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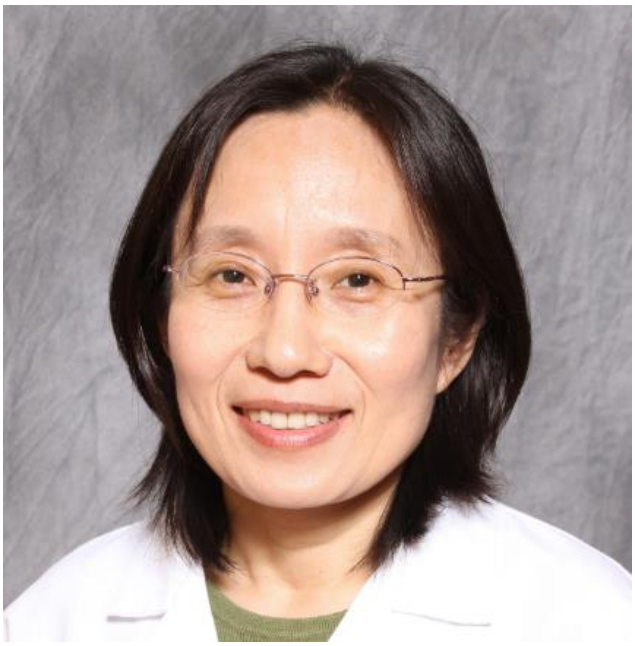
President's Note



Dear ASP members and colleagues,

Hope you have had a great summer! Here I would like to share with you a few exciting updates.

1. Thanks to all the ASP 2018 meeting attendees who shared their comments and suggestions. We will incorporate these points into our preparation for the ASP 2020 meeting as much as possible.

2. The ASP is re-establishing committees. Thanks to all the ASP members and councilors who have expressed interests in serving on those committees. Please feel free to email me with your interest in serving on these committees and being chair or co-chairs, if you have not done so. The committees are: membership committee, 2020 organizing committee, publication committee, and sponsorship committee. My email is yyhe@medicine.bsd.uchicago.edu.

3. After more than six months of careful preparation and comparison, we finally narrowed down the potential venue for the ASP 2020 meeting. It will likely be in Chicago in June. More information will be available soon.

Enjoy the rest of the summer!

Yu-Ying

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Learning Photobiology

There appear to be few academic opportunities for learning the elements of photobiology, although I am told these are slowly increasing. I can recall when even biochemistry courses were difficult to find in academic institutions although Medical Schools usually provided a discussion of the critical elements. Biochemistry has now come to predominate the sciences, with many departments of chemistry being gradually converted conglomerates that incorporate significant amounts of biology, biochemistry and even pharmacology.

When I was an undergraduate MIT, hard as this may be to believe in view of the massive investment in biochemistry today, there was essentially no biochemistry being taught. A few of us managed to persuade Prof. Bernard Gould to offer a course. There wasn't much to teach but he did what he could. As I recall, protein synthesis was proposed to involve proteolytic enzymes such as trypsin and pepsin running backwards!!!

Photobiology is in a similar state: I see no pertinent courses in the current MIT catalog although photosynthesis is likely covered. Perhaps an informed faculty member might be persuaded to follow in the footsteps of Prof. Gould and have a try. My own education in photobiology was strictly ad hoc. It all began when the NIH asked me, as part of a contract relating to characterizing unusual drugs, to investigate photodynamic therapy. I visited Prof. Brian Stevens at the University of South Florida for a crash course in the elements of photophysics, then began attending ASP meetings with a view toward learning something useful. Informal discussions with Chris Foote, Len Grossweiner, Kendric Smith and Tom Dougherty were helpful. There were 'photobiology schools' at ASP meetings that provided updates but these presumed that the audience members knew a photon from a proton. In my case, having a background in chemistry and physics was a distinct advantage, although I still periodically need to remember the difference between wavelength and wavenumbers.

We now have a Photobiology Compendium on the ASP website which might be useful in view of the trend to online learning. This contains most of the essential elements of photobiology but is not necessarily written for the beginner. I tend to believe that the learning process is often expedited when a well-informed professor points the accusing finger (in class) and asks: 'What did I just say? If you didn't understand this, you are going to be totally lost during the next lecture."

The status of photobiology in 2018 appears to be a bit like attempting to learn to play the Didgeridoo. You will likely not find a formal course, but there may be a helpful fellow in Australia willing to provide a tutorial. Is this important? I suspect that most practicing photobiologists came into the field by accident, having stumbled on some photobiological phenomenon as a graduate student or post-doc and deciding to follow it up. Many also drift in from chemistry or biochemistry backgrounds, occasionally medicine. Len started in Physics, Tom and Chris in chemistry. The original founders of PDT (Sam Schwartz and Robert Lipson) were physicians. It might be interesting for the Newsletter to solicit some comments from photobiologists on how they wandered into the field and how they learned the difference between irradiance and fluence.

-David Kessel, PhD

We need YOU!

Please submit content (science highlights, suggested links, personal stories, etc) to ASP News. Email: jflovell@buffalo.edu or Huang.Huang-Chiao@mgh.harvard.edu

Bacteriorhodopsin filmed in action

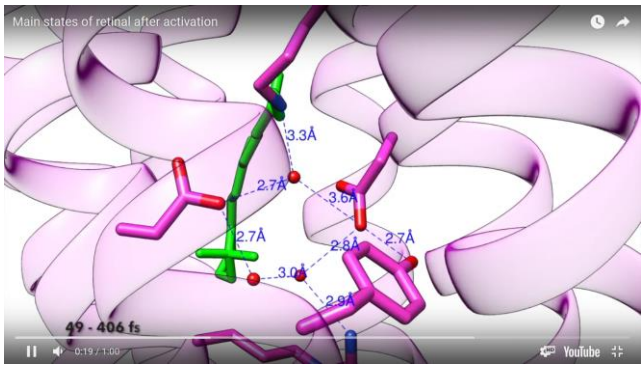
Using X-ray laser technology, a team led by researchers of the Paul Scherrer Institute PSI has recorded one of the fastest processes in biology. In doing so, they produced a molecular movie that reveals how the light sensor retinal is activated in a protein molecule. Such reactions occur in numerous organisms that use the information or energy content of light – they enable certain bacteria to produce energy through photosynthesis, initiate the process of vision in humans and animals, and regulate adaptations to the circadian rhythm. The movie shows for the first time how a protein efficiently controls the reaction of the embedded light sensor.

The images, published in the journal *Science*, were captured at the free-electron X-ray laser LCLS at Stanford University in California. Further investigations are planned at SwissFEL, the new free-electron X-ray laser at PSI. Besides the scientists from Switzerland, researchers from Japan, the USA, Germany, Israel, and Sweden took part in this study.

The molecule retinal is a form of vitamin A and is of central importance to humans, animals, certain algae, and many bacteria.

In the retina of the human eye, retinal triggers the process of vision when it changes its shape under the influence of light. In a similar form, certain bacteria also use this reaction to pump protons or ions through the cell membrane. Light energy can be stored in this way, as in the reservoir of an alpine hydropower plant, so that it is available on demand as biological fuel.

To ensure efficient utilisation of light, the retinal molecule is embedded in proteins that play a critical role in regulating the process. The protein-regulated reaction of retinal is one of the fastest biological processes and occurs within 500 femtoseconds (a femtosecond is one-millionth of one-billionth of a second). That is roughly a trillion times faster than the blink of an eye, says Jörg Standfuss, who heads the group for time-resolved crystallography in the Division of Biology and Chemistry at PSI. What happens in the process on the atomic level has now been captured for the first time, in 20 snapshots that they have assembled into a molecular movie. No one has previously measured a retinal protein at such high speed and with such precision.



The film shows the transition between the main states of retinal within the first picoseconds after activation in the binding pocket of the bacteriorhodopsin.

The researchers studied the protein bacteriorhodopsin, which is found in simple microbes. When the retinal molecule embedded in the bacteriorhodopsin traps a light particle, it changes its original elongated shape into a curving form, like when a cat arches its back, explains the PSI researcher. Such changes can also be observed when retinal is examined in a solution without protein. There, though, different reactions, which are also less productive, take place.

The researchers discovered that water molecules in the vicinity of the retinal play a critical role. They were able to observe how the water molecules moved aside and made room for the retinal molecule to do its cat-arching-its-back move – in the technical jargon, a trans-cis isomerisation. This detail, which no one had seen before, surprised Jörg Standfuss, as he explains with the help of the cat analogy: You expect that a cat might arch its back to scare another one away. But here the second cat runs away even before the first has arched its back. Computer simulations confirm the measurements, which could be explained by ultrafast quantum processes.

Besides the retinal reaction, the researchers detected protein quakes that had been predicted by theory. The arching of the cat's back does not require the entire energy of the light that falls on the protein. Excess energy is released, evidently, not in the form of heat but rather in vibrations of the protein.

As samples, the researchers use tiny crystals in which the bacteriorhodopsin is densely packed in an ordered state. The light sensor in the bacteriorhodopsin is excited by a short pulse from an optical laser. Afterwards, the X-ray flash hits the crystal and lights up the scene. The time between the optical signal and the X-ray flash determines how far the reaction will have progressed. Individual snapshots taken at different points in time can be spliced together into a movie.

In serial crystallography, crystals are injected into an X-ray beam. When the beam and the crystal meet, rays of light are diffracted. The diffracted light rays are recorded by a detector. From the light patterns that many identical crystals produce at the detector, the structure of the crystals can be determined. For time-resolved experiments, an additional optical laser is used to activate the biomolecules in the crystal at a definite point in time.

After studying bacteriorhodopsin, the PSI researchers want to use SwissFEL to investigate the retinal in rhodopsin in our eyes. Similar retinal proteins can also be artificially incorporated into nerve cells, so it becomes possible to selectively activate nerve cells with light and study their function.

- Paul Scherrer Institute

Upcoming Photobiology Events

PDT and Photodiagnosis 2018. Sep 19-22, 2018, Munich, Germany. http://pdt2018.com

Photonics West BiOS. Feb 2-7, 2019, San Francisco https://spie.org/conferences-and-exhibitions/photonics-west/bios

IPA World Congress. June 28-July 4, 2019, Boston, https://www.ipaboston2019.org

Photosynthesis Gordon Research Conference. 2019, July 21-26, 2019, Newry, ME. http://www.grc.org/photosynthesis-conference/2019

17th International Congress on Photobiology & 18th Congress of the European Society for Photobiology, Aug 25-30, 2019: Barcelona, Spain http://www.iuphotobiology.org

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