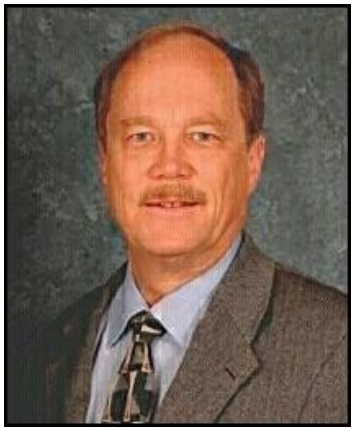
ASP NEWS

Winter 2008-09 vol. 39(1)

President's Message

Many members have expressed concerns to me regarding ASP's shift from annual to biennial meetings. Others have expressed relief and suggested that there have been too many meetings!



ASP Council has endorsed an approach to support ASP Topical Symposia in 2009. This should help fill the apparent void of ASP activity during 2009. We hope that these topical symposia are seen as a positive development. Topical symposia may appeal to scientists who tend to shun meetings that cover a broad range of subjects. With a few well-selected topical symposia focused on "hot topics" or new and developing topics, we hope to attract new members and invigorate former members who have strayed from the ASP.

Several symposium topics were proposed at the ASP meeting in Burlingame, CA and I described these in last summer's Newsletter. Out of the 7-8 proposals, two or three have matured. It was very unfortunate that **Colin Chignell**'s proposal of a symposium on singlet oxygen did not move forward because of Dr. Chignell's untimely death. Two symposia currently have organizing committees that have met or had teleconferences to formalize programs. These are:

The Science behind Low Level Light (Laser) Therapy (LLLT) – from molecular biology to cell and tissue level. What are the mechanisms of action? (University of Rochester for two full days, August 7-8, 2009)

Light and Internal Tissues: Applications, Basic Science and Future Directions. Implications for endoscopic and other medical devices (1 day in the early fall in the Washington, DC area)

If you are interested in either symposium, please contact the ASP Business Office or me. Two other topical symposia looked promising and may still happen, but may need to be postponed to future years: "The Photobiology of Circadian Rhythms and the Human Neuorendocrine Sytem" planned for Philadelphia, and "Photobiological Impact of Global Climate Change," planned for Washington, DC or a southern locale later in the fall.

-David Sliney, david.sliney@att.net

IN THIS ISSUE

Atmospheric Optics

Alexander's Dark Band

Alexander's Dark Band. *Photo by Les Cowley (www.atoptics.co.uk), Norfolk England*

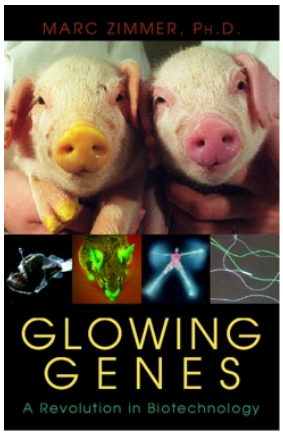
In 200 AD, **Alexander of Aphrodisias** described the dark band that appears between adjacent rainbows. Note also that the order of colors in the bright primary bow are reversed in the dim secondary bow.

Light rays undergoing a single reflection in raindrops form the primary bow or brighten the sky inside it. Rays reflected twice are deviated to form the secondary bow or brighten the sky outside. Raindrops along lines of sight between the two bows cannot send light to your eye and so the sky is darker there. - **Les Cowley** (www.atoptics.co.uk)

"It is inexcusable for scientists to torture animals; let them make their experiments on journalists and politicians."-**Henrik Ibsen**

Letter From the Editor

Green Fluorescent Protein



Unless you've been sleeping under a log for the past few months, you will have noticed that the 2008 Nobel Chemistry prize was given to **Osamu Shimomura**, **Martin Chalfie**, and **Roger Tsien** for their discovery and development of the Green Fluorescent Protein (GFP). If you want to read an engaging history of GFP research (or if you *have* been sleeping under a log), check out the recent book by **Marc Zimmer**, *Glowing Genes. A Revolution in Biotechnology* (2005, Prometheus Books). The ASP has a division dedicated to bio- and chemiluminescence. As of October 30, *Photochemistry and Photobiology* has published 91 papers on bioluminescence, 20 papers on GFP, and 5 papers on aequorin. PubMed lists 17202 publications on GFP, some of which were authored by long-time ASP members **Woody Hastings** (who was the first to call it "Green Fluorescent Protein") and **Bill Ward**.

In reviewing a list of important GFP publications (page 3), it is interesting to note that this Nobel Prize was given for discovery of the GFP protein and the use of GFP to study gene expression, but not for cloning of the gene. On page 4, **Milton Cormier**, in whose lab GFP was cloned, provides a brief history of the cloning of GFP by **Douglas Prasher** and colleagues. Thanks to financial assistance from a major pharmaceutical company (not the NIH or NSF), this important paper was published in 1992. On page 6, Bill Ward (former postdoc of Milt Cormier) argues that this Noble Prize was a great victory for basic research.

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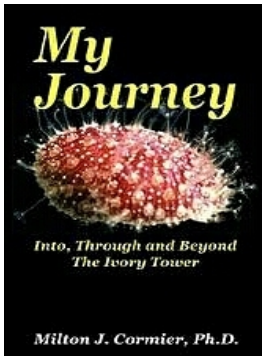
Milestones in GFP Research

Year	Key Publications [number of citations in scholar.google.com (Oct 30, 2008)]
1962	**Discovery of fluorescent proteins in *Aequorea victoria*** Shimomura O, Johnson FH, Saiga Y (1962) Extraction, purification and properties of aequorin, a bioluminescent protein from the luminous hydromedusan, *Aequorea*. J Cell Comp Physiol 59:223–39 [397]; Johnson FH, Shimomura O, Saiga Y, Gershman LC, Reynolds GT, Waters JR (1962) Quantum efficiency of *Cypridina* luminescence with a note on that of *Aequorea*. J Cell Comp Physiol 60:85-103.
1971	**Identification of *in vivo* energy transfer from aequorin to GFP** Morin JG, Hastings JW (1971) Energy transfer in a bioluminescent system. J Cell Physiol 77:313-18 [154]
1974-9	**Analysis of *in vitro* energy transfer from aequorin to GFP** Morise H, Shimomura O, Johnson FH, Winant J (1974) Intermolecular energy transfer in the bioluminescent system of *Aequorea*. Biochemistry 13:2656-62 [172]; Prendergast FG, Mann AG (1978) Chemical and physical properties of aequorin and the Green Fluorescent Protein isolated from *Aequorea forskalea*. Biochemistry, 17:3448-53 [40]; Ward WW, Cormier MJ (1979) An energy transfer protein in coelenterate bioluminescence. J Biol Chem 254:781-788 [52]
1979	**Initial characterization of GFP chromophore** Shimomura O (1979) Structure of the chromophore of *Aequorea* green fluorescent protein. FEBS Lett 104:220-22 [83]
1992	**Sequencing of *gfp* gene** Prasher D, Eckenrode V, Ward WW, Prendergast F, Cormier M (1992) Primary structure of the *Aequorea victoria* green-fluorescent protein. Gene 111:229–33 [997]
1993	**Determination of GFP chromophore structure** Cody CW, Prasher DC, Westler WM, Pendergast FG, Ward WW (1993) Chemical Structure of the hexapeptide chromophore of the *Aequorea* green-fluorescent protein. Biochemistry 32:1212-18 [379]
1994	**Expression of GFP in *E. coli* and *C. elegans*** Chalfie M, Tu Y, Euskirchen G, Ward WW, Prasher D (1994) Green-fluorescent protein as a marker for gene expression. Science 263:802–5 [3398]; Inouye S, Tsuji F (1994) *Aequorea* green fluorescent protein. Expression of the gene and fluorescence characteristics of the recombinant protein. FEBS Lett 341:277–80 [262]
1994	**Engineering of GFP-fusion proteins** Wang S, Hazelrigg T (1994) Implications for bcd mRNA localization from spatial distribution of exu protein in *Drosophila* oogenesis. Nature 369:400-03 [347]
1995	**Engineering of GFP mutants** R Heim, A Cubitt, RY Tsien (1995) Improved green fluorescence. Nature 373:663-64 [786]
1996	**Determination of crystal structure of GFP** Ormo M, Cubitt AB, Kallio K, Gross LA, Tsien RY, Remington SJ (1996) Crystal structure of the *Aequorea victoria* green fluorescent protein. Science 273:1392-95 [749]; F Yang, LG Moss, GN Phillips (1996) The molecular structure of green fluorescent protein. Nat Biotechnol 14:1246-51 [649]
1997	**Development of GFP-based Ca-sensors** Miyawaki A, Llopis J, Heim R, McCaffrey JM, Adams JA, Ikura M, Tsien RY (1997) Fluorescent indicators for Ca based on green fluorescent proteins and calmodulin. Nature 388:882-87 [1172]
1999	**Discovery of GFP homologues (DsRed) in coral** Matz MV, Fradkov AF, Labas YA, Savitsky AP, Zaraisky AG, Markelov ML, Lukyanov SA (1999) Fluorescent proteins from nonbioluminescent *Anthozoa* species. Nat Biotechnol 17:969-73 [801]
2002	**Directed evolution of DsRed (mRFP1)** Campbell RE, Tour O, Palmer AE, Steinbach PA, Baird GS, Zacharias DA, Tsien, RY (2002) A monomeric red fluorescent protein. Proc Natl Acad Sci 99:7877-7882 [943]

By Peter A. Ensminger, with constructive feedback from Milton Cormier, Woody Hastings, John Lee, Rebekka Wachter, Bill Ward, and Marc Zimmer.

Cloning the GFP Gene

Toward the end of the 1970's, members of my laboratory had isolated and characterized three proteins involved in the control and emission of luminescence in the sea pansy, *Renilla*. One of these was *Renilla* luciferase, which was isolated by my graduate student **John Matthews** in 1977. Another was a green fluorescent protein (GFP). **John Wampler** performed some of the early work on the purification and characterization of GFP. He was a postdoc in my lab at the time and later became a faculty member. **Bill Ward**, also a postdoc in my lab, accomplished the final purification of GFP and published the results in 1979.



My Journey, *Milton Cormier's recently published book*

We had also identified the structure of an organic compound, termed "coelenterazine". In *Renilla*, this molecule is oxidized in the presence of oxygen and produces blue light, with *Renilla* luciferase serving as the catalyst. However, the live animal produces green light. Green light could also be produced in a test tube by adding *Renilla* GFP to a mixture of *Renilla* luciferase, oxygen, and coelenterazine. Thus, we demonstrated that the production of green light was due to an energy transfer process, which also increased the quantum yield of light production.

In 1962, **Osamu Shimomura** identified a protein from the jellyfish *Aequorea* that produced blue light upon addition of small amounts of calcium. He named this protein "aequorin". During the course of our own investigations, we showed that the chemistry of light emission from aequorin was the same as that from *Renilla* and that coelenterazine was the substrate in both organisms. Shimomura also identified a green fluorescent protein from *Aequorea*. GFP from *Aequorea* is similar but not identical to GFP from *Renilla*. As in the case of *Renilla*, aequorin produces blue light, but *Aequorea* produces green light due to energy transfer.

I was interested in doing structure-function work on the bioluminescent proteins that we had isolated. The isolation of a few milligrams of pure luciferase or GFP from *Renilla* required thousands of animals. I realized that in order to obtain large amounts of pure bioluminescent proteins, I would have to change course from enzyme isolation and characterization to cloning of the genes for these proteins. If we could clone the genes, production of large amounts of bioluminescent proteins would not be a problem. At that time (1980), only a few genes had been cloned from higher organisms.

I was supported by granting agencies for over 30 years without interruption and was publishing an average of 8 to 10 peer-reviewed papers per year. Yet when I approached the granting agencies with the idea of cloning, the grant was turned down. Their main criticism was "How do we know he can do it". Fortunately, I had a contact with Hoffman-LaRoche. They invited me for a seminar, after which they agreed to give me a large 3-year grant to do the cloning work.

This grant allowed me to buy the necessary equipment and supplies. Two individuals from my lab went to Friday Harbor, Washington to collect bioluminescent jellyfish, which were used to purify milligram quantities of aequorin and GFP. We performed amino acid sequence analysis of the aequorin and GFP that we purified from *Aequorea*. Bill Ward, a former postdoc of mine (now Associate Professor at Rutgers University), provided the peptides and sequences derived from GFP. From this, we were able to obtain radioactive oligonucleotide probes for screening cDNA libraries. Much of this preparative work was done by the time I hired **Douglas Prasher**, who had just finished a postdoc in the Department of Genetics at the University of Georgia.

When Doug arrived in my lab, I arranged for him to collect *Aequorea* jellyfish at Friday Harbor for the express purpose of making a cDNA library. From this cDNA library, he was able to clone the first gene that coded a bioluminescent protein (aequorin). Doug's first attempts to detect expression of this gene were not successful. This went on for several weeks until I realized that he was attempting to detect expression in the classical way, i.e., looking for a protein band on an electrophoresis gel.

Rick McCann (my technician) and I reasoned that Doug may indeed be expressing the gene, but that the levels may have been too low to be detected by his standard assay. Rick and I talked Doug into looking for the protein by using bioluminescence, a much more sensitive assay. Doug had little knowledge of how to do this, so we agreed that Rick would make the measurements. I will always remember the day when Rick assayed the fractions

using the bioluminescence assay. There was a loud shout across the room by Doug and Rick who said "There are tons of light here. It's off scale!". That indeed was an exciting day in the lab. We knew that the aequorin gene was being expressed. In 1985, we published the first paper that demonstrated the cloning of a gene that coded a bioluminescent protein.

During that time, **Walt Lorenz**, a graduate student of mine, was able to clone the gene for *Renilla* luciferase. Walt was also able to express the gene, making it possible to obtain large amounts of luciferase. Walt received his PhD for this work, which was published in 1991. That was another exciting day.

After cloning of the aequorin gene, I suggested to Doug that he try to clone the *Aequorea* GFP gene. From the isolated and sequenced peptides derived from GFP, we arranged for radioactive oligonucloetide probes to be made for screening the *Aequorea* cDNA library. Doug was successful in cloning the GFP gene. He then sequenced the gene, but found that his chromophore-containing sequence represented only 70% of the full-length gene. At about that time, Doug accepted a job offer from the Woods Hole Oceanographic Institution. We continued to collaborate and eventually Doug succeeded in cloning the full-length of the GFP gene. In 1992, we published this work in the journal, *Gene*.

In 1992, while Doug was at Woods Hole, he gave the GFP gene to **Roger Tsien** and **Martin Chalfie**. They did some classic experiments on gene expression in living cells that used GFP as a marker. In 2008, they shared the Nobel Prize in Chemistry for their work with Osamu Shimomura.

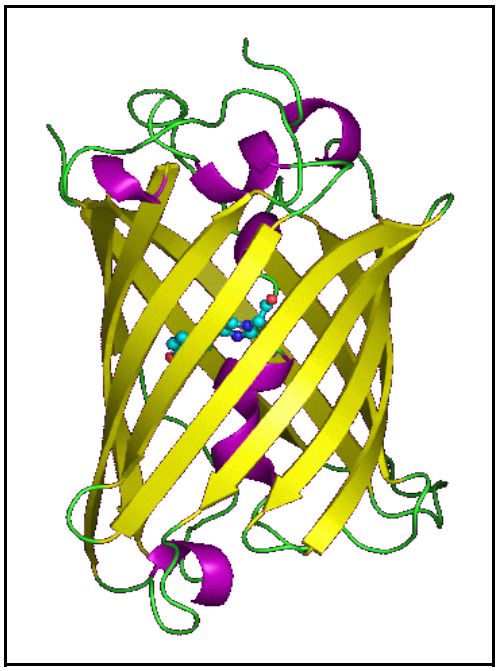
At about the time that Doug prepared to leave my lab, I had about one year left on my three-year grant from Hoffman-LaRoche. Thus, I applied once again to the granting agencies for support that would have allowed my lab, Doug's lab, and Bill Ward's lab to collaborate and finish our work on the cloning and expression of the *Aequorea* GFP gene. We also wanted to clone and express other genes that coded for proteins involved in bioluminescence. Unfortunately, this grant proposal was turned down. At that point, I helped members of my lab find other positions and decided to retire at the age of 67.

-Milton Cormier

GFP Nobel Prize

Victory for Basic Research

The Nobel Prize for Chemistry, awarded to GFP-researchers **Shimomura**, **Chalfie**, and **Tsien** on October 8, 2008, is as much a celebration of basic research as an acknowledgement of the achievements of three accomplished researchers.



Bioluminescence is an exciting and mysterious phenomenon that has been studied by scientists and philosophers for centuries. In his classic treatise on bioluminescence, **Edmund Newton Harvey** quotes **Pliny the Elder**, **Aristotle**, and other ancient scholars who were captivated by bioluminescence and sought to learn its secrets. Even the word "luciferin" has ancient roots, coming from the Roman god **Lucifer**, the bearer of light. The successes celebrated last month have their roots in hundreds of years of basic research – research for the sake of research. All of us with long-term investments in bioluminescence research began our studies because of the aesthetic appeal of bioluminescence. I remember taking a career preference test in 9th grade, a test that measures the broad areas that might appeal to a young student. My profile came out "Scientific/Artistic". How prophetic that evaluation was, as I became a research scientist motivated by the artistic beauty of bioluminescence.

It is ironic that, after decades of basic research on

bioluminescence, the research funding of **Milt Cormier** and **Doug Prasher** independently ran out just as they were about to complete the cloning of GFP. The foundation for this accomplishment was built, block-by-block, over 4 decades by Cormier, his students, and others, mostly in the United States. The Nobel Prize take-home message is not just that GFP is an amazingly valuable tool for research in the life sciences. The important message is that these applications of GFP rest upon decades of government-supported basic research that was performed by dozens of scientists engaged in basic research. Without decades of significant government support, there would have been no knowledge base that led the Nobel Prize winners to their ground-breaking research.

In a **Chris Matthews**-hosted panel discussion at the recent Biotech 2008 Symposium in Philadelphia Pennsylvania Congresswoman **Kathleen Buto** said that biotech scientists need to communicate more effectively with legislative leaders. I am now in discussions with BioNJ (www.biotechnj.org) about using GFP as a tool to excite state and congressional leaders about biotech. With brief hands-on exercises centered on GFP, we aim to convince state and national political leaders of the value of basic research in biotechnology. Our efforts will focus on the need for government funding of projects that are not yet at the able to solve major biomedical problems.

This country became the world leader in science and technology because our government has dared to fund "imagination" and "innovation", not just practical and goal-directed engineering. We cannot afford to pull the plug on funding for basic research, especially as the rest of the world challenges us for science supremacy.

-Bill Ward

Photobiological Sciences Online

www.photobiology.info

The Digital Photobiology Compendium (DPC), initiated by **Dennis Valenzeno**, was a prominent website for photobiology education between 2000 and 2004. Although never completed, it continued to be useful after that date.

In early 2008, the old files were extracted from the DPC website, and reformatted to display on current web browsers.

These old modules are being revised, and new modules posted. As of 11/12/08, the statistics are:

Revised Modules Posted:	19
Modules To Be Revised:	28
New Modules Posted:	16
New Modules in Preparation:	4

We still have a way to go to complete this online textbook on photobiology, but we are making progress.

Please check out the website (www.photobiology.info), and let the Editor know if you would like to volunteer to author a module on a missing subject, or suggest an author for a module on a missing subject.

Also, please let the Editor know if you have comments or suggestions about the existing modules or website.

The great advantage of an online textbook is that it can be easily kept up-to-date by the authors.
-Kendric C. Smith, Editor and Webmaster
Photobiological Sciences Online

ASP Homepage Usage

Dates: Sept 29-Nov 23, 2008 (56 days)

Total page views: 2822 (avg of 50.4 per day)

Total Unique visits: 1701 (avg of 30.4 per day)

Visits by operating system

Win-XP: 60.6%
Win-Vista: 6.1%
Win-NT: 15.2%
Win-2000: 2.0%
Linux/Unix: 5.1%
Mac-OSX: 11.1%

Visits by Continent

N. America: 61.0%
Europe: 23.0%
Asia: 13.0%
Africa: 1.0%
Unknown: 2.0%

"Be careful about reading health books. You may die of a misprint." -**Mark Twain**

Norman Krinsky Rest in Peace

Norman Krinsky, Charter member of the ASP and ASP President in 1982-1983 has recently passed away. He was Professor Emeritus in the Department of Biochemistry, Tufts University School of Medicine.

Professor Krinsky's research focused on the metabolism of carotenoids to retinoids and retinoic acid, the role of carotenoids in human vision, the function of carotenoids as antioxidants, the role of ß-carotene metabolites in breast cancer, and the role of ß-carotene and tobacco smoke in the development of lung cancer.

He has 138 publications listed in PubMed. His most recent publication is "Determination of 9-cis beta-carotene and zeta-carotene in biological samples." *J Nutr Biochem* 2008 Sep;19(9):612-8.

Below, we would like to share the words sent by **Susan Krinsky**, Norman's wife:

Friends,

It is with great sadness that we write to let you know that Norman died on Friday evening, November 28th. Our family gathered together for a wonderful Thanksgiving celebration which he was able to attend and enjoy. Friday morning he fell at home, was hospitalized and never regained consciousness. We were all with him throughout the day and he left us peacefully that evening.

The funeral service was Tuesday December 2nd at 10 AM. We sat for Shiva, the memorial observance, on Tuesday, Wednesday and Thursday, 2-4 PM and 7-9 PM.

Associate Councilor Needed

Nominations are needed for a new Associate Councilor. Due to unforeseen circumstances, the Associate Councilor, **Daryl Reynolds** (elected to represent ASP students/postdocs during the mentoring lunch in Burlingame CA) is unable to continue as Associate Councilor.

The ASP wants our students and postdocs represented on Council, so please take a moment to nominate someone you feel can represent you. You may nominate yourself or others. Submit your nominations to Linda Hardwick at: **lhardwick@allenpress.com** by **January 20, 2009** for consideration.

Please check with your mentor or Professor before nominating yourself to ensure they agree with your role as Associate Councilor.

What does an Associate Councilor do?

- Represent students/postdocs on council
- Write to students/postdocs in the newsletter and/or via e-mail
- Attend Council meetings via phone conference in off years
- Attend Council meetings during the ASP Biennial meeting (paid for by the ASP)
- Assist Mentoring committee with the mentor lunch

Serving on Council is a great way to get involved with the ASP, to meet and get to know the ASP officers, to represent students/postdocs, and looks great on your resume.

Donate to ASP

All donations are tax deductable

As the year draws to a close, please consider a tax-deductable donation to the American Society for Photobiology Urbach Student Travel Award. Students are the future of the ASP and photobiology. At the 34th ASP meeting in Burlingame CA, 57 students/postdocs attended. Through your tax-deductable donations, you can help bring students/postdocs to the 2010 ASP meeting. The ASP and our students/postdocs greatly appreciate your consideration.

-ASP Grants & Awards Committee
-ASP Finance Committee

Faculty Alert!

Why should your students join the ASP?

Students and Postdocs are eligible for Associate membership to the ASP. By having your students join the ASP they will foster relationships with others in the field and will stay excited about remaining in photobiology. Associate member benefits include:

- Reduced membership rates
- Travel awards
- Reduced meeting registration fees
- Mentoring lunch at biennial meeting – free for students
- Representation on council
- Online access to *Photochem Photobiol*
- Assistance from the Mentoring Committee
- ASP listserv announcements
- Job Search – free for members

Talk to your students about becoming members for 2009. ASP will be holding "Hot Topic" meetings in 2009 and the ASP biennial meeting is coming up in 2010. Your students must be members to get the reduced rates and information about the upcoming meetings.

To join, use the application on the next page or go to **www.photobiology.org** and click on "ASP Business Office"in the left menu.

Volunteers Needed

At its summer meeting, ASP council suggested 56 scientific keywords to use with PubMed to characterize our current members, recruit new members, and for other related uses.

I still need volunteers to do PubMed searches on 31 keywords. If you are interested in helping, please contact me and let me know which keyword(s) you are interested in. I will send you an instruction sheet with details on what we are looking for.

This project will be invaluable to the ASP and your help is greatly appreciated. Thank you for any assistance you can provide.

Linda Hardwick, hardwick@allenpress.com

Keywords

1. Animal studies
2. Dosimetry
3. Education
4. Experimental medicine
5. Genomics
6. Infrared
7. Melanin/melanoma
8. Nanoparticles
9. Non-ocular photoreception
10. Optical instrumentation
11. Photoadaptation
12. Photodynamic therapy
13. Photomedicine
14. Photomorphogenesis
15. Photomovement
16. Photo-oxidation
17. Photoreactivation
18. Photosensitization
19. Public health
20. Radiometry/spectroradiometry
21. Sun protection
22. UV germicidal technology
23. UV monitoring
24. Visible light effects
25. Vision
26. Vitamin D
27. pharmaceuticals
28. proteins
29. imaging
30. signal transduction
31. photoacoustics

"Astrology: The science of making the dupe see stars." **-Ambrose Bierce**

American Society for Photobiology

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Thank you for your interest in joining the American Society for Photobiology. Please print this page, fill out the form, and send it with payment to:

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__ $45/yr Associate Member (student/post-doc; online access to *Photochem Photobiol*)
__ $120/yr Member (online access to *Photochem Photobiol*)
__ $228/2-yrs Member (online access to *Photochem Photobiol*)
__ $160/yr Member (printed version and online access to *Photochem Photobiol*)
__ $308/2-yrs Member (printed version and online access to *Photochem Photobiol*)
__ $40/yr Emeritus (printed version and online access to *Photochem Photobiol*)
__ $0/yr Emeritus (online access to *Photochem Photobiol*)

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Photobiology Events

Online Map/Timeline
www.pol-us.net/meetings.html

Jan 4-9, 2009
Protein Purification: Principles and Practice
New Brunswick, NJ (USA)
Web site:
rci.rutgers.edu/~crebb/ProteinPurificationTitlePage.htm

Jan 10-14, 2009
Solar '09: Powering a Greener Future: Nanomaterials and Solar Energy Conversion
Luxor, Egypt
Web site: solar09.photoenergy.org/Site/overview.html

Jan 11-16, 2009
Plant Sensing, Response and Adaptation to the Environment
Big Sky, MT (USA)
Web site:
www.keystonesymposia.org/Meetings/ViewMeetings.cfm
?MeetingID=1009

Jan 24-29, 2009
BiOS/LASE/MOEMS-MEMS/OPTO
(Part of Biophotoncs West)
San Jose, California (USA)
Web site: spie.org/photonics-west.xml

March 15-20, 2009
Protein Purification: Principles and Practice
New Brunswick, NJ (USA)
Web site:
rci.rutgers.edu/~crebb/ProteinPurificationTitlePage.htm

June 11-15, 2009
2009 International Photodyamic Association World Congress
Seattle, WA (USA)
Web Site: www.pms.ac.uk/ipa/congress2009.php

June 18-23, 2009
15th International Congress on Photobiology
Duesseldorf (Germany)
Web site: www.iuf.uni-duesseldorf.de/ICP2009/index.html

June 28 - July 3, 2009
GRC: Photosynthesis
Smithfield, RI (USA)
Web site: www.grc.org/meetings.aspx?year=2009

July 5-10, 2009
GRC: Photochemistry
Smithfield, RI (USA)
Web site: www.grc.org/meetings.aspx?year=2009

July 8-10, 2009
Plant ROS-2009: Society for Free Radical Research International
Helsinki (Finland)
Web site: pog2009.org/

July 18-22, 2009
ASPB-2009 (American Society for Plant Biology)
Honolulu, HI (USA)
Web site: aspb.org/meetings/pb-2009/

July 19-24, 2009
Topical Problems of Biophotonics
Nizhny Novgorod - Samara, Russia
Web site: www.biophotonics.sci-nnov.ru/

July 19-24, 2009
GRC: Chronobiology
Newport, RI (USA)
Web site: www.grc.org/meetings.aspx?year=2009

July 26-31, 2009
ICTPPO 2009: International Conference on Tetrapyrrole Photoreceptors in
Photosynthetic Organisms
Asilomar Conference Center
Pacific Grove, CA (USA)
Web site: www.cevs.ucdavis.edu/Cofred/Public/Aca/ConfHome.cfm?confid=376

Aug 16-21, 2009
GRC: Laser Diagnostics in Combustion
Waterville Valley, NH (USA)
Web site: www.grc.org/meetings.aspx?year=2009

Sept 5-10, 2009
2009 ESP Congress
Wroclaw (Poland)
Web site: www.esp-photobiology.it/2009congress/

July 3 - Aug 5, 2010
Plant Biology 2010: American Society of Plant Biologists & Canadian Society of Plant Physiologists
Montreal, QC (Canada)
Web site: aspb.org/meetings/pb-2010/

Aug 12-16, 2010
ASP-2010: 35th Meeting of the American Society for Photobiology
Brown University
Providence, RI (USA)

SPIE Events: spie.org/x1375.xml
Plant Biology Events: aspb.org/calendar
Chemistry Events: www.chemistry.org