so small (several times smaller for Saturn's size than scaling from Jupiter would suggest), as well as why Saturn emits more than twice as much energy as it receives from the sun.

Saturn, like Jupiter, is essentially a ball of hydrogen with a bit of helium, probably wrapped around a small core of rock and/or ice. The crux of Stevenson's idea is that the heavier helium is transported to the lower portion of the hydrogen-helium "envelope," a process known as differentiation. This process would produce heating that could account for some of Saturn's "excess" energy output. In addition, Stevenson says, differentiation would concentrate the planet's mass toward its center, which would confine to the lower depths the region in which the hydrogen and helium are (1) compressed enough to conduct electricity and (2) hot enough for the large-scale convection that can generate a magnetic field. This in turn would reduce the size of the associated external field measured by Pioneer 11. (Jupiter's proportionately much larger field is possible in Stevenson's view because that planet is still too hot for differentiation to have begun, so the field's "source region" is larger.)

The lack of tilt of Saturn's magnetic-field axis is more difficult to explain, since theorists are not certain why the fields of other planets studied *are* tilted. Stevenson proposes that the key is in the nature of Saturn's differentiation. Downward motions in the outer part of the planet, caused by convection, transport the H and He down to a level at which the pressure and temperature are sufficient to condense some of the helium into droplets. This happens in a relatively stable layer (due to the limited range of temperature and pressure in which the condensation can happen), which is dense enough to be electrically conductive, but not hot enough to produce the strong convection that would let it help generate the field. The droplets then descend by gravity to a level at which the still greater temperatures cause the helium to re-dissolve into the hydrogen, producing a uniform mixture capable of large-scale, field-generating convection.

In addition, Stevenson says, the temperature gradient between equatorial and polar latitudes produces a differential rotation within the planet, with its strongest "thermal windshear" at the stable, droplet-forming layer. Of the magnetic field produced by the source region, the components that are aligned with Saturn's rotation axis are unaffected in their strength by the shear in the droplet-forming layer, which is also axially aligned. The non-aligned components, however, are distorted into small-scale eddy currents, whose energy is dissipated (as heat) much more rapidly than is that of the larger, aligned currents. The non-aligned, or tilted, portions of the field are thus in effect "filtered out," leaving only the aligned portion Pioneer 11 saw.

Stevenson's preliminary model is not necessarily the answer, however. Analyses of Pioneer 11 data on Saturn's gravity field that could show whether sufficient differentiation is taking place are not yet refined enough to be a check. Also, the detection of Saturn's "rotational signature" in radio emissions recently recorded by the Voyager spacecraft leaves open the possibility that the magnetic field is somewhat tilted after all.