Photobiology News (2003)

by Peter A. Ensminger

December 19, 2003
Questionable Efficacy of Sunscreens

Most sunscreens have been designed to prevent damage from ultraviolet-B radiation (UV-B, 280-315 nm). However, ultraviolet-A radiation (UV-A, 315-400 nm) also promotes skin aging and possibly melanoma. In a recent issue of *Journal of Investigative Dermatology*, **ASP** member Peter Wardman (Mount Vernon Hospital, Middlesex, UK) and colleagues report on their studies of the efficacy of three sunscreens by measuring their ability to prevent UV-A-induced free radical formation [1]. All three commercial sunscreens provided little protection from UV-A, even though they all had sun-protection factors (SPF) of 20 or higher.

1. Haywood R, Wardman P, Sanders R, Linge C, 2003, Sunscreens inadequately protect against ultraviolet-A-induced free radicals in skin: implications for skin aging and melanoma? *J Invest Dermatol* 121: 862-8. [PubMed]

Chloroplast Movements

Chloroplasts change their positions within cells according to the ambient light conditions. Under bright light, they typically move to the cell periphery and thereby reduce photooxidative damage; under dim light, they are more uniformly distributed and thereby increase photosynthetic rate. In the recent issue of *Plant Cell*, **ASP** member Akeo Kadota (Tokyo Metropolitan University) and colleagues report the isolation of *Arabidopsis* mutants (chloroplast unusual positioning; *chup*), in which the chloroplasts gather at the bottoms of cells [1]. The CHUP1 gene encodes a unique protein with multiple domains, including a coiled-coil domain, an actin binding domain, a proline-rich region, and two leucine zipper domains. This protein apparently localizes to chloroplast membranes.

1. Oikawa K, Kasahara M, Kiyosue T, Kagawa T, Suetsugu N, Takahashi F, Kanegae T, Niwa Y, Kadota A, Wada M, 2003, CHLOROPLAST UNUSUAL POSITIONING1 Is Essential for Proper Chloroplast Positioning. *Plant Cell* 15: 2805-15. [PubMed]

December 5, 2003
High Photosensitivity of Rhodopsin

Rhodopsin, the photoreceptive pigment of animals, consists of a retinoid chromophore that is bound to an opsin protein. Rhodopsin is well-known to have a very high photosensitivity. In the recent issue of *Proceedings of the National Academy of Sciences*, **ASP** member Robert S.H. Liu (University of Hawaii) and Leticia Colmenares propose a molecular mechanism that accounts for the high photosensitivity of rhodopsin [1]. Their model is based on NMR data of labeled rhodopsins, crystal structure data, and studies of the excited state properties of rhodopsin and model polyenes. They make several suggestions for improving the rhodopsin photosensitivity that involve incorporation of novel retinal analogues and use of opsin mutants. This publication was communicated by National Academy of Sciences member George S. Hammond, who is also an **ASP** member.

1. Robert S. H. Liu and Leticia U. Colmenares, 2003, The molecular basis for the high photosensitivity of rhodopsin. *Proc Natl Acad Sci USA*, 10.1073/pnas.2536769100 [Link]

PDT for Macular Degeneration

Photodynamic therapy (PDT) uses light and a photosensitive drug to destroy cancerous or other harmful cells. The National Institute for Clinical Evidence (NICE) of Great Britain recently recommended PDT with Visudyne (verteporfin) for certain patients with age-related macular degeneration. In particular, NICE recommended that patients with classic subfoveal choroidal neovascularisation, but no sign that this is occult, and with at least 6/60 vision should be considered for PDT. New blood vessels growing in the choroid layer (beneath the retina) is the classic sign of neovascular age-related macular degeneration. The new vessels typically leak, leading to loss of vision. The full NICE guidelines can be found at: http://www.nice.org.uk. Visudyne is already approved in the United States and Canada.

November 21, 2003

Non-Melanoma Skin Cancers Associated with Other Cancers

Exposure to sunlight is a major risk factor for development of basal cell carcinoma and squamous cell carcinoma [1]. More than one million Americans develop these non-melanoma skin cancers every year, although very few cases are fatal. A recent cross-sectional study to be published in *Cancer* [2] shows that women with a history of non-melanoma skin cancer were 2.3 times more likely to have had another form of cancer. The skin cancer association exists for several different types of cancer. Based on previous studies, the researchers believe that skin cancer preceded development of the other cancers. This study was a part of the "Women's Health Initiative Observational Study", and studied 93,676 postmenopausal women from 40 American communities.

1. Scientific American Editors, 1996, Twelve major cancers. *Scientific American* 275 (3), 126-32. [PubMed]
2. Rosenberg CA, Greenland P, Khandekar J, Loar A, Ascensao J, Lopez AM, 2004, Association of nonmelanoma skin cancer with second malignancy. *Cancer* [PubMed]

Comparison of Sunblocks

Short wavelength UV radiation (UV-B) causes sunburn and increases the expression of p53, a tumor suppressor gene. In contrast, long wavelength UV radiation (UV-A) causes increased expression of the protein vimentin. In the recent issue of *Photodermatology, Photoimmunology, and Photomedicine* **ASP** member Nicole Paillous (Laboratoire des IMRCP, France) and colleagues present their comparison of the effectiveness of different sunblocks [1]. They show that a ZnO/TiO2 based sunblock and a new organo-mineral sunblock containing Tinosorb M, OCM, ZnO and TiO2 are both effective in preventing UV-B-specific damage. However, only the novel organo-mineral sunblock prevents UV-A-specific damage.

1. Gelis C, Girard S, Mavon A, Delverdier M, Paillous N, Vicendo P, 2003, Assessment of the skin photoprotective capacities of an organo-mineral broad-spectrum sunblock on two ex vivo skin models. *Photodermatol Photoimmunol Photomed* 19: 242-53. [PubMed]

October 17, 2003

Widespread Distribution of Proteorhodopsin

Proteorhodopsins are widespread retinal-based pigments that, like the bacteriorhodopsin of *Halobacterium* [1], function as light-driven proton pumps. In the recent issue of *Environmental Microbiology*, **ASP** New Investigator awardee Oded Beja (Technion Institute of Technology, Israel) and colleagues report on their identification of novel proteorhodopsins in samples collected from the Red Sea [2]. These new proteorhodopsins are similar to the proteorhodopsins originally identified in Monterey Bay, California. However, each of these Red Sea proteorhodopsins has a glutamine residue at position 105, a site associated with spectral tuning.

They also identified additional proteorhodopsin variants in the Mediterranean Sea. The Mediterranean proteorhodopsins constitute a novel deep-branching phylogenetic group of proteorhodopsins.

1. Oesterhelt, D, Halorhodopsin.
2. Sabehi G, Massana R, Bielawski JP, Rosenberg M, Delong EF, Beja O, 2003, Novel Proteorhodopsin variants from the Mediterranean and Red Seas. *Environ Microbiol* 5: 842-9. [PubMed]

Topical Celecoxib Inhibits Ultraviolet-B Damage

Cyclooxygenase-2 (COX-2) is an enzyme that produces prostaglandins, which are implicated in the development of squamous cell carcinoma and other epithelial cancers. In the recent issue of *Molecular Carcinogenesis*, **ASP** member Donna Kusewitt (Ohio State University) and colleagues report that topical celecoxib, a selective COX-2 inhibitor, inhibits the acute oxidative damage to skin that is associated with ultraviolet-B radiation [1]. Their long-term studies show that topical celecoxib treatment reduces chronic inflammation and ultraviolet-B-induced papilloma and carcinoma formation. These results suggest that celecoxib or other COX-2 inhibitors may be useful for prevention of human skin cancers.

1. Wilgus TA, Koki AT, Zweifel BS, Kusewitt DF, Rubal PA, Oberyszyn TM, 2003, Inhibition of cutaneous ultraviolet light B-mediated inflammation and tumor formation with topical celecoxib treatment. *Mol Carcinog* 38: 49-58. [PubMed]

October 3, 2003

Photodynamic Therapy with Hypericin

Hypericin is a naturally occurring pigment present in Saint Johns wort (*Hypericum perforatum*) that absorbs strongly in the red and ultraviolet regions of the spectrum [1]. Hypericin has shown potential as an agent for photodynamic therapy (PDT), a treatment that destroys cancerous or other harmful cells with light and a chemical (such as hypericin) that is activated by light. In the recent issue of *International Journal of Cancer*, **ASP** member Peter A. De Witte (Faculty of Pharmaceutical Sciences, Katholieke Universiteit Leuven, Belgium) and colleagues present the results of their experiments on hypericin-PDT efficacy in an AY-27 orthotopic transitional cell carcinoma rat bladder tumor model [2]. Their results show that hypericin-based PDT has potential for treatment of bladder carcinoma in humans.

1. Ensminger, PA, 2001, A Menagarie of Molecules from *Life Under the Sun*
2. Kamuhabwa AA, Roskams T, D'Hallewin MA, Baert L, Van Poppel H, De Witte PA, 2003, Whole bladder wall photodynamic therapy of transitional cell carcinoma rat bladder tumors using intravesically administered hypericin. *Int J Cancer* 107: 460-467. [PubMed]

Blue Light Resets Human Circadian Rhythm

In humans and other mammals, specialized retinal ganglion cells receive light input through the eye that resets the endogenous circadian oscillator. In the recent issue of *Journal of Clinical Endocrinology and Metabolism*, Steven Lockley and **ASP** members George Brainard (Jefferson Medical College, Philadelphia) and Charles Czeisler (Brigham and Women's Hospital, Boston) show that the circadian rhythm in human pineal melatonin production is more sensitive to blue light (460 nm) than yellow light (555 nm) [1,2]. This contrasts to the well-known peak of human visual sensitivity near 555 nm under bright light and near 500 nm under dim light.

1. Cromie, WJ, 2003, When light has you singing the blues: Blue light resets body rhythms for sounder sleep, higher alertness. *Harvard Gazette* [Link]

2. Lockley SW, Brainard GC, Czeisler CA, 2003, High sensitivity of the human circadian melatonin rhythm to resetting by short wavelength light. *J Clin Endocrinol Metab* 88: 4502-5. [PubMed]

September 19, 2003
Phototransduction Review

Phototransduction in vertebrate eyes is the conversion of photons absorbed by the visual pigment rhodopsin into nerve impulses that lead to perception, the conscious registration of light. In the September issue of *Trends in Biochemical Sciences*, **ASP** member Kevin Ridge (NIST and University of Maryland) and colleagues review structural **ASP**ects of rhodopsin-mediated phototransduction, the most-studied G-protein-coupled receptor mediated response [1]. One of the most important advances has been the recent elucidation of the 3-dimensional crystal structure of rhodopsin. Structural information about the other components of visual phototransduction have also been obtained by X-ray diffraction, nuclear magnetic resonance spectroscopy, atomic force microscopy, and other methods. Future studies will be aimed at determining the structural interactions of the different components of visual phototransduction.

1. Ridge, KD, Abdulaev, NG, Sousa, M, Palczewski, K, 2003, Phototransduction: crystal clear. *TIBS* 28: 479-87. [Link]

New Treatment for Vitiligo

Vitiligo, which affects about one percent of the U.S. population, is a skin condition characterized by irregular white patches on otherwise normally pigmented skin [1]. Its cause in unknown, but many researchers believe that autoimmunity is a factor. Therapeutic exposure to narrow-band ultraviolet-B radiation is an important treatment option. In the recent issue of *Journal of the European Academy of Dermatology and Venereology* **ASP** member Giovanni Leone (Istituto Dermatologico San Gallicano, Rome) and colleagues reported their pilot studies of monochromatic (308 nm) excimer light (MEL) as treatment for vitiligo [2]. They concluded that MEL may be a more effective treatment than conventional narrow-band ultraviolet-B radiation.

1. National Library of Medicine, 2002, *Vitiligo* [NLM Medical Encyclopedia]
2. Leone G, Iacovelli P, Paro Vidolin A, Picardo M, 2003, Monochromatic excimer light 308 nm in the treatment of vitiligo: a pilot study. *J Eur Acad Dermatol Venereol* 17: 531-7. [PubMed]

September 5, 2003
Review of Photodermatoses

A recent issue of *Dermatologic Therapy* features a review article on photodermatoses, skin diseases caused by exposure to light [1]. The authors, Sharam Samson Yashar and **ASP** past-president Henry Lim (Henry Ford Health System in Detroit, Michigan), classify photodermatoses into five broad categories. They note that patients with a photodermatosis should be examined with regard to personal and family medical history. The morphology of the diseased skin and phototests are essential for diagnosis and for guiding the course of treatment. Skin biopsies and other tests may also be required.

1. Yashar SS, Lim HW, 2003, Classification and evaluation of photodermatoses. *Dermatol Ther* 16: 1-7. [PubMed]

Bacterial Blue Light Receptor

In a recent issue of *Photochemical and Photobiological Science*, **ASP** member Aba Losi, Benjamin Quest, and **ASP** member Wolfgang Gärtner (Max Planck Institute for Bioinorganic Chemistry in Mulheim, Germany) report on their studies of YtvA, a bacterial flavoprotein related

to phototropin, a blue light receptor in plants [1]. This extends their previous original identification of YtvA [2]. The new work examined the photochemistry of YtvA and its isolated LOV domain by use of optical spectroscopy, mass spectrometry and photocalorimetry. Their results indicate an interaction between the two domains of YtvA that is mediated by electrostatic effects. They suggest that formation of the photoadduct changes the dynamics of the protein and that this depends on the conformational flexibility of the parent state.

1. Losi A, Quest B, Gartner W, 2003, Listening to the blue: the time-resolved thermodynamics of the bacterial blue-light receptor YtvA and its isolated LOV domain. *Photochem Photobiol Sci* 2: 759-66. [PubMed]
2. Losi A, Polverini E, Quest B, Gartner W, 2002, First evidence for phototropin-related blue-light receptors in prokaryotes. *Biophys J* 82: 2627-34. [PubMed]

August 22, 2003

Retinal Counterion Switch in Rhodopsin

When retinal is free in solution, its absorption maximum is in the ultraviolet region. However, when retinal is bound to the visual pigment rhodopsin, its absorption maximum shifts to the visible region due to protonation of the retinylidene Schiff base. This positive charge is inherently unstable, but an amino acid counterion (Glu-113) stabilizes this bond in the dark. In a recent issue of *Proceedings of the National Academy of Sciences*, **ASP** member Richard Mathies (University of California, Berkeley) and colleagues present their studies of the retinal counterion switch during photoactivation of rhodopsin [1,2]. Based on site-selected mutagenesis and preresonance Raman spectroscopy, they propose a counterion switch that involves transfer of a proton from Glu-113 to Glu-181 in metarhodopsin-I, the photoactivated state of rhodopsin. This counterion switch is likely to be a general mechanism in the activation of G-Protein coupled receptors.

1. Yan EC, Kazmi MA, Ganim Z, Hou JM, Pan D, Chang BS, Sakmar TP, Mathies RA, 2003, Retinal counterion switch in the photoactivation of the G protein-coupled receptor rhodopsin. *Proc Natl Acad Sci* 100: 9262-7. [PubMed]
2. Birge RR, Knox BE, 2003, Perspectives on the counterion switch-induced photoactivation of the G protein-coupled receptor rhodopsin. *Proc Natl Acad Sci* 100: 9105-7. [PubMed]

Sunlight and Multiple Sclerosis

Multiple sclerosis (MS) is neurological disease caused by progressive damage to myelin, the outer covering of nerve cells. There are various neurological symptoms, but the cause is unknown [1]. About 400,000 Americans have been diagnosed with MS [2]. The recent issue of the *British Medical Journal* presents a population based case-control study of the effect of past sun exposure on the risk of MS in residents of Tasmania, Australia [3]. The results indicate that increased exposure to sunlight during childhood and early adolescence and greater actinic damage to the skin are associated with reduced risk of MS. The authors suggest that this effect may be due to the ultraviolet radiation-induced suppression of T helper cell type 1 immune responses via cytokine signaling.

1. MedLine Plus, *Medical Dictionary* [Link]
2. National Multiple Sclerosis Society [Link]
3. van der Mei IA, Ponsonby AL, Dwyer T, Blizzard L, Simmons R, Taylor BV, Butzkueven H, Kilpatrick T, 2003, Past exposure to sun, skin phenotype, and risk of multiple sclerosis: case-control study. *BMJ* 327:316. [PubMed]

August 1, 2003

Halorhodopsin of Natronobacterium pharaonis

Halorhodopsin is a retinal-based light driven archaeal protein that pumps chloride ions into cells and thereby helps to maintain osmotic balance. **ASP** member Naoki Kamo (Hokkaido University) and colleagues recently investigated chloride binding to wild type and site-selected mutants of the halorhodopsin of *Natronobacterium pharaonis* [1]. They show that the Ser-130 residue of pharaonis halorhodopsin is important for chloride binding. This residue corresponds to Ser-115 in the better known halorhodopsin of *Halobacterium salinarum*.

1. Sato M, Kikukawa T, Araiso T, Okita H, Shimono K, Kamo N, Demura M, Nitta K, 2003, Ser-130 of Natronobacterium pharaonis halorhodopsin is important for the chloride binding. *Biophys Chem* 104: 209-16. [PubMed]

Ultraviolet Screening by Snow Algae

Chlamydomonas nivalis is a chlorophyte alga that grows in Rocky Mountain snowfields and gives these snowfields a characteristic red color. An article in the June issue of *Photochemistry and Photobiology* extends recent studies of photosynthesis in this species [1]. In the new study, **ASP** members Holly Gorton and Thomas Vogelmann present a characterization of the ultraviolet radiation (UV) environment of the snow alga and an examination of UV screening compounds within snow alga cells [2]. This paper shows that snow alga cells are protected from UV damage by living several centimeters beneath the snow surface, where UV levels are significantly lower. In addition, this alga accumulates high levels of astaxanthin, an extra-chloroplastic carotenoid that screens out UV.

1. American Society for Photobiology, Photosynthesis in Snow Algae, *Photobiology News Archives* (January 17, 2003) [Link]
2. Gorton HL, Vogelmann TC, 2003, Ultraviolet radiation and the snow alga Chlamydomonas nivalis (Bauer) Wille. *Photochem Photobiol* 77: 608-15. [PubMed]

July 18, 2003

Treatment of Psoriasis with Narrowband Ultraviolet-B Radiation

Plaque psoriasis is a common skin disorder that is characterized by dry scales, irritation, swelling, and itching [1]. Current guidelines recommend psoralen plus ultraviolet-A radiation (PUVA) as second-line therapy. In the recent issue of *British Journal of Dermatology*, **ASP** members Sally Ibbotson, James Ferguson (both from the University of Dundee) and colleagues report their comparison of PUVA with narrowband ultraviolet-B radiation in the treatment of psoriasis [2]. The results of their clinical study of 28 patients show that narrowband ultraviolet-B radiation is more effective than PUVA.

1. National Library of Medicine, 2002, *Medical Encyclopedia*, Psoriasis. [Link]
2. Dawe RS, Cameron H, Yule S, Man I, Wainwright NJ, Ibbotson SH, Ferguson J, 2003, A randomized controlled trial of narrowband ultraviolet B vs. bath-psoralen plus ultraviolet A photochemotherapy for psoriasis. *Br J Dermatol* 148: 1194-204. [PubMed]

Dung Beetles use Polarized Moonlight for Orientation

The African dung beetle (*Scarabaeus zambesianus*) spends much of its nightlife rolling small balls of dung toward hiding places for subsequent consumption. This backwards walking beetle uses its back legs to push a dung ball, while it walks with its front legs and directs its face toward the ground. Interestingly, the dung beetle walks in straight lines on clear moonlit nights (when the light is polarized) but walks on erratic paths on cloudy nights (when there is no light polarization). Researchers from Sweden and South Africa performed experiments with

polarization filters to prove that the African dung beetle does indeed use the polarization pattern of moonlight to orient itself [1]. This study appears in the July 3rd issue of *Nature*.

1. Dacke M, Nilsson D-E, Scholtz CH, Byrne M, Warrant EJ, 2003, Animal behaviour: Insect orientation to polarized moonlight *Nature* 424: 33-4. [PubMed]

July 4, 2003

Microarray Detection of High Light-Stress Plant Genes

DNA microarray analysis is a powerful new technology that allows researchers to simultaneously monitor changes in the expression of thousands of genes [1]. In a recent issue of *Photochemistry and Photobiology*, **ASP** member Katsushi Manabe (Yokohama City University, Japan) and colleagues describe their use of cDNA microarrays to detect gene expression changes following high light-stress (HL) in the model plant *Arabidopsis thaliana* [2]. They show that HL induces genes with roles in the scavenging of reactive oxygen species and in the biosynthesis of lignins and flavonoids. Seventy-two of the HL-induced genes are induced by drought and ten of the HL-induced genes are induced by drought, cold stress, and salt stress.

1. Baldi P, Hatfield GW, Hatfield, WG, 2002, *DNA Microarrays and Gene Expression : From Experiments to Data Analysis and Modeling*. Cambridge Univ Press.
2. Kimura M, Yamamoto YY, Seki M, Sakurai T, Sato M, Abe T, Yoshida S, Manabe K, Shinozaki K, Matsui M, 2003, Identification of Arabidopsis genes regulated by high light-stress using cDNA microarray. *Photochem Photobiol* 77: 226-33. [PubMed]

Inadequacy of the Sun Protection Factor (SPF)

When a sunscreen is properly applied, the Sun Protection Factor (SPF) indicates the increased time that someone can stay in the sun without burning. In addition to sunscreens, manufacturers also list the SPF for creams, lipsticks, lotions, and other cosmetic products. In the recent issue of *European Journal of Dermatology*, **ASP** member Francoise Bernerd (Loreal Life Sciences in Clichy, France) and colleagues show that two different sunscreens with the same SPF provide different levels of protection with regard to skin damage and photoaging [1]. In particular, the two formulations tested displayed significantly different protection to UV-A radiation (320-400 nm), which is associated with alterations of dermal fibroblasts.

1. Bernerd F, Vioux C, Lejeune F, Asselineau D, 2003, The sun protection factor (SPF) inadequately defines broad spectrum photoprotection: demonstration using skin reconstructed in vitro exposed to UVA, UVB or UV-solar simulated radiation. *Eur J Dermatol* 13: 242-9. [PubMed]

June 20, 2003

Photochemistry of Rhodobacter Photoreceptor

AppA is an blue light photoreceptive protein in *Rhodobacter spaaeroides*, a photosynthetic bacterium. This protein antirepresses the expression of photosynthesis genes in response to light and oxygen. An FAD (flavin adenine dinucleotide) serves as the AppA chromophore. In a recent issue of *Biochemistry*, **ASP** member Gordon Tollin (University of Arizona) and colleagues report their photochemical studies of this blue light photoreceptor [1]. They propose that blue light excitation of AppA strengthens the hydrogen bond between the FAD and tyrosine-21 of the protein and that this causes a local change in protein conformation.

1. Kraft BJ, Masuda S, Kikuchi J, Dragnea V, Tollin G, Zaleski JM, Bauer CE, 2003, Spectroscopic and Mutational Analysis of the Blue-Light Photoreceptor AppA: A Novel

Photocycle Involving Flavin Stacking with an Aromatic Amino Acid. *Biochemistry*. 42: 6726-6734. [PubMed]

Novel Rod Cell Opsin in Xenopus

The eyes of *Xenopus leavis*, the African clawed frog, have red rod cells (absorption maximum near 500 nm), green rod cells (absorption maximum near 450 nm), and three or more types of cone cells. In a recent issue of *Molecular Vision*, **ASP** member Rosalie Crouch (Medical University of South Carolina) and colleagues report their characterization of the green rod cell opsin from *Xenopus laevis* [1]. This opsin has 362 amino acids, seven hydrophobic helices, and an absorption maximum at 434 nm upon reconstitution with 11-cis retinal. Immunohistochemcal analysis indicates expression in rod cells, but sequence analysis clearly indicates that this opsin belongs to the SWS-2 (short-wavelength-sensitive-2) class of opsins, which are typically expressed in cone cells.

1. Darden AG, Wu BX, Znoiko SL, Hazard ES 3rd, Kono M, Crouch RK, Ma JX, 2003, A novel Xenopus SWS2, P434 visual pigment: structure, cellular location, and spectral analyses. *Mol Vis* 9:191-9. [PubMed]

June 6, 2003

Dimericine Featured on ABC News

On May 23, "ABC World News Tonight" featured a story about Dimericine, a liposome lotion that contains the DNA repair enzyme, T4 endonuclease V [1]. Dimericine was developed by AGI Dermatics to repair sunlight-induced DNA damage in human cells [2]. Dimericine would be particularly helpful to xeroderma pigmentosum (XP) patients, who are at greatly increased risk for skin cancer. In fact, a previous study of XP patients indicated that topical application of Dimericine to their sun-damaged skin lowers the rate of development of actinic keratoses and basal cell carcinomas [3]. Daniel Yarosh, **ASP** member and treasurer, is the president and chairman of AGI Dermatics.

1. ABC News (May 23, 2003) Anti-cancer Lotion? Experimental Lotion Repairs Sun Damage, May Prevent Skin Cancer. [Link]
2. AGI Dermatics. [Link]
3. Yarosh D, Klein J, O'Connor A, Hawk J, Rafal E, Wolf P, 2001, Effect of topically applied T4 endonuclease V in liposomes on skin cancer in xeroderma pigmentosum: a randomised study. Xeroderma Pigmentosum Study Group. *Lancet* 357: 926-9. [PubMed]

Nucleotide Excision Repair

Nucleotide excision repair (NER) eliminates the cyclobutane pyrimidine dimers (CPDs) in DNA that are induced by ultraviolet radiation. Global NER removes CPDs from the overall genome whereas transcription-coupled NER removes CPDs from the transcribed strands of active genes. The p53 tumor suppressor is important in the NER response. In the May 29 issue of *Proceedings of the National Academy of Sciences*, **ASP** members Regen Drouin (Laval University), Jean Philippe Therrien (Guy-Bernier Research Center), and colleagues demonstrate that the requirement for p53 is dependent on the incident ultraviolet wavelength for transcription-coupled NER but not for global NER [1]. This resolves an apparent conflict between previous studies, some of which showed that p53 is required for transcription-controlled NER and others which showed it had no role in this response.

1. Mathonnet G, Leger C, Desnoyers J, Drouin R, Therrien JP, Drobetsky EA, 2003, UV wavelength-dependent regulation of transcription-coupled nucleotide excision repair in p53-deficient human cells. *Proc Natl Acad Sci* [Epub ahead of print] [PubMed]

May 23, 2003

Melanoma Gene

Increasing exposure to UV radiation is believed to contribute to the increasing incidence of melanoma, the most lethal form of skin cancer. In the recent issue of *Nature Genetics*, researchers at Rutgers University show that aberrant expression of the *Grm1* gene leads to melanoma in mice [1]. They also show that this gene is involved in about one third of all human melanomas. *Grm1* encodes the metabotropic glutamate receptor-1, a gene that is normally expressed in the brain and is associated with memory and learning. This study provides compelling evidence for the importance of abnormal *Grm1* expression as a cause of melanoma and suggests that future researchers may be able to develop novel drugs that target the GRM1 protein.

1. Pollock PM, Cohen-Solal K, Sood R, Namkoong J, Martino JJ, Koganti A, Zhu H, Robbins C, Makalowska I, Shin SS, Marin Y, Roberts KG, Yudt LM, Chen A, Cheng J, Incao A, Pinkett HW, Graham CL, Dunn K, Crespo-Carbone SM, Mackason KR, Ryan KB, Sinsimer D, Goydos J, Reuhl KR, Eckhaus M, Meltzer PS, Pavan WJ, Trent JM, Chen S, 2003, Melanoma mouse model implicates metabotropic glutamate signaling in melanocytic neoplasia. *Nat Genet* 34: 108-12. [PubMed]

Enhanced Photosynthesis following Pinatubo Eruption

A significant decrease in the growth rate of atmospheric CO2 levels followed the 1991 eruption of Mount Pinatubo in the Philippines. In a recent issue of *Science*, researchers report that Pinatubo volcanic aerosols increased diffuse radiation and thereby increased photosynthesis of the Harvard Forest in 1992 and 1993 [1]. This new study indicates that the early 1990's decrease in the growth rate of global CO2 was caused by enhanced worldwide photosynthesis. Furthermore, it points to the importance of cloudiness and atmospheric aerosols in regulating the global carbon cycle [2].

1. Gu L, Baldocchi DD, Wofsy SC, Munger JW, Michalsky JJ, Urbanski SP, Boden TA, 2003, Response of a deciduous forest to the Mount Pinatubo eruption: enhanced photosynthesis. *Science* 299: 2035-8. [PubMed]
2. Working Group I, 2001, *Climate Change 2001: The Scientific Basis*. [Link]

May 9, 2003

Effect of Sunscreen and Beta-Carotene on Solar Keratoses

The recent issue of *Archives of Dermatology* features a study of methods that have been proposed for prevention of solar keratoses (SKs), rough scaly spots on the skin that can give rise to squamous cell carcinoma [1]. In this 3-year long randomized control trial, **ASP** member Adele Green (University of Queensland, Australia) and colleagues studied the effect of sunscreen application and dietary supplementation with beta-carotene (30 mg per day) on the prevalence of SKs. In the study population of 1621 Australian adults, sunscreen application reduced SK prevalence but beta-carotene had no effect.

1. Darlington S, Williams G, Neale R, Frost C, Green A, 2003, A randomized controlled trial to assess sunscreen application and Beta carotene supplementation in the prevention of solar keratoses. *Arch Dermatol* 139: 451-5. [PubMed]

New DNA Repair Gene

A forthcoming issue of the *Journal of Biological Chemistry* features an article by **ASP** member Gary D. Small (University of South Dakota) and colleagues that describes their discovery of a new DNA repair gene [1]. These researchers isolated a UV-sensitive mutant of the green alga, *Chlamydomonas reinhardtii* and then isolated a novel gene - REX1 - that rescues this mutant.

The REX1 gene codes for both a small (8.9 kDa) protein and a large (31.8 kDa) protein, neither of which is homologous to previously described DNA repair genes. However, the 8.9 kDa protein has homologues in *Saccharomyces cerevisiae*, *Arabidopsis thaliana*, humans, and other species.

1. Cenkci B, Petersen JL, Small GD, 2003, REX1, a novel gene required for DNA repair. *J Biol Chem* Apr 14 [epub ahead of print] [PubMed]

April 25, 2003
Growing Better Basil

Agricultural researchers at the USDA have shown previously that covering the ground with different colors of plastic mulch can affect the yield and chemical composition of crop plants [3]. For example, turnips have a sharp taste when grown over blue mulch, but a sweet taste when grown over green mulch. John Loughrin and **ASP** member Michael Kasperbauer (Agricultural Research Service, USDA) measured the effect of mulch color on the level of aromatic compounds in sweet basil (*Ocimum basilicum* L.). They found that basil plants develop larger leaves when grown over red mulch, but that plants grown over black mulch produce higher concentrations of aromatics [1,2]. This study indicates that it may be possible to alter the concentration of bioactive agents in other crop plants by manipulating mulch color.

1. Loughrin JH, Kasperbauer MJ, 2001, Light reflected from colored mulches affects aroma and phenol content of sweet basil (*Ocimum basilicum* L.) leaves. *J Agric Food Chem* 49: 1331-5. [PubMed]
2. Loughrin JH, Kasperbauer MJ, 2003, Aroma content of fresh basil (*Ocimum basilicum* L.) leaves is affected by light reflected from colored mulches. *J Agric Food Chem* 51: 2272-6. [PubMed]
3. Raloff J, 2003, Perk Up Food Flavors with. . .Black Plastic? (with pesto recipe). *Science News* [Link]

The PAS of PYP

PAS (Per/Arnt/Sim) domains are regions of sensor proteins that contain an a/b fold and are important in the transduction reactions of many different photoreceptors, including photoactive yellow protein (PYP), phytochrome, cryptochrome, and phototropin. In the recent issue of *Journal of Biological Chemistry*, **ASP** member Klaas Hellingwerf (E.C. Slater Institute, Amsterdam) and colleagues report their studies of the structure of the PAS domain of PYP, a bacterial blue light photoreceptor [1]. They show that a PYP deletion mutant lacking its N-terminal helix-turn-helix motif is still able to fold properly. Simulations of the PAS domains of other proteins show that they are structurally conserved but have similar conformational flexibility.

1. Vreede J, Van Der Horst MA, Hellingwerf KJ, Crielaard W, Van Aalten DM, 2003, PAS domains - common structure, common flexibility? *J Biol Chem* Mar 14 [epub ahead of print]. [PubMed]

April 11, 2003
Wavelength-Dependent Quantum Yield in Rhodopsin

Vision in higher animals is based upon the cis to trans photo-isomerization of the 11-cis-retinal of rhodopsin. A previous study has shown that the quantum yield of this photoreaction is wavelength-dependent, with a quantum yield of 0.65 from 450 to 500 nm and declining quantum yield above 500 nm [1]. In the recent issue of *Biophysical Journal*, Judy Kim, Michael Tauber, and **ASP** member Richard Mathies report their studies of this phenomenon [2]. Their new results indicate that absorption by high-frequency unreactive modes increases as the excitation

wavelength declines from 570 to 450 nm, with less energy being directed to reactive low-frequency modes. This reveals the importance of delocalized torsional modes in the photoisomerization reaction and explains the wavelength dependence of the rhodopsin photochemical quantum yield.

1. Kim JE, Tauber MJ, Mathies RA, 2001, Wavelength dependent cis-trans isomerization in vision. *Biochemistry* 40: 13774-8. [PubMed]
2. Kim JE, Tauber MJ, Mathies RA, 2003, Analysis of the mode-specific excited-state energy distribution and wavelength-dependent photoreaction quantum yield in rhodopsin. *Biophys J* 84: 2492-501. [PubMed]

Ultraviolet Radiation and Amphibian Decline

Previous studies in the U.S. Pacific northwest have suggested that ultraviolet-B radiation (UV-B; 280-320 nm) is a major contributor to the decline of amphibian populations [1]. However, these studies have not fully considered the UV-B transparency of water at amphibian breeding sites. In a recent issue of *Ecology*, Wendy Palen and colleagues report their measurements of the UV-B transparency of water at 136 potential amphibian breeding sites in the Pacific northwest [2]. Most sites are substantially protected from UV-B exposure by dissolved organic matter; only a few sites experience UV-B levels that would be expected to cause egg mortality. The researchers suggest that UV-B could be important at individual sites, but not at regional or landscape scales in the Pacific northwest.

1. Blaustein AR, Wake DB, 1995, The puzzle of declining amphibian populations. *Sci Am* 272: 52-57.
2. Palen WJ, Schindler DE, Adams MJ, Pearl CA, Bury RB, Diamond SA, 2002, Optical characteristics of natural waters protect amphibians from UV-B in the U.S. Pacific northwest. *Ecology* 83: 2951-2957. [Link]

March 28, 2003

New Green Light Photoreceptor

In the recent issue of *Molecular Microbiology*, **ASP** member Kwang-Hwan Jung, Vishwa Trivedi, and **ASP** past-president John Spudich (University of Texas) report their discovery of the first sensory rhodopsin found in eubacteria [2]. This rhodopsin is a 26 kDa membrane-bound protein in *Anabaena*, a common freshwater cyanobacterium that is capable of nitrogen fixation and photosynthesis [1]. *Anabaena* opsin binds to all-trans retinal and forms a pigment with maximal absorption at 543 nm. The researchers conclude from its photochemical reactions and its interaction with a 14-kDa soluble protein (encoded in an operon with the opsin gene) that *Anabaena* rhodopsin is a photosensory receptor and that the 14 kDa protein apparently transduces signals from this novel photoreceptor.

1. Anabaena sp. PCC7120, CyanoBase. [Link]
2. Jung KH, Trivedi VD, Spudich JL, 2003, Demonstration of a sensory rhodopsin in eubacteria. *Mol Microbiol* 47: 1513-22. [PubMed]

Photodynamic Therapy for Prostate Cancer

Photodynamic therapy (PDT) uses light and a chemical photosensitizer to destroy cancerous or other unwanted cells. Early clinical studies suggest that PDT has potential for treatment of prostate cancer [1]. In the recent issue of *International Journal of Molecular Medicine*, **ASP** member Steven H. Selman (Medical College of Ohio) and colleagues report on their studies of the photosensitizer SnET2 (liposome encapsulated tin etiopurpurin dichloride) in PDT of canine prostate cancer [2]. Their studies included development of a computer program to guide

placement of light diffusers within the prostate. The concentration of SnET2 is heterogeneous, so future use of computerized modeling must consider its sequestration and the consequential asymmetrical necrosis of the prostate.

1. Nathan TR, Whitelaw DE, Chang SC, Lees WR, Ripley PM, Payne H, Jones L, Parkinson MC, Emberton M, Gillams AR, Mundy AR, Bown SG, 2002, Photodynamic therapy for prostate cancer recurrence after radiotherapy: a phase I study. *J Urol* 168: 1427-32. [PubMed]
2. Aniola J, Selman SH, Lilge L, Keck R, Jankun J, 2003, Spatial distribution of liposome encapsulated tin etiopurpurin dichloride (SnET2) in the canine prostate: Implications for computer simulation of photodynamic therapy. *Int J Mol Med* 11: 287-91. [PubMed]

Emission of Nitrogen Oxides by Scotch Pine

Photochemical smog, a mixture of pollutants that develops when nitrogen oxides (NOx) and volatile organic compounds interact with sunlight, is a serious problem in many urban areas [1]. In a recent issue of *Nature*, Pertti Hari (University of Helsinki) and colleagues show that Scotch Pine (*Pinus sylvestris*), emits NOx upon exposure to ultraviolet radiation [2]. Future studies should test whether this occurs in other tree species and the significance of this phenomenon for the global environment.

1. Photochemical Smog.
2. Hari P, Raivonen M, Vesala T, Munger JW, Pilegaard K, Kulmala M, 2003, Atmospheric science: Ultraviolet light and leaf emission of NOx. *Nature* 422:134. [PubMed]

March 14, 2003

Red Light Cure

Accidental consumption of methanol, which is often present in antifreeze, can lead to permanent blindness. Formic acid, a byproduct of methanol metabolism that can damage the mitochondria of ocular tissues, is apparently responsible for this effect. A recent study by Janis Eells and colleagues at the Medical College of Wisconsin [1] shows that red light treatment can prevent the development of methanol-induced blindness in laboratory rats. Red light therapy has a potential role in treatment of other eye diseases associated with malfunctioning mitochondria, such as macular degeneration and glaucoma.

1. Eells JT, Henry MM, Summerfelt P, Wong-Riley MTT, Buchmann EV, Kane M, Whelan NT, and Whelan HT, 2003, Therapeutic photobiomodulation for methanol-induced retinal toxicity. Proc Natl Acad Sci USA March 7 [epub ahead of print] [PubMed]

Protective Role of Carotenoids in the Eye

In the recent edition of *Annual Review of Nutrition*, **ASP** member Norman Krinsky (Tufts University Medical School) and colleagues at Florida International University review the protective role of the macular carotenoids, lutein and zeaxanthin [1]. These yellow pigments protect underlying photoreceptor cells from the damage caused by excess light. Epidemiology studies have shown that the amount of macular pigment inversely correlates with the incidence of macular degeneration, the major cause of blindness in the elderly. Increasing the dietary intake of lutein and zeaxanthin increases the concentration of yellow macular pigments and may protect against development of macular degeneration.

1. Krinsky NI, Landrum JT, Bone RA, 2003, Biologic Mechanisms of the Protective Role of Lutein and Zeaxanthin in the Eye. *Annu Rev Nutr* Feb 27; [epub ahead of print] [PubMed]

February 28, 2003

Ultraviolet Radiation and Beta-Carotene

Ultraviolet radiation causes oxidative stress and damage to human skin. The activation of heme oxygenase-1 (HO-1) via singlet oxygen is a marker of oxidative stress in dermal fibroblasts. Carotenoids are potent quenchers of singlet oxygen and should suppress the ultraviolet induction of HO-1. In the recent issue of *Free Radical Biology and Medicine*, **ASP** member Rex Tyrrell (University of Bath) and colleagues report their studies of beta-carotene's effect upon HO-1 expression in cultured human fibroblasts [1]. Their results show that beta-carotene exhibits a concentration-dependent suppression of ultraviolet-induced activation of HO-1. This suppression occurs at beta-carotene concentrations that occur in human plasma following dietary supplementation with beta-carotene.

1. Trekli MC, Riss G, Goralczyk R, Tyrrell RM, 2003, Beta-carotene suppresses UVA-induced HO-1 gene expression in cultured FEK4. *Free Radic Biol Med* 34: 456-464. [PubMed]

p53 Mutations and Basal and Squamous Cell Carcinomas

Ultraviolet radiation can cause basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). These skin cancers may be aggressive or nonaggressive. It might be expected that the ultraviolet-induced mutation spectrum of p53 (a tumor suppressor gene) would differ in the aggressive and nonaggressive forms of BCC and SCC. **ASP** member Margaret Kripke (M.D. Anderson Cancer Center) and colleagues addressed this question in a study reported in the recent issue of *Clinical Cancer Research*. Their results show that ultraviolet radiation induces p53 mutations, but the spectrum of p53 mutations does not provide a clear diagnostic indication of tumor aggressiveness. Presumably, other ultraviolet-induced effects cause differences in tumor aggressiveness.

1. Bolshakov S, Walker CM, Strom SS, Selvan MS, Clayman GL, El-Naggar A, Lippman SM, Kripke ML, Ananthaswamy HN, 2003, p53 mutations in human aggressive and nonaggressive basal and squamous cell carcinomas. *Clin Cancer Res* 9: 228-34. [PubMed]

February 14, 2003

Donation Program for *Photochem Photobiol*

The **ASP** is dedicated to making *Photochemistry and Photobiology* available to people in need. There are two ways that members can help. You can either donate your hardcopy of *Photochem Photobiol* to be shipped to someone in need or, for an additional $50 donation, we will provide someone in need with a separate subscription to the journal. As a member of the **ASP**, you will continue to have on-line access to the journal. You can provide us with the name of someone in need and we will send issues directly to that person. Alternatively, we can select a candidate from our request list and set you up as a sponsor. Sponsoring is easy. Just complete the request form on page 4 of the winter 2003 issue of *ASP News* [1] and return it to the secretariat.

1. *ASP News*, winter 2003 [PDF file]

New Treatment for Erythropoietic Protoporphyria

Patients with erythropoietic protoporphyria (EPP), a rare genetic disorder, accumulate protoporphyrin in the serum and are extremely sensitive to visible light [2,3,4]. Oral beta-carotene, which quenches reactive oxygen species, is an FDA-approved therapy for EPP. In the recent issue of *Photodermatology, Photoimmunology, and Photomedicine*, **ASP** member Micheline Mathews-Roth (Brigham and Women's Hospital) and Bernard Rosner report on their Phase III study of the long-term treatment of EPP with cysteine [1]. Their results indicate that 500

mg cysteine per day effectively increases the time of symptom-free light exposure for patients with EPP.

1. Mathews-Roth MM, Rosner B, 2002, Long-term treatment of erythropoietic protoporphyria with cysteine. *Photodermatol Photoimmunol Photomed* 18: 307-9. [PubMed]
2. Erythropoietic Protoporphyria Research and Education Fund.
3. Metabolic Basis and Characteristic Features of the Porphyrias.
4. Desnick RJ, 1998, "The Porphyrias" pp 2152-2158 in: *Harrison's Principles of Internal Medicine*, 14th edition, McGraw-Hill, NY.

Ocular Phototoxicity

In a recent issue of the *International Journal of Toxicology*, **ASP** member Joan Roberts (Fordham University) reviews the methods used to screen exogenous substances for phototoxic effects upon the eye. Endogenous antioxidants protect the eye, but these decline after middle age. The extent to which an exogenous substance may damage the eye depends on its absorption spectrum, its ability to bind ocular tissues, and its ability to cross amphiphilic and lipophilic layers at the blood-eye interface. Various photophysical techniques are used to predict which substances may damage the eye. Preclinical testing is also important in determining which substances may cause phototoxic side effects, such as mild and reversible blurred vision or permanent blindness.

1. Roberts JE, 2002, Screening for Ocular Phototoxicity. *Int J Toxicol* 21: 491-500. [PubMed]

January 31, 2003

Function of Novel Fern Photoreceptor

In the January 17 issue of *Nature*, **ASP** member Akeo Kadota (Tokyo Metropolitan University) and his colleagues report their studies of the polypodiaceous fern, *Adiantum capillus-veneris* [1]. This fern codes for a gene (phy3) that is a chimera of phytochrome, a red/far-red light photoreceptor, and phototropin, a blue-light photoreceptor [2]. Their new research shows that this novel fern photoreceptor controls red light-induced phototropism and red light-induced chloroplast relocation. In addition, the researchers show that phy3-like genes are present in other polypodiaceous ferns, but not in more primitive ferns nor in higher plants. They suggest that the rapid proliferation of polypodiaceous ferns during the Upper Cretaceous and Tertiary (about 65 million years ago) may have been facilitated by evolution of the phy3 gene.

1. Kawai H, Kanegae T, Christensen S, Kiyosue T, Sato Y, Imaizumi T, Kadota A, Wada M, 2003, Responses of ferns to red light are mediated by an unconventional photoreceptor. *Nature* 421: 287-90. [PubMed]
2. Nozue K, Kanegae T, Imaizumi T, Fukuda S, Okamoto H, Yeh KC, Lagarias JC, Wada M, 1998, A phytochrome from the fern Adiantum with features of the putative photoreceptor NPH1. *Proc Natl Acad Sci USA* 95:15826-30. [PubMed]

Regulation of DNA Repair

In a recent issue of *Oncogene*, **ASP** member Philip Hanawalt (Stanford University) reviews the subpathways of nucleotide excision repair and their regulation [1]. These important defense mechanisms repair DNA damage following exposure to numerous harmful agents, including ultraviolet radiation and mutagenic chemicals. The two subpathways of nucleotide excision repair are global genome repair (GGR) and transcription coupled repair (TCR). TCR is selective for the transcribed strands of expressed genes. GGR enzyme levels are normally kept very low unless cells are genomically stressed . In *E. coli*, the well-known SOS response controls GGR. In humans, the p53 tumor suppressor gene controls GGR. In fact, the upregulation of GGR is essential for the efficient repair of the primary UV photoproduct, the cyclobutane pyrimidine

dimer. Interestingly, while rodents are used for risk assessments of environmental cancer risks, most rodent tissues are deficient in the p53-dependent GGR pathway.
1. Hanawalt PC, 2002, Subpathways of nucleotide excision repair and their regulation. *Oncogene* 21(58): 8949-56. [PubMed]

January 17, 2003
New Function for Melanopsin
In the January 10 issue of *Science*, **ASP** member Robert J. Lucas and his colleagues report their studies of photosensitive retinal ganglion cells of mice [1]. These cells express melanopsin, an opsin-like protein that may be responsible for their photosensitivity. Their results show that melanopsin-knockout mice have diminished pupillary light reflex at high irradiances. This shows that melanopsin is an integral component of the mammalian visual system. However, as discussed in an accompanying article by **ASP** member Michael Menaker [2], the precise role of melanopsin is still unclear.

1. Lucas RJ, Hattar S, Takao M, Berson DM, Foster RG, Yau KW, 2003, Diminished pupillary light reflex at high irradiances in melanopsin-knockout mice. *Science* 299, 245-7. [PubMed]
2. Menaker, M, 2003, Circadian rhythms. Circadian photoreception. *Science* 299, 213-214. [PubMed]

Photosynthesis in Snow Algae
In a forthcoming issue of *Proceedings of the National Academy of Sciences* [2], William Williams and **ASP** members Holly Gorton and Thomas Vogelmann extend their previous work with *Chlamydomonas nivalis* [1]. This chlorophyte alga is common in the summer snowfields of the Rocky Mountains and gives these snowfields a characteristic reddish hue. In their new work [2], they measured photosynthesis rates in snow patches colonized by this alga. Colonized snow patches can achieve CO2 uptake rates of 0.3 micro mol m^{-2} s^{-1}. Their calculations show that summer snowfields can absorb significant amounts of CO2 and are important primary producers.

1. Gorton HL, Williams WE, Vogelmann TC, 2001, The light environment and cellular optics of the snow alga *Chlamydomonas nivalis* (Bauer) Wille. *Photochem Photobiol* 73, 611-20. [PubMed]
2. Williams WE, Gorton HL, Vogelmann TC, 2003, Surface gas-exchange processes of snow algae. *Proc Natl Acad Sci* Jan 7 [epub ahead of print] [PubMed]

Role of Gene Transfer in Photosynthetic Microbes
In horizontal gene transfer, genetic material moves between different organisms by a mechanism other than descent. Many microbes are believed to have evolved adaptations to new environments mostly by the acquisition of genes from horizontal transfer, rather than selection of genes altered by mutation. In a recent issue of *Science*, researchers from Arizona State University report a whole-genome comparison of species from all five groups of photosynthetic prokaryotes. They show that genes important for photosynthesis have been subject to horizontal transfer and that gene transfer has been pivotal in the evolution of photosynthetic microbes.

1. Raymond J, Zhaxybayeva O, Gogarten JP, Gerdes SY, Blankenship RE, 2002, Whole-genome analysis of photosynthetic prokaryotes. *Science* 298, 616-20. [PubMed]

January 3, 2003
Review of Photodynamic Therapy
Photodynamic therapy (PDT) is a medical treatment that uses light and a photosensitizing substance to destroy cancerous or other unwanted cells. PDT was pioneered in the early 1970's by

Thomas Dougherty, **ASP** member and 2001 recipient of the **ASP** Lifetime Achievement Award. The January issue of *Scientific American* features a very readable review of PDT by Nick Lane, from the University of London [1]. Lane begins with a brief description of the molecular mechanisms of PDT and then reviews the use of PDT in treatment of cancer and macular degeneration. He concludes with an overview of future treatment avenues for PDT.

1. Lane N, 2003, New light on medicine. *Sci Am* 288(1): 38-45. [PubMed]

Identification of New Excited State in Carotenoids

Light energy that is absorbed by plant carotenoids is transferred to chlorophylls and used to drive photosynthesis. In the December 20 issue of *Science*, researchers provide the first direct evidence for an intermediate excited state (Sx) of carotenoids that mediates the internal conversion from the S2 to S1 states [1]. This study makes it necessary to reexamine previously proposed mechanisms for energy transfer from carotenoids to chlorophylls.

1. Cerullo G, Polli D, Lanzani G, De Silvestri S, Hashimoto H, Cogdell RJ, 2002, Photosynthetic light harvesting by carotenoids: detection of an intermediate excited state. *Science* 298: 2395-8. [PubMed]

New View of Circadian Clock Protein

The KaiC protein from the cyanobacterium *Synechococcus elongatus* is an essential component of this organism's circadian clock. In a forthcoming issue of *Proceedings of the National Academy of Sciences*, **ASP** member Carl H. Johnson and colleagues use electron microscopy and additional biophysical techniques to demonstrate that KaiC forms hexameric ring complexes with a central pore and that formation of these hexamers requires ATP [1]. This study argues for inclusion of KaiC in the RecA/DnaB superfamily and supports the previous suggestion that KaiC may be a global regulator of circadian gene expression [2].

1. Mori T, Saveliev SV, Xu Y, Stafford WF, Cox MM, Inman RB, Johnson CH, 2002, Circadian clock protein KaiC forms ATP-dependent hexameric rings and binds DNA. *Proc Natl Acad Sci USA* 99:17203-17208. [PubMed]
2. Mori T, Johnson CH, 2001, Circadian programming in cyanobacteria. *Semin Cell Dev Biol* 12: 271-8. [PubMed]