2024 Biennial Meeting
American Society for Photobiology

Chicago, Illinois · July 27–30, 2024 · Sheraton Grand Chicago Riverwalk

"Future of and Diversity in Photosciences"

PROGRAM AND ABSTRACTS

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WELCOME

TO THE 2024 AMERICAN SOCIETY FOR PHOTOBIOLOGY BIENNIAL MEETING

Dear ASP members and guests,

On behalf of the organizing committee, it is my pleasure to welcome you to the 2024 42nd ASP Biennial Meeting in Chicago. This year's theme is "Future and Diverse" reflecting our commitment to supporting young scientists, promoting diversity in our field, and diversifying research topics in the meeting. In line with this theme, we are excited to introduce two new travel award categories: ASP First-Time Attendee Travel Awards, which honor exceptional scientists who are new to our society, and ASP International Travel Awards, designed to assist researchers from around the world in participating in our meeting.

We are thrilled to have you join us for this exciting event, where we will explore the latest developments in our field and connect with colleagues from around the world. Our program includes a wide range of presentations, keynote lectures, mentoring sessions, and networking opportunities, all designed to foster collaboration and exchange among scientists from diverse geographical and cultural backgrounds. Key areas of focus will include innovations in photodynamic therapy (PDT), advances in UV signaling and DNA repair mechanisms, cutting-edge research in photochemistry and protein-DNA interactions, and the role of photobiology in agriculture and renewable energy. Additionally, we will delve into the mechanisms of light signaling and allosteric regulation, as well as the applications of optogenetics tools in subcellular signaling and photomedicine.

We are also proud to feature the Kendric C. Smith Symposia, which will cover topics including spatially resolved transcriptomic profiling in melanoma, engineering nanomaterials for cancer photodynamic therapy, and exploring protein binding sites as cellular laboratories of DNA photochemistry. Additionally, we are excited to present the ASP-JSPP Symposium on Biological Responses to UV Radiation for the first time, showcasing our efforts to include more scientists from the Asia-Pacific region, represented by the Japanese Society for Photomedicine and Photobiology (JSPP). Alongside this new addition, we continue our tradition of hosting the ASP-ESP Symposium: From Sunlight to Actions and Solutions, in collaboration with the European Society for Photobiology (ESP). These symposia will highlight innovative research and solutions addressing the effects of UV radiation and the harnessing of sunlight for practical applications.

We hope that you will take advantage of all that the meeting has to offer and that you will leave feeling inspired and energized. Once again, welcome to Chicago and to the 2024 ASP Biennial Meeting. We look forward to a productive and enjoyable time together.

Sincerely,

President
Shiyong Wu

Past President
Alexander Greer

President-Elect
Sherri McFarland

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ASP 2024 PROGRAM HIGHLIGHTS

- Theme "Future of and Diversity in Photosciences"
- 190 abstracts (Option: a presenter can submit multiple abstracts)
- 269 presentations (Option: an abstract can be presented as oral, poster, or both)
  - 13 oral presentations in 5 plenary sessions
    - » Keynote Lectures (Drs. Mauricio Baptista, Akimichi Morita, and Bennett Van Houten)
    - » Kendric C. Smith Inter-Disciplinary Symposia on Photobiology (Drs. Nihal Ahmad, John Wyrick, and Huang Chiao Huang), followed by discussion session with food and drink
    - » ASP Presidential Lecture (Dr. Shiyong Wu)
    - » ESP Presidential Lecture (Dr. Massimo Trotta)
    - » ASP Editor Lecture (Dr. Jean Cadet)
    - » ASP Research Award Lecture (Dr. Alexander Greer)
    - » ASP New Investigator Award Lecture (Dr. Juan Pablo Fuenzalida Werner)
    - » ASP Lifetime Achievement Award Lecture (Dr. Santi Nonell)
    - » ASP Photon Award Lecture (Dr. Theresa Busch)
  - 124 oral presentations in 21 concurrent sessions (including ASP-ESP Symposium and ASP-JSPP Symposium)
  - 81 poster presentations in 3 poster sessions with coffee break
  - 51 presentations for "Come See My Presentation" (1-minute presentation with 1 slide)
- Awards Ceremony & Business Meeting (All are invited)
  - ASP 2024 Awards
    - » 8 ASP Awards
    - » 9 ASP First-Time Attendee Travel Awards
    - » 11 ASP International Travel Awards
    - » 34 ASP Urbach Travel Awards
  - Oral and poster presentation awards
- 3 mentoring sessions with breakfast (40 ASP Associate Members per session)
- Social Event "Chicago River Cruise" (Ticketed event)
- Sign up for pay-your-own-way dinner (Optional event)
- Outreach program for local high school and undergraduate students (Free registration for the first 100 registrants)

ASP 2024 MENTORING SESSIONS WITH BREAKFAST

ASP Associate Member Event (Registration required)

We will have 3 mentoring sessions with breakfast (7:30 AM – 8:45 AM on July 28, 29, and 30). Each session is limited to 40 ASP Associate Members (students and postdocs). It is complimentary to attend, but the registration for this event is required.

Career Conversations with ASP Leadership (July 28)

Chairs: Shiyong Wu & Gurleen Kaur

Dr. Shiyong Wu (ASP President), Dr. Alexander Greer (Past ASP President), and Dr. Sherri McFarland (ASP President-Elect) will talk about their career journeys and discuss what career paths are available for photoscientists.

Peer Mentoring Circles (July 29)

Chair: Masaoki Kawasumi

Mentoring is critical for career advancement, particularly for junior researchers who experience unique career challenges. It is sometimes challenging to find a safe, brave space to talk about real-world problems and seek advice. Peers often have better understanding of the issues and can make nice suggestions from colleague's viewpoint. Here, we will create "Peer Mentoring Circles" and build a junior researcher community and mentoring network. Participants bring any challenges to discuss within a Circle, and other participants ask questions and make suggestions.

Grant Writing (July 30)

Chairs: Shobhan Gaddameedhi & Verónica Bahamondes Lorca

Dr. Mike Humble (National Institute of Environmental Health Sciences), Dr. Yu-Ying He (The University of Chicago), and Dr. Shobhan Gaddameedhi (North Carolina State University) will talk about how to find grant opportunities and how to write successful grant applications.

ASP 2024 OUTREACH PROGRAM

SCIENTIFIC CONFERENCE EXPERIENCE FOR LOCAL HIGH SCHOOL AND UNDERGRADUATE STUDENTS

Date & Time: Saturday, July 27, 2024 at 1:30–5:30 pm

Location: Sheraton Grand Chicago Riverwalk (301 East North Water Street, Chicago, IL 60611)

Photobiology researchers study the interactions of light with living organisms. Have you ever attended a research conference and discussed science with researchers? Join this outreach program (4 hours) with free registration (first 100 registrants)!

Outreach Program Chairs: Drs. Masaoki Kawasumi, Xiaojing Yang, and Yu-Ying He

1:30–2:15 pm
Outreach Orientation

- How to get the most out of your first research conference (8 min) *Emma Wilkinson*
- Short research talk 1 (8 min) *Nikolas Kambitsis*
  "Structural basis and molecular mechanism of B_{12}-based Photoreceptor CarH"
- Short research talk 2 (8 min) *Manvitha Sanjaya*
  "DNA Damage and Repair Mechanism in Duckweed (Spirodela polyrhiza) Under Ultraviolet (UV-B) Radiation Stress"
- Short research talk 3 (8 min) *Rina Iwata*
  "Using Optogentics to Uncover Mechanisms of Cytokinesis"
- Short research talk 4 (8 min) *Adedotun Adekeye*
  "Improved Photodynamic Therapies"

2:15–4:30 pm
Join the Main Program: Plenary Session 1. Opening and Award Lecture

- Opening Remarks (10 min)
- Program Highlights (5 min)
- "Come See My Presentation" Part 1 (30 min) [1-minute presentation with 1 slide]
- ASP Lifetime Achievement Award Lecture (1 h)
- "Come See My Presentation" Part 2 (30 min) [1-minute presentation with 1 slide]

4:30–5:20 pm
Join the Main Program: Poster Session 1 & Coffee Break

- Scientific conversations with photoscience researchers (27 posters)

5:20–5:30 pm
Wrap up

ASP 2024 AWARDS

ASP Research Award

Alexander Greer

ASP New Investigator Award

Juan Pablo Fuenzalida Werner

ASP Lifetime Achievement Award

Santi Nonell

ASP Photon Award

Theresa Busch

ASP Editor's Student Research Award

Brittany Rickard

Photocite-A Award

Chikako Nishigori
Jose-Luis Sagripanti

Photocite-B Award

Arash Darafsheh

ASP First-Time Attendee Travel Awards

Tashmeeta Ahad
Bushra Aziz
José Bonomi-Barufi
Min Chen
Jiefu Jin
Tae-Hyuk Kwon
Kathiresan Selvam
Takuma Uo
Alice Walker

ASP International Travel Awards

Leonardo de Assis
Giorgio Delrosso
Anna-Maria Gierke
Hironobu Ikehata
Keiichi Inoue
Yoshifumi Kanayama
Rossella Labarile
Santi Nonell
Susana Carolina Nuñez Montoya
José Robinson-Duggon
Yu Shimojo

ASP Urbach Travel Awards

Established in memory of Fred Urbach (ASP Past President), ASP Urbach Travel Awards are intended to assist ASP Associate Members (students and postdocs) with travel expenses in order to present a poster or talk of their work at the ASP Meetings.

Chris Acquah
Carla Arnau del Valle
Chanda Bhandari
Loris Busch
Fernanda Cabral
Omar Castillo Gutierrez
Alejandro Garcia Ruiz
Gisele George
Natalia Gutierrez-Bayona
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Irin Pottanani Tom
Sithurandi Ubeysinghe
Michelle Verghese
Shruti Vig
Emma Wilkinson
Daniela F. Zamudio Diaz
Kai Zhang

ASP 2024 PLENARY SESSION SPEAKER PROFILES

Saturday, July 27, 2024

3:00 PM – 4:00 PM

ASP Lifetime Achievement Award Lecture

Light and Life: highlights of lifelong contributions to advancing photobiology

Santi Nonell

Santi Nonell is a ICREA Professor of Physical Chemistry at the IQS School of Engineering, (University Ramon Llull, Barcelona, Spain). He earned his Ph.D. for work carried out at the Max-Planck-Institut für Strahlenchemie (Silvia Braslavsky) and conducted postdoctoral research at the Arizona State University (Tom Moore) and the University of California Los Angeles (Chris Foote).

His core research interests lie in the area of physical and chemical photobiology, with a focus on singlet oxygen and the photochemical aspects of photodynamic therapy, a field to which he has contributed more than 200 papers.

He served as President of the European Society of Photobiology, Editor-in-Chief of the journal Photochemical & Photobiological Sciences, and as Chair of the Spanish Network of Biological Photochemistry. He is currently the Director of the Photobiology School of the European Society for Photobiology.

His honours include the Otto Hahn Medal of the Max Planck Society and the election as Fellow of the Royal Society of Chemistry.

5:45 PM – 6:15 PM

ASP New Investigator Award Lecture

Fluoresent proteins understanding, design, and applications

Juan Pablo Fuenzalida Werner

I am a Chilean protein engineering and spectroscopist; I have studied pharmaceutical chemistry at the Universidad Austral de Chile and earned my Ph.D. in protein and polysaccharide nanomaterials from the University of Münster, Germany, in collaboration with Johns Hopkins University and Hyderabad University. In the last eight years, from postdoc to the junior group leader at the Helmholtz Zentrum Munich and the Technical University of Munich, I have played with proteins like Lego bricks to manipulate their colors and properties, create new materials, and understand physicochemical processes. I have optimized proteins for optoelectronic applications and optoacoustic and fluorescence imaging. I have highly cited papers on polysaccharide base materials and on the fundamental understanding of exciton coupling and aromatic-aromatic interactions of different chromophores and fluorescent proteins. I will soon be promoted to Associate Professor at the Department of Chemistry at the University of Navarra in Spain.

Plenary Session Speaker Profiles

6:15 PM – 6:45 PM

ASP Photon Award Lecture

Form follows function in photodynamic therapy

Theresa Busch

Theresa M. Busch, PhD is professor and Associate Director of the Division of Research, Department of Radiation Oncology at the University of Pennsylvania. She serves as Vice Chair of Community Engagement in the Department of Radiation Oncology and is Co-director of the Radiobiology and Imaging Program at the University of Pennsylvania Abramson Cancer Center. Dr. Busch's laboratory performs translational research in the study of tumor microenvironment as it relates to radiation therapy, delivered as nonionizing radiation in the form of photodynamic therapy or ionizing radiation generated by photons or protons. This includes research of high dose rate FLASH proton radiotherapy in sparing of normal tissues. Using mechanistic knowledge gained from these studies, her laboratory investigates clinically relevant approaches to improve the therapeutic window of cancer treatment. Dr. Busch is involved in national and international societies on photomedical and radiation oncology research. She is currently Treasurer for the American Society for Photobiology.

6:50 PM – 7:15 PM

Kendric C. Smith Symposia Lecture

Spatially resolved transcriptomic profiling of melanoma development and progression

Nihal Ahmad

Nihal Ahmad is a Professor and Vice Chair for Research in the Department of Dermatology at the University of Wisconsin-Madison. He is also the Dr. Frederic E. Mohs Skin Cancer Research Endowed Chair and serves as a co-leader of the Cancer Prevention and Control program of the University of Wisconsin Carbone Cancer Center. Dr. Ahmad also has a joint appointment as a Senior Research Career Scientist at the William S. Middleton Memorial Veterans' Hospital (Madison, WI). He is also an elected Fellow of the American Association for the Advancement of Science (AAAS). Dr. Ahmad's research focuses on two major lines of investigation: (1) the mechanism of cancer development, with a specific focus on cell cycle and cell signaling; and (2) the prevention and experimental therapeutics of cancer by naturally occurring agents. Dr. Ahmad also studies the mechanisms associated with cutaneous ultraviolet (UV) responses. His research is funded by the National Institutes of Health and the Department of Veterans Affairs. He has published more than 225 papers in a wide range of high-impact scientific journals, in addition to a number of book chapters and scientific abstracts. He serves as the Editor-in-Chief of the Journal of Dermato-Oncology and an Associate Editor of Photochemistry and Photobiology, Toxicology and Applied Pharmacology, and Frontiers in Oncology. He also serves on the editorial board of several journals including, Life Sciences, Skin Pharmacology and Physiology, Clinical Medicine Insights: Urology, Journal of Clinical and Investigative Dermatology, Biomedicine Hub. In addition, Dr. Ahmad has trained a number of graduate students and postdoctoral fellows and most of his trainees are well placed in academics. He is continuously involved in training young scientists (clinicians and basic scientists) at the University of Wisconsin as well as the Madison VA. Also, he is actively involved in undergraduate and graduate level classroom teaching.

7:15 PM – 7:40 PM

Kendric C. Smith Symposia Lecture

Protein binding sites as cellular laboratories of DNA photochemistry

John Wyrick

Dr. John Wyrick did his undergraduate studies in biochemistry and biophysics at Washington State University, and then went on to complete his PhD degree at MIT, where he studied the regulation of genome-wide transcription in yeast by transcription factors and nucleosomes. He did a short postdoctoral stint at the California Institute of Technology before joining the faculty at his alma mater (WSU) in 2002, where he has remained since. His laboratory studies UV damage, DNA excision repair, and mutagenesis in yeast and human cells, with a particular focus on developing and utilizing genome-wide methods to map DNA damage formation, repair activity, and mutation rates.

7:40 PM – 8:05 PM

Kendric C. Smith Symposia Lecture

Engineering nanomaterial characteristics for cancer photodynamic therapy

Huang Chiao Huang

Huang-Chiao (Joe) Huang is an Associate Professor of Bioengineering at the University of Maryland, College Park. He completed his Ph.D. in Chemical Engineering at Arizona State University and his postdoctoral training in photomedicine at Harvard Medical School in 2018. His work is funded by NSF, NIH, private foundations, and industry. He has been recognized with several distinctions, such as the NIH Pathway to Independence Award and the NIH NIBIB Trailblazer Award. In 2020, Dr. Huang was elected to the board of councilors of the American Society for Photobiology. His research interests center around developing photodynamic therapy and light activatable nanotechnology to detect and treat disease.

Sunday, July 28, 2024

12:30 PM – 1:00 PM

ASP Editor Lecture

Publishing in Photochemistry and Photobiology

Jean Cadet

Jean CADET has graduated and obtained his PhD from the University of Grenoble before being the head of the Laboratory "Lésions des Acides Nucléiques" that he created at the French Atomic Energy Institute in Grenoble, France. He is affiliated since 2001 as Adjunct Professor at University of Sherbrooke, Sherbrooke, Canada. His main research interests focus on the elucidation of molecular effects of solar radiation and biologically relevant oxidants including ionizing radiation on nucleic acids ranging from compounds to cells. He is co-author of 640 peer-reviewed articles and book chapters and his h-index is 101. He is Editor-in-Chief of Photochemistry & Photobiology.

Plenary Session Speaker Profiles

1:00 PM – 2:00 PM

Keynote Lecture

Endogenous photosensitizers excited by visible light in skin cells: molecular understanding of the photodamage and photoprotection during and after sun exposure

Mauricio Baptista

Mauricio S. Baptista graduated in Pharmacy and Biochemistry, University of São Paulo in 1990, obtained a Master in Biological Sciences (Biochemistry) at the University of São Paulo in 1992 and a Ph.D. in Chemistry at Marquette University, USA in 1996. He did post-doctorate at UW-Madison School of Pharmacy, USA in 1997 and was a visiting professor at the Université Joseph Fourier (Grenoble-France) in 2006. Is full professor of Biochemistry at University of Sao Paulo. He is a member of the São Paulo State Academy of Sciences, of the Brazilian Societies of Biochemistry and Molecular Biology, of Chemistry, and of Biophysics and is board member of the American Society of Photobiology (ASP). Has scientific interest in the following subjects: photochemistry and photobiology, photoprotection, photodynamic therapy, sun care, redox processes, cell death, cell membranes and interfaces. Published more than 200 scientific articles that have been cited more than 20,000 times in Google Scholar.

2:00 PM – 3:00 PM

Keynote Lecture

Is PUVA (Psoralen+UVA) no longer necessary for refractory skin diseases?

Akimichi Morita

Professor Akimichi Morita graduated from Nagoya City University and received his MD in 1989. He later received his Ph.D. in basic immunology from Aichi Cancer Center in Nagoya. As a Humboldt Foundation Fellow, he studied photobiology and photoimmunology at Düsseldorf University in Düsseldorf, Germany, and underwent further training at the University of Texas Southwestern Medical Center in Dallas, TX, USA. Since then, he has introduced numerous standard phototherapies to Japan. He was appointed Professor and Chairman of the Department of Geriatric and Environmental Dermatology at Nagoya City University Graduate School of Medical Sciences in 2003 and currently holds the position of Vice Director of Nagoya City University Hospital. Professor Morita's main research interests are photobiology, phototherapy, cutaneous immunology, skin aging, cutaneous T-cell lymphoma, and psoriasis.

Professor Morita holds the title of President at the Japanese Society for Psoriasis Research (2022-) and is a board of directors for the International Council of Psoriasis (IPC). He was the President of the Japanese Society for Photomedicine and Photobiology (2018-2022) and the President of the Japanese Society for Investigative Dermatology (JSID)(2018-2020). He is an editorial board member of several prestigious medical journals and currently serves as Editor-in-Chief of Experimental Dermatology. He also served as Editor-in-Chief of the journal Photodermatology, Photomedicine & Photoimmunology (2018-2021) and Editor-in-Chief of the Journal of Dermatological Science (2008-2013). In addition, he has published over 290 articles in peer-reviewed journals (H-index: 51) and has written 26 books or book chapters.

Monday, July 29, 2024

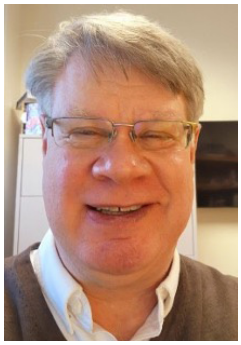
12:15 PM – 12:45 PM

ASP Research Award Lecture

Using Photochemistry to Help Solve Problems in Photomedicine and Photobiology

Alexander Greer

Alexander Greer is a professor of chemistry at Brooklyn College of the City University of New York (CUNY). His research focuses on mechanistic details underlying complex photochemical and biological processes, including those relating to anti-cancer photodynamic therapy (PDT). He is interested in light-initiated, and latent dark effects and unraveling mechanistic details that occur post-illumination. He served as ASP President-elect, President, and then Past-president from 2018-2024; during this time, initiatives launched include LatASP and the monthly webinar series. He also co-founded SingletO2 Therapeutics LLC and is an associate editor of Photochemistry & Photobiology, and co-chair of the Committee of Concerned Scientists.



12:45 PM – 1:45 PM

Keynote Lecture

Watching DNA repair at the single molecule level in chromatin: seeing is believing.

Bennett Van Houten

Dr. Bennett Van Houten is the Richard M. Cyert Professor of Molecular Oncology, in the Department of Pharmacology and Chemical Biology, and a member of the Molecular Biophysics & Structural Biology Graduate faculty. Dr. Van Houten and Dr. Patricia Opresko co-lead the Genome Stability Program at the UPMC-Hillman Cancer Center, where they oversee a group of 38 faculty studying mechanisms of genome stability and cancer.

Dr. Van Houten received his Bachelor's degree from Clarion University, Pennsylvania, and his Ph.D. from the University of Tennessee at the Oak Ridge Graduate School of Biomedical Sciences, Tennessee, in 1984. Ben did his postdoctoral training with Professor Aziz Sancar who was recognized with a Nobel Prize for Chemistry in 2015 for his mechanistic insights into DNA repair. Prior to moving to the University of Pittsburgh, Dr. Van Houten was the Chief of the Program Analysis Branch and Senior Investigator in the Laboratory of Molecular Genetics at National Institute of Environmental Health Sciences, NIH from 1999-2008.

Dr. Van Houten's laboratory is doing cutting-edge research the structure and function of DNA repair enzymes at the single molecule level and is currently supported by a NIEHS Revolutionizing Innovative Visionary Environmental health Research (RIVER) Award R35 ES031638.

Plenary Session Speaker Profiles

1:45 PM – 2:15 PM

ASP Presidential Lecture

Illuminating Horizons: The Diverse Future of Photomedicines

Shiyong Wu

Dr. Shiyong Wu is scientist and entrepreneur with extensive experience in academic research and biotechnology. He serves as a Professor in the Department of Chemistry and Biochemistry and directs the Edison Biotechnology Institute at Ohio University. Additionally, he is the President & CEO of ASAKE Biotechnology, LLC, a company he co-founded in 2020.

Dr. Wu earned his Ph.D. in Biochemistry in the Department of Chemistry from the University of Nebraska - Lincoln. He completed his B.S. in Chemistry majoring in Polymer Science at the University of Science and Technology of China. His postdoctoral training includes work at the Howard Hughes Medical Institute, University of Michigan Medical School.

Dr. Wu has been serving as the President of the American Society for Photobiology from 2022 to 2024. His career highlights include receiving the Presidential Research Scholar Award of Ohio University. He has secured significant NIH grant support for his research on chemoprevention of ultraviolet light-related diseases including skin cancer. Dr. Wu has published 87 peer-reviewed manuscripts. He also serves as an Associate Editor for Photochemistry and Photobiology, and The Journal of Dermato-Oncology.

2:15 PM – 2:45 PM

ESP Presidential Lecture

Photosynthetic Odyssey: A Quest for Sustainable Solutions

Massimo Trotta

Massimo graduated with a degree in Chemistry from the University of Bari, where he initially focused on NMR of solutions. Captivated by the beauty of photosynthesis, he then moved to the University of Bologna to join the lab of Prof. Andrea Melandri. Later, he continued his research at the University of California, San Diego, in the lab of Prof. George Feher. His early work centered on the molecular mechanisms of bacterial photosynthesis, but over time, his research expanded to explore the environmental applications of photosynthesis and photosynthetic organisms. His research topics range from bioremediation and solar energy transduction to the recent application of photosynthesis in space exploration.

Massimo has authored over 130 scientific publications, including articles, reviews, and book chapters. He has been invited to present his group's scientific findings at more than 60 conferences. Dedicated to science communication, Massimo has written over 80 articles for the popular science journal “Sapere” (“Knowledge”), founded in 1934 by Guglielmo Marconi. He recently published a book titled “The Power of Trees: How Photosynthesis Helps the Planet.”

Massimo previously chaired the Educational and Training Committee of the European Society for Photobiology (ESP) and currently serves as the president of ESP. He is organizing the upcoming ESP congress in Bari in August 2025.

GENERAL INFO

Registration Desk Hours

- Chicago Foyer (4th floor)
  Saturday, July 27: 1:00 PM – 6:30 PM
  Sunday, July 28: 7:30 AM – 3:00 PM
  Monday, July 29: 7:30 AM – 3:00 PM
  Tuesday, July 30: 7:30 AM – 3:00 PM

Exhibit Hall Hours

- Chicago Foyer (4th floor)
  Sunday, July 28: 9:30 AM – 4:00 PM
  Monday, July 29: 9:30 AM – 4:00 PM
  Tuesday, July 30: 9:30 AM – 4:00 PM

Meeting rooms

- Riverwalk A (1st floor) for poster sessions
- River Esplanade West (1st floor) for Kendric C. Smith Symposia discussion session with food and drink
- Sheraton 1 (4th floor) for concurrent and mentoring sessions
- Wrigleyville (3rd floor) for ASP Editor's Dinner and Council Meeting
- Chicago Foyer (4th floor) for registration desk and exhibits
- Sheraton 4 (4th floor) for plenary, concurrent, and outreach sessions
- Sheraton 5 (4th floor) for concurrent sessions

Coffee breaks

- Coffee Breaks will be provided mid morning in the Chicago Foyer (4th floor) and will be provided in the afternoons in Riverwalk A (1st floor).

Food and drink

- During the Kendric C. Smith Symposia at 6:45 pm–9:30 pm on Saturday, July 27, 2024, food and drink will be provided to all participants for the discussion with the lecturers and audience.

Poster presentation

- Riverwalk A
- Posters (up to 42 x 42 inches) can be displayed throughout the meeting (4 days: 4:00 pm, Saturday, July 27 to 5:00 pm, Tuesday, July 30).
- Push pins will be provided.
- Presenters are assigned to one of three poster sessions and are expected to be available in front of their posters during the 1-hour session.
  - Poster Session 1 (4:30 PM – 5:30 PM, Saturday, July 27): P01, P04, …, P79
  - Poster Session 2 (3:00 PM – 4:00 PM, Sunday, July 28): P02, P05, …, P80
  - Poster Session 3 (3:00 PM – 4:00 PM, Tuesday, July 30): P03, P06, …, P81

Oral presentation

- Please bring your presentation on a USB drive to the session room before the session starts.

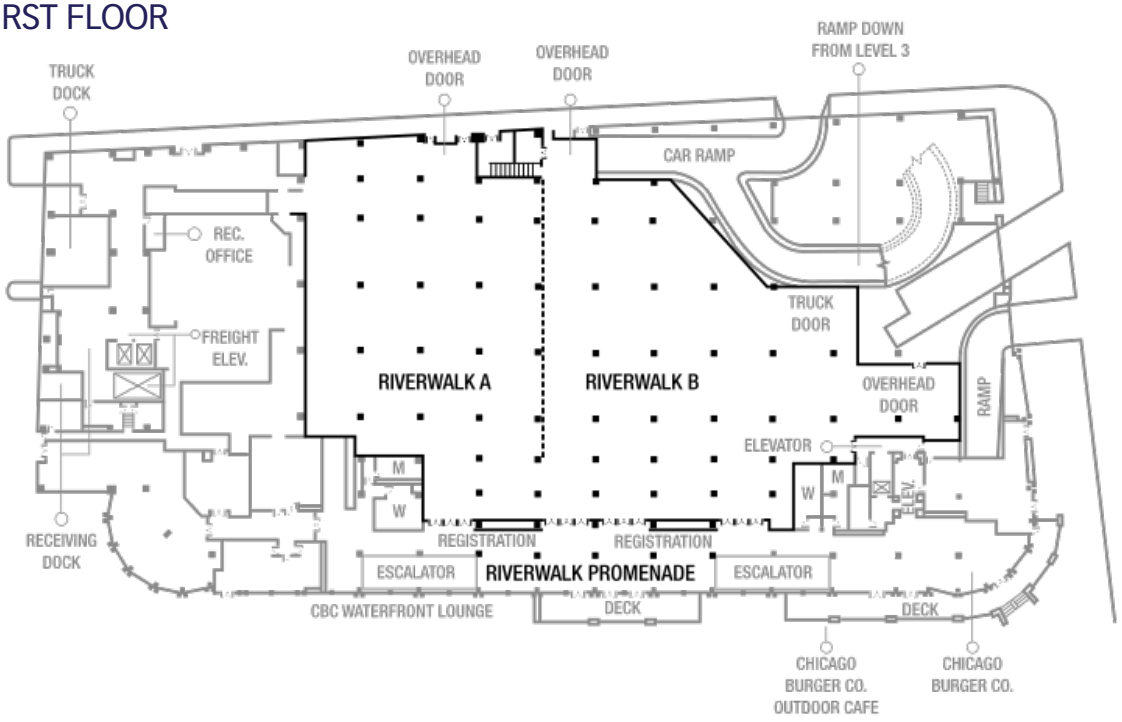
Oral presentation length

- Keynote Lectures, Lifetime Achievement Award Lecture
  - 1 hour: **45-minute presentation, 10-minute Q&A**, 5-minute speaker introduction/transition
- Presidential Lectures, Research Award Lecture, New Investigator Award Lecture, Photon Award Lecture, Editor Lecture
  - 30 minutes: **22-minute presentation, 5-minute Q&A**, 3-minute speaker introduction/transition
- Concurrent session presentations, Kendric C. Smith Symposia Lectures
  - 25 minutes: **20-minute presentation, 4-minute Q&A**, 1-minute speaker introduction/transition
- "Come See My Presentation" (1 slide without animation)
  - 1 minute: **55-second presentation**, 5-second transition

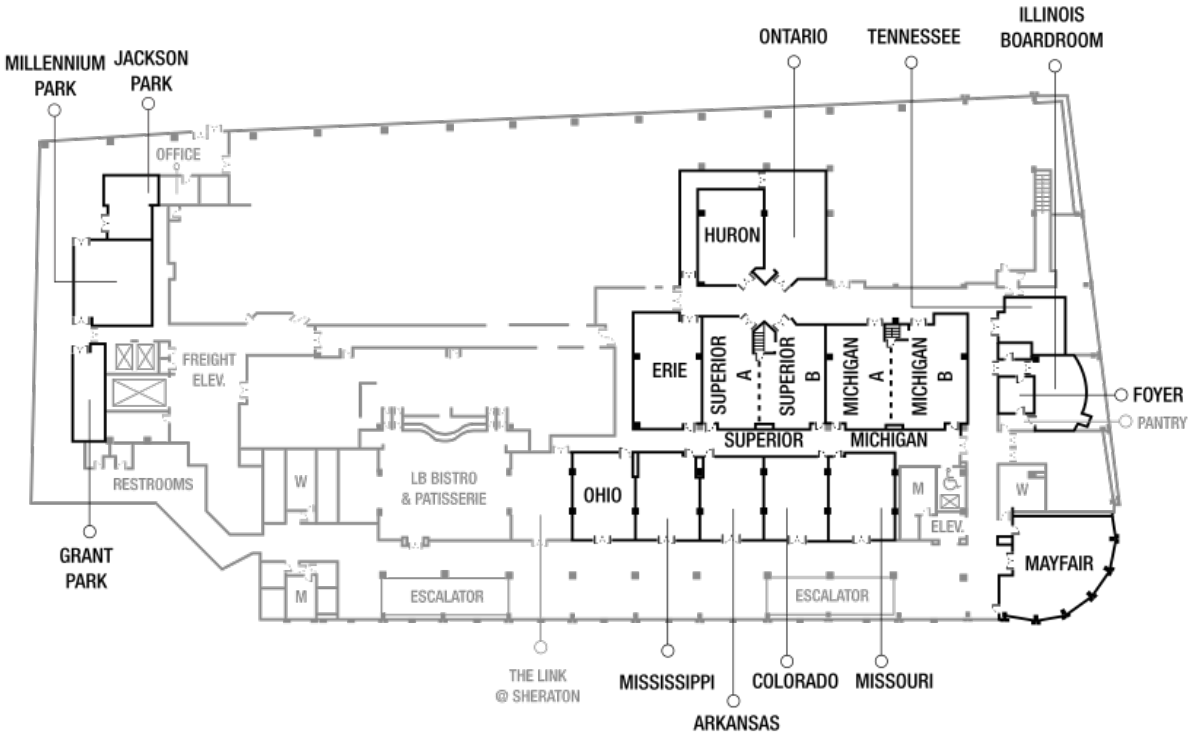
FLOOR PLAN

Sheraton Grand Chicago Riverwalk (301 East North Water Street, Chicago, IL 60611)

FIRST FLOOR

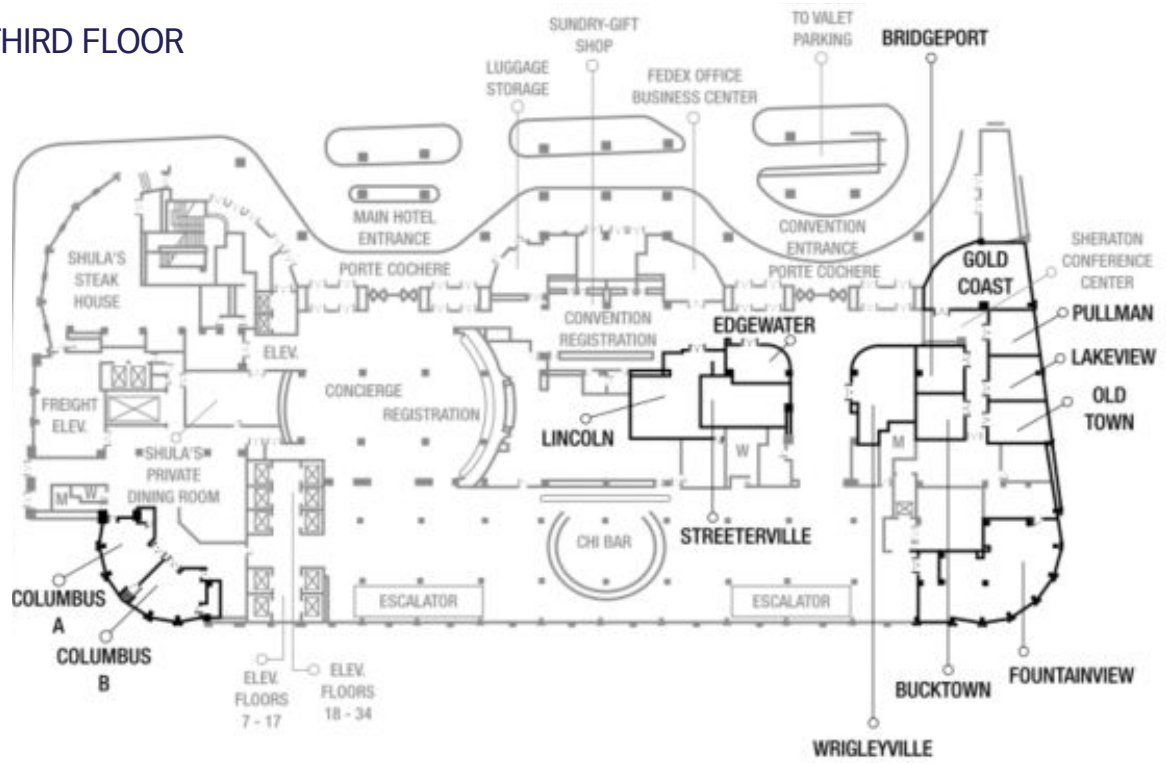


SECOND FLOOR

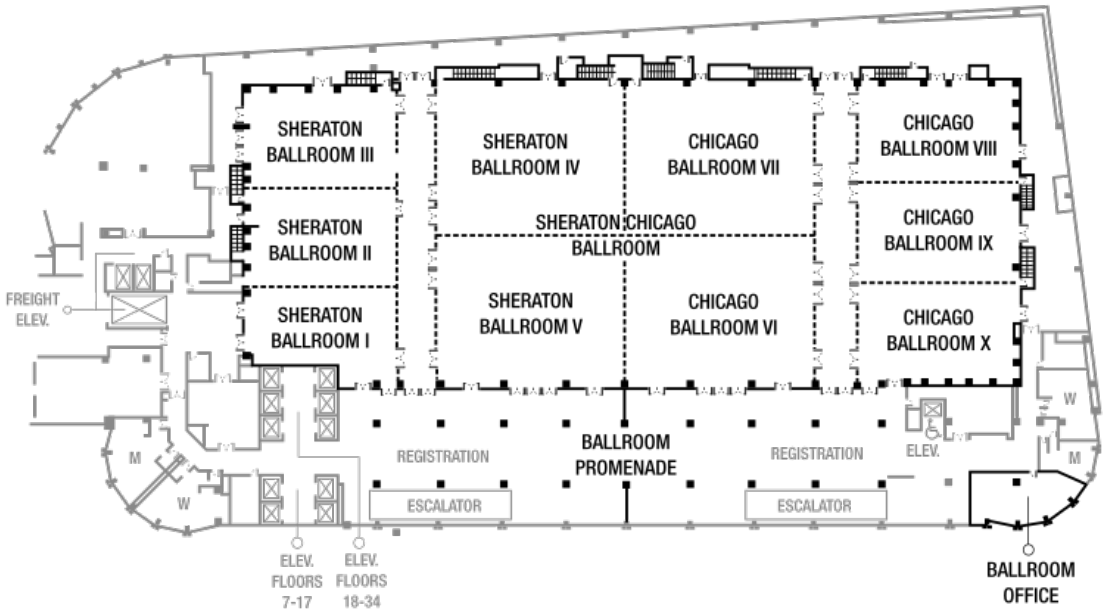


Sheraton Grand Chicago Riverwalk Floor Plan

THIRD FLOOR



FOURTH FLOOR



CONFERENCE CODE OF CONDUCT

The American Society for Photobiology (ASP) is dedicated to ensuring a discrimination-free and harassment-free environment at its conferences. All attendees (including, but not limited to, participation as a volunteer, vendor, exhibitor, registrant, member of the public, or guest) are required to adhere to the ASP Conference Code of Conduct to maintain an inclusive, safe, and respectful atmosphere.

Expected Behavior

- Respect and Dignity: Treat all individuals with respect and dignity, valuing diversity and differing viewpoints.
- Non-Discrimination: Refrain from discrimination based on race, ethnicity, gender, sexual orientation, disability, age, nationality, or religion.
- Harassment-Free Environment: Avoid any form of harassment, including unwelcome sexual advances, requests for sexual favors, or other verbal or physical harassment of a sexual nature.
- Professional Behavior: Engage in professional behavior, avoiding disruptive conduct during oral and poster presentations.
- Confidentiality and Privacy: Respect the confidentiality and privacy of other participants, and do not disclose personal or sensitive information without consent.

Reporting Procedures

If you experience or observe harassment or other unacceptable behavior, we recommend that you write down the details as soon as possible, in as much detail as possible, to help you to recall specific events in the future. If you believe you have experienced or observed harassment, notify ASP in one or more of the following ways:

- The Code of Conduct rapid response line (703) 592-9946.
- Via our confidential reporting web portal burkinc.ethicspoint.com which connects to ASP's independent Safety Officer.
- At the meeting registration desk for in-person meetings.
- By contacting one of the Society's Executive Officers (President, Past President, President-Elect, Secretary, Treasurer) or ASP 2024 Program Chair.

Enforcement

The ASP will not tolerate harassment of conference participants in any form or retaliation for reporting of misconduct.

- Immediate Compliance: Attendees asked to stop any inappropriate behavior are expected to comply immediately.
- Consequences of Misconduct: The ASP reserves all rights to take any lawful and appropriate remedial and/or preventative action with respect to any individual who does not abide by this Code of Conduct and/or the incorporated policies, or disregards or violates sanctions imposed by other adjudicating bodies (e.g., court orders, universities), including:
  - Removal from or denial of access to the meeting without a refund of any applicable registration fees.
  - Disqualification from attendance at future meetings.
  - Reporting to the attendee's institution or employer if necessary.

Commitment to Inclusivity

- ASP is committed to fostering an inclusive environment where all participants feel welcome and valued, regardless of their background, identity, or experience.
- By fostering an inclusive and respectful environment, ASP aims to ensure a productive and enjoyable experience for all participants.

ASP President

Shiyong Wu

ASP 2024 Program Chairs

Masaoki Kawasumi, kawasumi@uw.edu
Shobhan Gaddameedhi, sgaddam4@ncsu.edu

ABBREVIATED SCHEDULE

	Saturday, July 27, 2024
7:30 AM	
7:45 AM	
8:00 AM	
8:15 AM	
8:30 AM	
8:45 AM	
9:00 AM	
9:15 AM	
9:30 AM	
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11:00 AM	
11:15 AM	
11:30 AM	
11:45 AM	
12:00 PM	
12:15 PM	
12:30 PM	
12:45 PM	
1:00 PM	
1:15 PM	
1:30 PM	1:30 PM – 2:15 PM Sheraton 4 (4th fl.) **Outreach Orientation** *(Outreach ends at 5:30 PM)* Masaoki Kawasumi, Xiaojing Yang, and Yu-Ying He
1:45 PM	
2:00 PM	
2:15 PM	2:15 PM – 4:30 PM Sheraton 4 (4th fl.) **Plenary Session 1. Opening and Award Lecture** Shiyong Wu Sherri McFarland · Opening Remarks (10 min) · Program Highlights (5 min) · "Come See My Presentation" Part 1 (30 min) · Lifetime Achievement Award (1 h) Santi Nonell · "Come See My Presentation" Part 2 (30 min)
2:30 PM	
2:45 PM	
3:00 PM	
3:15 PM	
3:30 PM	
3:45 PM	
4:00 PM	
4:15 PM	
4:30 PM	4:30 PM – 5:30 PM Riverwalk A (1st fl.) **Poster Session 1 & Coffee Break**
4:45 PM	
5:00 PM	
5:15 PM	
5:30 PM	
5:45 PM	5:45 PM – 6:45 PM Sheraton 4 (4th fl.) **Plenary Session 2. Award Lectures** Shiyong Wu · New Investigator (0.5 h) Juan Pablo Fuenzalida Werner · Photon Award (0.5 h) Theresa Busch
6:00 PM	
6:15 PM	
6:30 PM	
6:45 PM	6:45 PM – 9:30 PM Sheraton 4 (4th fl.) **Plenary Session 3. Kendric C. Smith Symposia** Shiyong Wu · Introduction (5 min) · Lecture (25 min) Nihal Ahmad · Lecture (25 min) John Wyrick · Lecture (25 min) Huang Chiao Huang · Discussion with the Lecturers and audience (1.5 h) (Food and drink will be provided to all participants)
7:00 PM	
7:15 PM	
7:30 PM	
7:45 PM	
8:00 PM	
8:15 PM	
8:30 PM	
8:45 PM	
9:00 PM	
9:15 PM	

Orange series: Plenary Sessions and Poster Sessions

Blue series: Concurrent Sessions

Green series: Registration required or invitation only

Bold: Abbreviated Session Titles
Red: Session Chairs
Black: Speakers

Social Media Channels

Please share your pictures and impressions taken during the meeting. Use **#photobio2024** when posting about the event!

ASPhotobiology
@ASPhotobiology
company/photobiology

Abbreviated Schedule

Sunday, July 28, 2024

7:30 AM – 8:45 AM Sheraton 1 (4th fl.)
Mentoring with Breakfast 1
Shiyong Wu & Gurleen Kaur
"Career Conversations"
[Registration required]

9:00 AM – 11:30 AM Sheraton 4 (4th fl.)
C01. UV Damage and Carcinoma
Yu-Ying He
Georg Wondrak
· Masaoki Kawasumi
· Emma Wilkinson
· Jonathan Hall
· Jim Mai
· Tashmeeta Ahad

9:00 AM – 11:30 AM Sheraton 5 (4th fl.)
C02. Narrowband UVB and PDT
Marigdalia Ramirez-Fort
Christopher Lange
· Christopher Lange
· Marigdalia Ramirez-Fort
· Zhahedia-Zhaythseff Fort
· Sourav Seth
· Chris Acquah
· Sanjay Anand

9:00 AM – 11:30 AM Sheraton 1 (4th fl.)
C03. Light Harvesting
Wendy Schluchter
María Agustina Domínguez-Martín
· Christopher Gisriel
· Jindong Zhao
· Min Chen
· Wendy Schluchter
· Rossella Labarile
· Jean-Luc Ayitou Ayitou

12:30 PM – 3:00 PM Sheraton 4 (4th fl.)
Plenary Session 4. Editor and Keynote Lectures
Shiyong Wu
Alexander Greer
· Editor (30 min) Jean Cadet
· Keynote (1 h) Mauricio Baptista
· Keynote (1 h) Akimichi Morita

3:00 PM – 4:00 PM Riverwalk A (1st fl.)
Poster Session 2 & Coffee Break

4:00 PM – 6:30 PM Sheraton 4 (4th fl.)
C04. Far-UVC
David Sliney
David Welch
· David Welch
· Natalia Gutierrez-Bayona
· Daniela F. Zamudio Díaz
· Loris Busch
· Anna-Maria Gierke
· Richard Williamson

4:00 PM – 6:30 PM Sheraton 5 (4th fl.)
C05. Biocompatible Photosensitizers
Andrés Thomas
Carlos E. Crespo-Hernández
· Wenfang Sun
· Denis Fuentealba
· Carla Arnau del Valle
· Sherri McFarland
· Virginie Lhiaubet-Vallet
· Carlos E. Crespo-Hernández

4:00 PM – 6:30 PM Sheraton 1 (4th fl.)
C06. Photoreceptors
Xiaojing Yang
Jimena Rinaldi
Nathan Rockwell
Dongping Zhong
Irin Pottanani Tom
Keiichi Inoue
Jimena Rinaldi
Ajith Karunarathne

7:00 PM – 8:30 PM Wrigleyville (3rd fl.)
ASP Editor's Dinner
[Invitation only]

Sign up for pay-your-own-way dinners
[Optional]

Abbreviated Schedule

Monday, July 29, 2024

7:30 AM – 8:45 AM Sheraton 1 (4th fl.)
Mentoring with Breakfast 2
Masaoki Kawasumi
"Peer Mentoring Circles"
[Registration required]

9:00 AM – 11:30 AM Sheraton 4 (4th fl.)
C07. Immune System and UV
Nabiha Yusuf
Hui Xu
- Mitch Denning
- Savannah Scruggs
- Michelle Verghese
- Ming-Lin Liu
- Yu-Ying He
- Georg Wondrak

9:00 AM – 11:30 AM Sheraton 5 (4th fl.)
C08. Phototherapy in Dermatology
Piergiacomo Calzavara-Pinton
Elizabeth Buzney
- Elizabeth Buzn dey
- Piergiacomo Calzavara-Pinton
- Iltefat Hamzavi
- Bernhard Ortel
- Edward Maytin

9:00 AM – 11:30 AM Sheraton 1 (4th fl.)
C09. Photoactive Materials
Ryan McCulla
Alexander Greer
- Clemens Burda
- Evgueni Nesterov
- Ryan McCulla
- Christian Liboy
- Anna Gudmundsdottir
- Tadeusz Sarna

12:15 PM – 2:45 PM Sheraton 4 (4th fl.)
Plenary Session 5. Award/Keynote/Presidential Lectures
Alexander Greer
Sherri McFarland
- Research Award (0.5 h) Alexander Greer
- Keynote (1 h) Bennett Van Houten
- ASP President (0.5 h) Shiyong Wu
- ESP President (0.5 h) Massimo Trotta

2:45 PM – 3:15 PM Riverwalk A (1st fl.)
Coffee Break

3:15 PM – 5:45 PM Sheraton 4 (4th fl.)
C10. Biological Responses to UV
Teruhiko Makino
Masaoki Kawasumi
- Teruhiko Makino
- Hironobu Ikehata
- Yoshifumi Kanayama
- Takuma Uo
- Yu Shimojo
- Taiki Seki

3:15 PM – 5:45 PM Sheraton 5 (4th fl.)
C11. PDT in Combination Strategies
Patrycja Nowak-Sliwinska
Theresa Busch
- Arjan Griffioen
- Patrycja Nowak-Sliwinska
- Marta Overchuk
- Shakir Khan
- Fernanda Cabral
- Austin Nguyen

3:15 PM – 5:45 PM Sheraton 1 (4th fl.)
C12. Computational Photobiology
Igor Schapiro
Elisa Pieri
- Alice Walker
- Nancy Makri
- Ji Tae Park
- Elisa Pieri
- Omar Castillo Gutierrez
- Samer Gozem

6:15 PM Boarding starts
6:30 PM – 8:30 PM
Social Event "Chicago River Cruise"
(Food and drink are included)
[Ticketed event]

Abbreviated Schedule

Tuesday, July 30, 2024

7:30 AM – 8:45 AM Sheraton 1 (4th fl.)
Mentoring with Breakfast 3
Gaddameedhi & Bahamondes Lorca
"Grant Writing"
[Registration required]

9:00 AM – 11:30 AM Sheraton 4 (4th fl.)
C13. UV Damage, Repair, Mutagenesis
John Wyrick
Peng Mao
· John-Stephen Taylor
· Steven Roberts
· Kathiresan Selvam
· Peng Mao
· John Wyrick
· Douglas Brash

9:00 AM – 11:30 AM Sheraton 5 (4th fl.)
C14. Photoprotection
Miguel Puertas
Flavia Vischi Winck
· Miguel Puertas
· Flavia Vischi Winck
· Juliette Bertrand
· Katie Varman
· Janis Eells
· Gisele George

9:00 AM – 11:30 AM Sheraton 1 (4th fl.)
C15. Optical Control of Signaling
Ajith Karunarathne
Sithurandi Ubeysinghe
· Phyllis Robinson
· Waruna Thotamune
· Wenjing Wang
· Patrick O'Neill
· Igor Schapiro
· Chaiheon Lee

12:15 PM – 2:45 PM Sheraton 4 (4th fl.)
C16. Circadian Rhythms and Sleep
Shobhan Gaddameedhi
Michael Kemp
· Shobhan Gaddameedhi
· Sami Qutob
· John Rogers
· Leonardo de Assis
· Michael Kemp
· Gagan Chhabra

12:15 PM – 2:45 PM Sheraton 5 (4th fl.)
C17. Nanotechnology and PDT
Sherri McFarland
Nihal Ahmad
· John Quinlan
· Jose Quilez Alburquerque
· Chanda Bhandari
· Nimit Shah
· Jonathan Celli
· Gurleen Kaur

12:15 PM – 2:45 PM Sheraton 1 (4th fl.)
C18. Photosensitization
Jean Cadet
Mauricio Baptista
· Andrés Thomas
· José Robinson-Duggon
· Shruti Vig
· Albert Girotti
· Alexander Greer
· Tae-Hyuk Kwon

3:00 PM – 4:00 PM Riverwalk A (1st fl.)
Poster Session 3 & Coffee Break

4:00 PM – 6:30 PM Sheraton 4 (4th fl.)
C19. Natural Products in Photobiology
Carolina Lorente
Verónica Bahamondes Lorca
· Erick Bastos
· Carolina Lorente
· José Bonomi-Barufi
· Susana Carolina Nuñez Montoya
· Cristian Villa
· Samjhana Maharjan

4:00 PM – 6:30 PM Sheraton 5 (4th fl.)
C20. Photoimmunotherapy for Cancer
Huang Chiao Huang
Carla Arnau del Valle
· Hisataka Kobayashi
· Bryan Spring
· Rebecca Harman
· Jiefu Jin
· Sumiao Pang
· Liam Price

4:00 PM – 6:30 PMSheraton 1 (4th fl.)
C21. ASP-ESP Symposium
Shiyong Wu
Massimo Trotta
· Shiyong Wu
· Massimo Trotta
· Xiaojing Yang
· Ardemis Boghossian
· Jeffrey Cameron
· María Agustina Domínguez-Martín

6:45 PM–7:15 PM Sheraton 4 (4th fl.)
Awards Ceremony & Business Meeting

7:30 PM – 9:30 PM Wrigleyville (3rd fl.)
Council Meeting (1 h)
Executive Council Meeting (1 h)
[Invitation only]

Sign up for pay-your-own-way dinners
[Optional]

TECHNICAL PROGRAM

Saturday, July 27, 2024

2:15 PM – 4:30 PM Sheraton 4 (4th floor)

Plenary Session 1. Opening and Award Lecture

Chairs: Shiyong Wu & Sherri McFarland

2:15 PM – 2:25 PM
Opening Remarks
Shiyong Wu

2:25 PM – 2:30 PM
Program Highlights
Masaoki Kawasumi & Shobhan Gaddameedhi

2:30 PM – 3:00 PM
"Come See My Presentation" Part 1

#1 *Yuxi Zhou*
Innovating Precision Delivery Systems for NOTCH Activation in Cutaneous Squamous Cell Carcinoma

#2 *Jonathan Hall*
C/EBPβ mediates keratinocyte apoptosis after UVB-induced DNA damage via regulation of the innate immune inflammatory response and extrinsic apoptosis

#3 *Jim Mai*
Residential ambient UVB and UVA and incidence of keratinocyte carcinoma in the nationwide US Radiologic Technologists cohort

#4 *Marigdalia Ramirez-Fort*
nbUVB Photo- and/or Brachy-therapy for the treatment of virus in tissue (Part I)

#5 *Christopher Lange*
Lessons from ionizing radiation radiobiology with potential applicability to photobiology (Part I)

#6 *Carla Arnau del Valle*
Development of verteporfin nanoparticles for the targeted photodynamic therapy of ovarian cancer

#7 *Irin Pottanani Tom*
Mechanisms of Light Signaling and Allosteric Regulation in Dual-sensor Photoreceptor PPHK

#8 *Jimena Rinaldi*
Structural bases of the light sensing in the phytopathogen Xanthomonas campestris. Long-range signaling mechanism of a bacteriophytochrome

#9 *Ajith Karunarathne*
Magical Power of Optogenetics Tools in Subcellular Signaling Interrogation-Statins and other Tales.

#10 *Michelle Verghese*
The N6-methyladenosine RNA methylation-binding protein YTHDC2 regulates the repair of UVB-induced DNA damage and histone modification

#11 *Ming-Lin Liu*
UVB irradiation empowered neutrophils with transmigratory and proinflammatory abilities to mediate acute lupus flares with skin and kidney inflammation

#12 *Dieter Manstein, Jr.*
Enhanced antibacterial effect of blue light in combination with an Amazonian tree sap (Croton lechleri)

#13 *Christian Liboy*
Imaging protoporphyrin IX photoproduct formation kinetics for monitoring of PDT response

#14 *Anna Gudmundsdottir*
Photoinitated Release of Oxygen and Nitrogen Gases and Potential Applications of Gas Release in Biomedical Applications

#15 *David Sliney*
Studies of Ocular Effects of Far-UV-C Wavelengths on the Human Cornea

#16 *Yoshifumi Kanayama*
Ultraviolet C (UVC) irradiation induces regulatory T cells in skin and lymph nodes

#17 *Patrycja Nowak-Sliwinska*
Enhancing photodynamic immunotherapy with optimized drug combinations reprograming the immunosuppressive tumor microenvironment

#18 *Marta Overchuk*
Photochemical targeting of platinum resistance in ovarian cancer cells: The role of lipid peroxidation

#19 *Jose Quilez Alburquerque*
Photoactivable liposomes in combination with minocycline cooperatively overcome resistance to irinotecan in pancreatic cancer

#20 *Austin Nguyen*
Increased conjugation of IRDye800CW potentiates photodynamic therapy with Cetuximab-IRDye800CW

#21 *Alice Walker*
Excited state simulations of fluorescent and photoactive proteins for rational design

#22 *Ji Tae Park*
Mathematical modeling of antibody-photosensitizer conjugate tumor distribution for predicting photoimmunotherapy dosimetry and efficacy

#23 *Elisa Pieri*
Conical intersection accessibility dictates brightness in red fluorescent proteins

#24 *Omar Castillo Gutierrez*
Functionalization of Protoporphyrin IX, experiments and computational modeling

#25 *Flavia Vischi Winck*
Regulation of microalgae metabolism using nanocarrier and light inducible systems

3:00 PM – 4:00 PM

ASP Lifetime Achievement Award Lecture

Light and Life: highlights of lifelong contributions to advancing photobiology

Santi Nonell

4:00 PM – 4:30 PM

"Come See My Presentation" Part 2

#26 *Janis Eells*
Unblinded by the Light: Photobiomodulation for the Treatment of Retinal Injury and Disease

#27 *Gisele George*
Chemical and morphological markers for melanin aging: Part 1

#28 *Patrick O'Neill*
Controlling intracellular receptor activation with a genetically encoded opto-ligand

#29 *Leonardo de Assis*
The cutaneous photosensitive system and its role in physiological and pathological processes of the skin

#30 *Gagan Chhabra*
Functional significance of squamous cell carcinoma antigen 2 (SCCA2) in human melanoma

#31 *John Quinlan*
Self-assembled verteporfin nanoaggregates for photodynamic therapy in glioblastoma multiforme

#32 *Jonathan Celli*
Enabling technology for precision, image-guided photodynamic therapy of oral lesions

#33 *Shruti Vig*
ABC efflux transporter-mediated translocation of photosensitizers

#34 *José Bonomi-Barufi*
Algal biological responses photo-regulated by using monochromatic LEDs strategy

#35 *Rebecca Harman*
Activatable photoimmunotherapy to target cancer cells, spare T cells, and engage anti-tumor immunity

#36 *Liam Price*
Investigating how gain-modulated pulse amplification impacts femtosecond laser ablation efficiency in soft tissue

#37 *Ardemis Boghossian*
There's plenty of room at the (nano-bio) boundary

#38 *Kai Zhang*
Open-source high-power light-emitting diode array platform for cell-culture photodynamic therapy

#39 *Manvitha Sanjaya*
DNA Damage and Repair Mechanism in Duckweed (Spirodela polyrhiza) Under Ultraviolet (UV-B) Radiation Stress

#40 *Witold Korytowski*
A Spheroid Model of Nitric Oxide's Pro-tumor Effects in Anti-tumor Photodynamic Therapy

#41 *Jasmyn Johnson*
Chemical and morphological markers for melanin aging: Part 2

#42 *Nicholas Otero*
Optimizing antibody-photosensitizer conjugate specificity and dosimetry in 3D cell culture tumor models

#43 *Jose Quilez Alburquerque*
Light-triggered nanoliposomes to combat multi-drug resistance

#44 *Kai Zhang*
Fiber-scanning video multiphoton microendoscope towards real-time guidance of photo-immuno therapy

#45 *Umar Sheikh*
Inhibitory role of Frizzled 1 in melanoma development and progression

#46 *Sarita Rawool*
Organic-Quantum Dot Hybrid Assemblies as Novel Type II Photodynamic Therapy Agents: Spectroscopy Mapping of Triplet Exciton Migration within the Hybrid Photo-materials

#47 *Linta Maruthurethu Biju*
Mechanisms of light perception and signal integration in a far-red-sensing photoreceptor

#48 *Jesus Gomez*
Polylactic Acid/Photosensitizer-Based Filament for the Design of Light-Activatable 3D-Printed Antimicrobial Platforms

#49 *Chathuri Rajarathna*
Optically Controllable Blue Opsin at the Endoplasmic Reticulum

#50 *Bushra Aziz*
Synergistic effects of Ficus Carica leaves extract mediated chemo-photodynamic therapy on rhabdomyosarcoma cells

#51 *Juan Pablo Fuenzalida Werner*
Fluoresent proteins understanding, design, and applications.

4:30 PM – 5:30 PM Riverwalk A (1st floor)
Poster Session 1 & Coffee Break

P01 *David Sliney*
Studies of Ocular Effects of Far-UV-C Wavelengths on the Human Cornea

P04 *Yoshifumi Kanayama*
Ultraviolet C (UVC) irradiation induces regulatory T cells in skin and lymph nodes

P07 *Marta Overchuk*
Photochemical targeting of platinum resistance in ovarian cancer cells: The role of lipid peroxidation

P10 *Austin Nguyen*
Increased conjugation of IRDye800CW potentiates photodynamic therapy with Cetuximab-IRDye800CW

P13 *Omar Castillo Gutierrez*
Functionalization of Protoporphyrin IX, experiments and computational modeling

P16 *Flavia Vischi Winck*
Regulation of microalgae metabolism using nanocarrier and light inducible systems

P19 *Gisele George*
Chemical and morphological markers for melanin aging: Part 1

P22 *Gagan Chhabra*
Functional significance of squamous cell carcinoma antigen 2 (SCCA2) in human melanoma

P25 *John Quinlan*
Self-assembled verteporfin nanoaggregates for photodynamic therapy in glioblastoma multiforme

5:45 PM – 6:45 PM Sheraton 4 (4th floor)

Plenary Session 2. Award Lectures

Chair: Shiyong Wu

5:45 PM – 6:15 PM

ASP New Investigator Award Lecture

Fluoresent proteins understanding, design, and applications.

Juan Pablo Fuenzalida Werner

6:15 PM – 6:45 PM

ASP Photon Award Lecture

Form follows function in photodynamic therapy

Theresa Busch

6:45 PM – 9:30 PM Sheraton 4 (4th floor)

Plenary Session 3. Kendric C. Smith Inter-Disciplinary Symposia on Photobiology

Chair: Shiyong Wu

The purpose of this symposium shall be to stimulate the cross-fertilization of ideas and techniques between different areas of photobiology. The symposium generally shall consist of lectures focusing on up to three different areas of photobiology, with discussion periods to include a discussion at the end of the program in which the Lecturers and audience shall consider how the information presented can be used in other fields of photobiology.

6:45 PM – 6:50 PM

Introduction

Shiyong Wu

6:50 PM – 7:15 PM

Kendric C. Smith Symposia Lecture

Spatially resolved transcriptomic profiling of melanoma development and progression

Nihal Ahmad

7:15 PM – 7:40 PM

Kendric C. Smith Symposia Lecture

Protein binding sites as cellular laboratories of DNA photochemistry

John Wyrick

7:40 PM – 8:05 PM

Kendric C. Smith Symposia Lecture

Engineering nanomaterial characteristics for cancer photodynamic therapy

Huang Chiao Huang

8:05 PM – 9:30 PM River Esplanade West (1st floor)

Discussion with the Lecturers and audience

(Food and drink will be provided to all participants)

7:30 AM – 8:45 AM Sheraton 1 (4th floor)
Mentoring with Breakfast 1 (Registration required)
Career Conversations with ASP Leadership
Chairs: Shiyong Wu & Gurleen Kaur

9:00 AM – 11:30 AM Sheraton 4 (4th floor)
Concurrent Session 1. UV Damage and Keratinocyte Carcinoma
Chairs: Yu-Ying He & Georg Wondrak

C01-1 9:00 AM – 9:25 AM
Integrative analysis of transcriptome and DNA methylation to identify potential epigenetic targets in poorly differentiated cutaneous squamous cell carcinoma
Masaoki Kawasumi

C01-2 9:25 AM – 9:50 AM
Unveiling an m6A RNA methylation-independent role of METTL14 in response to UV damage
Emma Wilkinson

C01-3 9:50 AM – 10:15 AM
C/EBPβ mediates keratinocyte apoptosis after UVB-induced DNA damage via regulation of the innate immune inflammatory response and extrinsic apoptosis
Jonathan Hall

C01-4 10:15 AM – 10:40 AM
Residential ambient UVB and UVA and incidence of keratinocyte carcinoma in the nationwide US Radiologic Technologists cohort
Jim Mai

C01-5 10:40 AM – 11:05 AM
Longitudinal non-invasive optical biopsy of keratinocyte cancers to monitor efficacy and response to treatment
Tashmeeta Ahad

9:00 AM – 11:30 AM Sheraton 5 (4th floor)
Concurrent Session 2. Narrowband UVB and Photodynamic Therapy
Chairs: Marigdalia Ramirez-Fort & Christopher Lange

C02-1 9:00 AM – 9:25 AM
Lessons from ionizing radiation radiobiology with potential applicability to photobiology (Part I)
Christopher Lange

C02-2 9:25 AM – 9:50 AM
nbUVB Photo- and/or Brachy-therapy for the treatment of virus in tissue (Part I)
Marigdalia Ramirez-Fort

C02-3 9:50 AM – 10:15 AM
Narrowband UVB phototherapy in the management of cutaneous human papillomavirus infection
Zhahedia-Zhaythseff Fort

C02-4 10:15 AM – 10:40 AM
6-Azauridine Derivatives as Phototheranostic and Photodynamic Therapeutic Agents for Cancer Treatment
Sourav Seth

C02-5 10:40 AM – 11:05 AM
Investigation of Biocompatible Organic Photosensitizers and Development of a Low-Cost, 3D Printed Irradiation System for Reproducible Photodynamic Therapy Experiments
Chris Acquah

C02-6 11:05 AM – 11:30 AM
Old dog, new tricks: Differentiation therapy causes immunomodulation during photodynamic therapy of murine squamous precancers of the skin
Sanjay Anand

9:00 AM – 11:30 AM Sheraton 1 (4th floor)

Concurrent Session 3. Light Harvesting Proteins: Structure, Biogenesis, and Applications

Chairs: Wendy Schluchter & María Agustina Domínguez-Martín

C03-1 9:00 AM – 9:25 AM
Structure-function relationships of far-red light-absorbing allophycocyanins
Christopher Gisriel

C03-2 9:25 AM – 9:50 AM
Energy transfer from phycobilisomes to photosystems in cyanobacteria
Jindong Zhao

C03-3 9:50 AM – 10:15 AM
The molecular basis of phycobiliproteins having red-shifted absorption beyond 700 nm
Min Chen

C03-4 10:15 AM – 10:40 AM
The role of bilin lyases and lyase-isomerases in blue-green chromatic acclimation in marine Synechococcus.
Wendy Schluchter

C03-5 10:40 AM – 11:05 AM
Photosynthetic bacteria for environmentally safe biotechnological applications
Rossella Labarile

C03-6 11:05 AM – 11:30 AM
Novel Sulfur-Containing Auxiliaries as Emerging Tools for Photochemical Transformations and Drug Discovery
Jean-Luc Ayitou Ayitou

12:30 PM – 3:00 PM Sheraton 4 (4th floor)
Plenary Session 4. Editor and Keynote Lectures
Chairs: Shiyong Wu & Alexander Greer

12:30 PM – 1:00 PM

ASP Editor Lecture

Publishing in Photochemistry and Photobiology

Jean Cadet

1:00 PM – 2:00 PM

Keynote Lecture

Endogenous photosensitizers excited by visible light in skin cells: molecular understanding of the photodamage and photoprotection during and after sun exposure

Mauricio Baptista

2:00 PM – 3:00 PM

Keynote Lecture

Is PUVA (Psoralen+UVA) no longer necessary for refractory skin diseases?

Akimichi Morita

3:00 PM – 4:00 PM Riverwalk A (1st floor)
Poster Session 2 & Coffee Break

P02 Michelle Verghese
The N6-methyladenosine RNA methylation-binding protein YTHDC2 regulates the repair of UVB-induced DNA damage and histone modification

P05 Nikolas Kambitsis
Structural basis and molecular mechanism of B_{12}-based Photoreceptor CarH

P08 Kai Zhang
Open-source high-power light-emitting diode array platform for cell-culture photodynamic therapy

P11 Manvitha Sanjaya
DNA Damage and Repair Mechanism in Duckweed (Spirodela polyrhiza) Under Ultraviolet (UV-B) Radiation Stress

P14 Mingyu Park
Lysosomal oxidation by neutral Ir(III) complexes to overcome drug-resistant cancer by downregulating autophagy

P17 Brittany Rickard
Photochemical targeting of chemotherapy resistance and functional mitochondrial enhancements induced by perfluoroalkyl substances (PFAS) in ovarian cancer cells

P20 Alexis Iverson
Photochemistry of N-Aryl and N-Alkyl Dibenzothiophene Sulfoximines

P23 Ravi Kishore Dakoju
Synthesis of Novel Photo-Active Indolizines & Azepines as Potential Candidates for Synergistic Medicinal Applications

P26 Sudip Timilsina
Identification of biomarkers for photoimmunotherapy of patient-derived primary ovarian cancer cell models

4:00 PM – 6:30 PM Sheraton 4 (4th floor)

Concurrent Session 4. Biological Studies of Far-UVC – A Hot Current Topic

Chairs: David Sliney & David Welch

C04-1 4:00 PM – 4:25 PM
Recent progress in exploring the antimicrobial efficacy and potential health hazards of far-UVC
David Welch

C04-2 4:25 PM – 4:50 PM
Extending the Erythema Action Spectrum to Include the Far-UVC
Natalia Gutierrez-Bayona

C04-3 4:50 PM – 5:15 PM
In vivo skin tolerance to 233 nm far UV-C irradiation in healthy humans: implications for effective and safe disinfection strategies
Daniela F. Zamudio Díaz

C04-4 5:15 PM – 5:40 PM
Tissue tolerability of 233 nm far UV-C light promises a wide range of applications: Latest results from ex vivo experiments
Loris Busch

C04-5 5:40 PM – 6:05 PM
Inactivation of C. auris via radiation (far-UVC up to blue light)
Anna-Maria Gierke

C04-6 6:05 PM – 6:30 PM
A Blueprint for the use of far-UVC to improve indoor air quality and prevent future pandemics
Richard Williamson

4:00 PM – 6:30 PM Sheraton 5 (4th floor)

Concurrent Session 5. Development and Use of New Biocompatible Photosensitizers

Chairs: Andrés Thomas & Carlos E. Crespo-Hernández

C05-1 4:00 PM – 4:25 PM
Developing Ir(III) Bis(terpyridine) Complexes for in vitro Photodynamic Therapy of Melanoma Cells
Wenfang Sun

C05-2 4:25 PM – 4:50 PM
Controlling Photosensitized-Singlet Oxygen Generation with Acyclic Cucurbituril-like Containers
Denis Fuentealba

C05-3 4:50 PM – 5:15 PM
Development of verteporfin nanoparticles for the targeted photodynamic therapy of ovarian cancer
Carla Arnau del Valle

C05-4 5:15 PM – 5:40 PM
Harnessing the Excited State Dynamics of Metal Complexes for Phototherapy
Sherri McFarland

C05-5 5:40 PM – 6:05 PM
Topical retinoids as efficient singlet oxygen sensitizers
Virginie Lhiaubet-Vallet

C05-6 6:05 PM – 6:30 PM
Biocompatible Organic Photosensitizers for Cancer Treatment
Carlos E. Crespo-Hernández

4:00 PM – 6:30 PM Sheraton 1 (4th floor)

Concurrent Session 6. Structures and Light Signaling Mechanisms of Photoreceptors

Chairs: Xiaojing Yang & Jimena Rinaldi

C06-1 4:00 PM – 4:25 PM
An additional lineage of two-Cys cyanobacteriochromes reveals plasticity of second linkage formation
Nathan Rockwell

C06-2 4:25 PM – 4:50 PM
New perspectives on the BLUF photoreceptors
Dongping Zhong

C06-3 4:50 PM – 5:15 PM
Mechanisms of Light Signaling and Allosteric Regulation in Dual-sensor Photoreceptor PPHK
Irin Pottanani Tom

C06-4 5:15 PM – 5:40 PM
New photochemistry of microbial rhodopsins revealed by time-resolved spectroscopy
Keiichi Inoue

C06-5 5:40 PM – 6:05 PM
Structural bases of the light sensing in the phytopathogen Xanthomonas campestris. Long-range signaling mechanism of a bacteriophytochrome
Jimena Rinaldi

C06-6 6:05 PM – 6:30 PM
Magical Power of Optogenetics Tools in Subcellular Signaling Interrogation-Statins and other Tales.
Ajith Karunarathne

7:00 PM – 8:30 PM Wrigleyville (3rd floor)

ASP Editor's Dinner (Invitation only)

7:00 PM –

Sign up for pay-your-own-way dinner (Optional)

7:30 AM – 8:45 AM Sheraton 1 (4th floor)
Mentoring with Breakfast 2 (Registration required)
Peer Mentoring Circles
Chair: Masaoki Kawasumi

9:00 AM – 11:30 AM Sheraton 4 (4th floor)
Concurrent Session 7. Regulation of Immune System by Ultraviolet Radiation
Chairs: Nabiha Yusuf & Hui Xu

C07-1 9:00 AM – 9:25 AM
UVB radiation induces multiple types of inflammatory necrotic cell death in human epidermal keratinocytes
Mitch Denning

C07-2 9:25 AM – 9:50 AM
An Enzyme-Coupled Istotope Dilution Mass Spectrometry Assay for Non-adjacent DNA Photoproducts as Intrinsic Probes for G-quadruplexes in vivo
Savannah Scruggs

C07-3 9:50 AM – 10:15 AM
The N6-methyladenosine RNA methylation-binding protein YTHDC2 regulates the repair of UVB-induced DNA damage and histone modification
Michelle Verghese

C07-4 10:15 AM – 10:40 AM
UVB irradiation empowered neutrophils with transmigratory and proinflammatory abilities to mediate acute lupus flares with skin and kidney inflammation
Ming-Lin Liu

C07-5 10:40 AM – 11:05 AM
Epitranscriptomic mechanisms of UV-induced inflammation and immune modulation
Yu-Ying He

C07-6 11:05 AM – 11:30 AM
Harnessing topical small molecule interventions impacting innate and adaptive responses for pharmacological protection of skin against solar UV damage
Georg Wondrak

9:00 AM – 11:30 AM Sheraton 5 (4th floor)
Concurrent Session 8. Reshaping the Role of Phototherapy in Dermatology
Chairs: Piergiacomo Calzavara-Pinton & Elizabeth Buzney

C08-1 9:00 AM – 9:25 AM
Realistic reappraisal of the use of phototherapy in the age of biologics: Psoriasis
Elizabeth Buzney

C08-2 9:25 AM – 9:50 AM
Realistic reappraisal of the use of phototherapy at the age of biologics: atopic dermatitis
Piergiacomo Calzavara-Pinton

C08-3 9:50 AM – 10:15 AM
A Realistic reappraisal of the use of Phototherapy at the age of biologics: Vitiligo
Iltefat Hamzavi

C08-4 10:15 AM – 10:40 AM
Reshaping the role of phototherapy in photodermatoses
Bernhard Ortel

C08-5 10:40 AM – 11:05 AM
Clinical trial of photodynamic therapy for actinic keratoses using short-contact protocols to reduce pain yet maintain therapeutic efficacy
Edward Maytin

9:00 AM – 11:30 AM Sheraton 1 (4th floor)

Concurrent Session 9. Photoactive Materials and Compounds for Biomedical Applications

Chairs: Ryan McCulla & Alexander Greer

C09-1 9:00 AM – 9:25 AM
Targeted Gold Nanoparticles Enhanced Photodynamic Cancer Therapy
Clemens Burda

C09-2 9:25 AM – 9:50 AM
Phthalocyanine near-infrared fluorescent probes for selective detection and assessment of kinase inhibitors in live cells
Evgueni Nesterov

C09-3 9:50 AM – 10:15 AM
Applications of the rare dual-release photochemistry of sulfoximines
Ryan McCulla

C09-4 10:15 AM – 10:40 AM
Imaging protoporphyrin IX photoproduct formation kinetics for monitoring of PDT response
Christian Liboy

C09-5 10:40 AM – 11:05 AM
Photoinitated Release of Oxygen and Nitrogen Gases and Potential Applications of Gas Release in Biomedical Applications
Anna Gudmundsdottir

C09-6 11:05 AM – 11:30 AM
Application of selected diene probes to monitor excited triplet states of synthetic eumelanin and pheomelanin
Tadeusz Sarna

12:15 PM – 2:45 PM Sheraton 4 (4th floor)

Plenary Session 5. Award, Keynote, and Presidential Lectures

Chairs: Alexander Greer & Sherri McFarland

12:15 PM – 12:45 PM

ASP Research Award Lecture

Using Photochemistry to Help Solve Problems in Photomedicine and Photobiology

Alexander Greer

12:45 PM – 1:45 PM

Keynote Lecture

Watching DNA repair at the single molecule level in chromatin: seeing is believing.

Bennett Van Houten

1:45 PM – 2:15 PM

ASP Presidential Lecture

Illuminating Horizons: The Diverse Future of Photomedicines

Shiyong Wu

2:15 PM – 2:45 PM

ESP Presidential Lecture

Photosynthetic Odyssey: A Quest for Sustainable Solutions

Massimo Trotta

2:45 PM – 3:15 PM Riverwalk A (1st floor)

Coffee Break

3:15 PM – 5:45 PM Sheraton 4 (4th floor)

Concurrent Session 10. ASP-JSPP (Japanese Society for Photomedicine and Photobiology) Symposium: Biological Responses to UV Radiation

Chairs: Teruhiko Makino & Masaoki Kawasumi

C10-1 3:15 PM – 3:40 PM

Ultraviolet B irradiation alters the expression of S100-fused proteins in human skin.

Teruhiko Makino

C10-2 3:40 PM – 4:05 PM

Wavelength-dependent variation of UVR-induced mutation signatures

Hironobu Ikehata

C10-3 4:05 PM – 4:30 PM

Ultraviolet C (UVC) irradiation induces regulatory T cells in skin and lymph nodes

Yoshifumi Kanayama

C10-4 4:30 PM – 4:55 PM
The effect of UV-induced mutations on the binding of ETS transcription factors to the Cdkn2a/p16 promoter
Takuma Uo

C10-5 4:55 PM – 5:20 PM
In silico evaluation of the effect of skin type on light dosimetry for photodynamic therapy
Yu Shimojo

C10-6 5:20 PM – 5:45 PM
In vivo NAMPT in epidermis is essential for UVB irradiation-induced oxidative and genomic stress responses and epidermal homeostasis.
Taiki Seki

3:15 PM – 5:45 PM Sheraton 5 (4th floor)

Concurrent Session 11. PDT in Combination Strategies

Chairs: Patrycja Nowak-Sliwinska & Theresa Busch

C11-1 3:15 PM – 3:40 PM
Vaccination against the tumor vasculature, an ideal strategy for anti-cancer combination strategies.
Arjan Griffioen

C11-2 3:40 PM – 4:05 PM
Enhancing photodynamic immunotherapy with optimized drug combinations reprograming the immunosuppressive tumor microenvironment
Patrycja Nowak-Sliwinska

C11-3 4:05 PM – 4:30 PM
Photochemical targeting of platinum resistance in ovarian cancer cells: The role of lipid peroxidation
Marta Overchuk

C11-4 4:30 PM – 4:55 PM
Modeling micro-invasive disease progression and response to ALA-PDT in 3D Head and Neck Carcinoma cell cultures
Shakir Khan

C11-5 4:55 PM – 5:20 PM
Photodynamic Priming as a Promising Strategy to Overcome Drug Resistance in Pancreatic Ductal Adenocarcinoma
Fernanda Cabral

C11-6 5:20 PM – 5:45 PM
Increased conjugation of IRDye800CW potentiates photodynamic therapy with Cetuximab-IRDye800CW
Austin Nguyen

3:15 PM – 5:45 PM Sheraton 1 (4th floor)

Concurrent Session 12. Frontiers in Computational Photobiology

Chairs: Igor Schapiro & Elisa Pieri

C12-1 3:15 PM – 3:40 PM
Excited state simulations of fluorescent and photoactive proteins for rational design
Alice Walker

C12-2 3:40 PM – 4:05 PM
Real-time path integral simulation of energy transfer in light harvesting complexes
Nancy Makri

C12-3 4:05 PM – 4:30 PM
Mathematical modeling of antibody-photosensitizer conjugate tumor distribution for predicting photoimmunotherapy dosimetry and efficacy
Ji Tae Park

C12-4 4:30 PM – 4:55 PM
Conical intersection accessibility dictates brightness in red fluorescent proteins
Elisa Pieri

C12-5 4:55 PM – 5:20 PM
Functionalization of Protoporphyrin IX, experiments and computational modeling
Omar Castillo Gutierrez

C12-6 5:20 PM – 5:45 PM
Flavoprotein Photoreceptors Through the Quantum Mechanical Looking Glass
Samer Gozem

6:30 PM – 8:30 PM (6:15 PM Boarding starts)

Social Event "Chicago River Cruise" (Ticketed event)

(Food and drink are included)

7:30 AM – 8:45 AM Sheraton 1 (4th floor)
Mentoring with Breakfast 3 (Registration required)
Grant Writing
Chairs: Shobhan Gaddameedhi & Verónica Bahamondes Lorca

9:00 AM – 11:30 AM Sheraton 4 (4th floor)
Concurrent Session 13. Genome Cartography of UV Damage Formation, Repair, and Mutagenesis
Chairs: John Wyrick & Peng Mao

C13-1 9:00 AM – 9:25 AM
Nanopore sequencing of DNA photoproducts
John-Stephen Taylor

C13-2 9:25 AM – 9:50 AM
Mutagenic bypass of atypical UV photoproducts
Steven Roberts

C13-3 9:50 AM – 10:15 AM
Phosphorylation of yeast Elf1 regulates transcription-coupled nucleotide excision repair by promoting binding of TFIIH to Elf1 C-terminal domain
Kathiresan Selvam

C13-4 10:15 AM – 10:40 AM
Genome-wide repair of UV damage in the chromatin of fission yeast
Peng Mao

C13-5 10:40 AM – 11:05 AM
Genome-wide map of repair by CPD photolyase
John Wyrick

C13-6 11:05 AM – 11:30 AM
Genome mapping of CPDs refractory to repair in keratinocytes after acute or chronic UV exposure
Douglas Brash

9:00 AM – 11:30 AM Sheraton 5 (4th floor)
Concurrent Session 14. Photoprotection and Photobiomodulation
Chairs: Miguel Puertas & Flavia Vischi Winck

C14-1 9:00 AM – 9:25 AM
Bioactives from marine macroalgae, a natural strategy to mitigate the prevalence of skin cancer associated with climate change
Miguel Puertas

C14-2 9:25 AM – 9:50 AM
Regulation of microalgae metabolism using nanocarrier and light inducible systems
Flavia Vischi Winck

C14-3 9:50 AM – 10:15 AM
Long-lasting and safe photoprotection using a skin-bioadhesive technology: A proof of concept with a novel M10 skin-bioadhesive UVA Filter
Juliette Bertrand

C14-4 10:15 AM – 10:40 AM
Applications of Photoprotective Agents in Clinical Dermatology
Katie Varman

C14-5 10:40 AM – 11:05 AM
Unblinded by the Light: Photobiomodulation for the Treatment of Retinal Injury and Disease
Janis Eells

C14-6 11:05 AM – 11:30 AM
Chemical and morphological markers for melanin aging: Part 1
Gisele George

9:00 AM – 11:30 AM Sheraton 1 (4th floor)

Concurrent Session 15. Optical Control of Cellular Signaling

Chairs: Ajith Karunarathne & Sithurandi Ubeysinghe

C15-1 9:00 AM – 9:25 AM
Melanopsin as an optogenetic switch for activating G-protein pathways
Phyllis Robinson

C15-2 9:25 AM – 9:50 AM
Optical Control of Cell-Surface and Endomembrane-Exclusive β-Adrenergic Receptor Signaling
Waruna Thotamune

C15-3 9:50 AM – 10:15 AM
Protein-based sensors and tools for studying neuromodulatory systems
Wenjing Wang

C15-4 10:15 AM – 10:40 AM
Controlling intracellular receptor activation with a genetically encoded opto-ligand
Patrick O'Neill

C15-5 10:40 AM – 11:05 AM
The role of the protein environment in the photoisomerization of the retinal chromophore
Igor Schapiro

C15-6 11:05 AM – 11:30 AM
Oxidative photocatalysis on membranes triggers non-canonical pyroptosis
Chaiheon Lee

12:15 PM – 2:45 PM Sheraton 4 (4th floor)

Concurrent Session 16. Circadian Rhythms, Sleep, and Photoreceptors in Skin Disease

Chairs: Shobhan Gaddameedhi & Michael Kemp

C16-1 12:15 PM – 12:40 PM
Environmental Circadian Disruption Aggravates UVB-induced Skin Cancer Progression in Mice
Shobhan Gaddameedhi

C16-2 12:40 PM – 1:05 PM
Transcriptome Analysis in Mouse Skin After Exposure to Ultraviolet Radiation from a Canopy Sunbed
Sami Qutob

C16-3 1:05 PM – 1:30 PM
Wireless Devices for Monitoring Sleep and Circadian Rhythms
John Rogers

C16-4 1:30 PM – 1:55 PM
The cutaneous photosensitive system and its role in physiological and pathological processes of the skin
Leonardo de Assis

C16-5 1:55 PM – 2:20 PM
REV-ERB inhibition impacts gene expression and UV responses in keratinocytes and human skin
Michael Kemp

C16-6 2:20 PM – 2:45 PM
Functional significance of squamous cell carcinoma antigen 2 (SCCA2) in human melanoma
Gagan Chhabra

12:15 PM – 2:45 PM Sheraton 5 (4th floor)

Concurrent Session 17. Nanotechnology and PDT

Chairs: Sherri McFarland & Nihal Ahmad

C17-1 12:15 PM – 12:40 PM
Self-assembled verteporfin nanoaggregates for photodynamic therapy in glioblastoma multiforme
John Quinlan

C17-2 12:40 PM – 1:05 PM
Photoactivable liposomes in combination with minocycline cooperatively overcome resistance to irinotecan in pancreatic cancer
Jose Quilez Alburquerque

C17-3 1:05 PM – 1:30 PM
Targeting PD-L1 with photoactivable liposomes: Promoting self-penetration through dense collagen and improving immunotherapy in pancreatic cancer
Chanda Bhandari

C17-4 1:30 PM – 1:55 PM
Comparative analysis of a solid lipid nanoparticle formulation and a liposomal formulation of a verteporfin lipid conjugate
Nimit Shah

C17-5 1:55 PM – 2:20 PM
Enabling technology for precision, image-guided photodynamic therapy of oral lesions
Jonathan Celli

C17-6 2:20 PM – 2:45 PM
Adapting traditional drug discovery approaches for identifying optimal photosensitizers for photodynamic inactivation of resistant bacteria
Gurleen Kaur

12:15 PM – 2:45 PM Sheraton 1 (4th floor)

Concurrent Session 18. Photosensitization of Biomolecules: From Model Reactions to the Cell

Chairs: Jean Cadet & Mauricio Baptista

C18-1 12:15 PM – 12:40 PM
Type I photosensitized oxidations in proteins and the oxygen paradox
Andrés Thomas

C18-2 12:40 PM – 1:05 PM
Understanding Toluidine Blue Photochemistry for Applications in Photosensitized Oxidations
José Robinson-Duggon

C18-3 1:05 PM – 1:30 PM
ABC efflux transporter-mediated translocation of photosensitizers
Shruti Vig

C18-4 1:30 PM – 1:55 PM
Anti-PDT and pro-tumor effects of nitric oxide in photodynamic therapy: an update
Albert Girotti

C18-5 1:55 PM – 2:20 PM
Mechanistic Underpinnings of Phototoxicity: Studies of Post-Illumination Damage Effects
Alexander Greer

C18-6 2:20 PM – 2:45 PM
Photodynamic Therapy-Induced Cell Death Based on Targeted Organelles
Tae-Hyuk Kwon

3:00 PM – 4:00 PM Riverwalk A (1st floor)
Poster Session 3 & Coffee Break

P03 Jim Mai
Residential ambient UVB and UVA and incidence of keratinocyte carcinoma in the nationwide US Radiologic Technologists cohort

P06 Tashmeeta Ahad
Longitudinal non-invasive optical biopsy of keratinocyte cancers to monitor efficacy and response to treatment

P09 Sourav Seth
6-Azauridine Derivatives as Phototheranostic and Photodynamic Therapeutic Agents for Cancer Treatment

P12 Chris Acquah
Investigation of Biocompatible Organic Photosensitizers and Development of a Low-Cost, 3D Printed Irradiation System for Reproducible Photodynamic Therapy Experiments

P15 Chanda Bhandari
Targeting PD-L1 with photoactivable liposomes: Promoting self-penetration through dense collagen and improving immunotherapy in pancreatic cancer

P18 Irin Pottanani Tom
Mechanisms of Light Signaling and Allosteric Regulation in Dual-sensor Photoreceptor PPHK

P21 Savannah Scruggs
An Enzyme-Coupled Istotope Dilution Mass Spectrometry Assay for Non-adjacent DNA Photoproducts as Intrinsic Probes for G-quadruplexes in vivo

P24 Takuma Uo
The effect of UV-induced mutations on the binding of ETS transcription factors to the Cdkn2a/P16 promoter

P27 Yu Shimojo
In silico evaluation of the effect of skin type on light dosimetry for photodynamic therapy

P30 Chaiheon Lee
Oxidative photocatalysis on membranes triggers non-canonical pyroptosis

P33 Michael Kemp
REV-ERB inhibition impacts gene expression and UV responses in keratinocytes and human skin

P36 Nimit Shah
Comparative analysis of a solid lipid nanoparticle formulation and a liposomal formulation of a verteporfin lipid conjugate

P39 Susana Carolina Nuñez Montoya
Natural anthraquinones with antimicrobial and antitumor potential in Photodynamic Therapy.

P42 Cristian Villa
Development of chlorophyllin – gold nanoparticles (Chi-Au Nps) systems for dual photothermal and photoinactivation of bacteria.

P45 Jiefu Jin
Near-infrared photoimmunotherapy of cancer cells and cancer-associated fibroblasts

P48 Xiaojing Yang
Light Signaling and Allostery Mechanisms of Bacteriophytochromes

P51 *Carolina Lorente*
Photosensitizing properties of a pterin containing adduct on DNA and related molecules

P54 *Marigdalia Ramirez-Fort*
nbUVB Photo- and/or Brachy-therapy for the treatment of virus in tissue (Part II)

P57 *Christopher Lange*
Lessons from ionizing radiation radiobiology with potential applicability to photobiology (Part II)

P60 *Cristian Villa*
Synergetic effect of chlorophyllin (Chi) and curcumin (Cur) in aPDT of A. niger spores.

P63 *Alexander Greer*
Practical Aspects in the Study of Biological Photosensitization Including Reaction Mechanisms and Product Analyses: A Do's and Don'ts Guide

P66 *Hironobu Ikehata*
Wavelength-dependent variation of UVR-induced mutation signatures

P69 *Melannie Garcia*
Photosensitizing effect and binding of Toluidine Blue on Human Serum Albumin

P72 *Gretchen Ritacco*
New Approach Methodologies for Photoallergy: Preliminary Investigations with Reference Chemicals

P75 *Andrés Thomas*
Functionalization of polyallylamine with 6-carboxypterin: A promising and novel biocompatible polymer with photosensitizing properties

P78 *Georg Wondrak*
UVA-photosensitization impacts miRNA expression in reconstructed human epidermis

P81 *Alexander Greer*
Theoretical Investigation of Optical and Nonlinear Optical (NLO) Properties of X@ZnPc Complexes

4:00 PM – 6:30 PM Sheraton 4 (4th floor)

Concurrent Session 19. Latest Progress in the Use of Natural Products in Photobiology

Chairs: Carolina Lorente & Verónica Bahamondes Lorca

C19-1 4:00 PM – 4:25 PM
Plant biofluorescence: Insights from betalain-pigmented systems
Erick Bastos

C19-2 4:25 PM – 4:50 PM
Prevention of Ptr Photosensitized Damage of Biomolecules by Vanillin
Carolina Lorente

C19-3 4:50 PM – 5:15 PM
Algal biological responses photo-regulated by using monochromatic LEDs strategy
José Bonomi-Barufi

C19-4 5:15 PM – 5:40 PM
Natural anthraquinones with antimicrobial and antitumor potential in Photodynamic Therapy.
Susana Carolina Nuñez Montoya

C19-5 5:40 PM – 6:05 PM
Development of chlorophyllin – gold nanoparticles (Chi-Au Nps) systems for dual photothermal and photoinactivation of bacteria.
Cristian Villa

C19-6 6:05 PM – 6:30 PM
Rapid Synthesis and Structural Derivatization of Bioactive Bibenzyl Scaffolds via Metal-Free Organic Photocatalysis
Samjhana Maharjan

4:00 PM – 6:30 PM Sheraton 5 (4th floor)

Concurrent Session 20. Photoimmunotherapy for Cancer

Chairs: Huang Chiao Huang & Carla Arnau del Valle

C20-1 4:00 PM – 4:25 PM
Near Infrared Photoimmunotherapy (NIR-PIT) of Cancer
Hisataka Kobayashi

C20-2 4:25 PM – 4:50 PM
Concepts and technology development towards image-guided, multiplexed photoimmunotherapy
Bryan Spring

C20-3 4:50 PM – 5:15 PM
Activatable photoimmunotherapy to target cancer cells, spare T cells, and engage anti-tumor immunity
Rebecca Harman

C20-4 5:15 PM – 5:40 PM
Near-infrared photoimmunotherapy of cancer cells and cancer-associated fibroblasts
Jiefu Jin

C20-5 5:40 PM – 6:05 PM
Targeting the Unseen: Nanotechnology-enhanced photoimmunotherapy combined with fluorescence-guided intervention enhances survival in peritoneal carcinomatosis mouse models
Sumiao Pang

C20-6 6:05 PM – 6:30 PM
Investigating how gain-modulated pulse amplification impacts femtosecond laser ablation efficiency in soft tissue
Liam Price

4:00 PM – 6:30 PM Sheraton 1 (4th floor)

Concurrent Session 21. ASP-ESP (European Society for Photobiology) Symposium: From Sunlight to Actions and Solutions

Chairs: Shiyong Wu & Massimo Trotta

C21-1 4:00 PM – 4:25 PM
Photosynthesis: From Natural Marvel to Modern Solutions: Powering a Sustainable Future
Shiyong Wu

C21-2 4:25 PM – 4:50 PM
Photoactive Soft Materials based on Photosynthetic Enzymes
Massimo Trotta

C21-3 4:50 PM – 5:15 PM
Light Signaling and Allostery Mechanisms of Bacteriophytochromes
Xiaojing Yang

C21-4 5:15 PM – 5:40 PM
There's plenty of room at the (nano-bio) boundary
Ardemis Boghossian

C21-5 5:40 PM – 6:05 PM
Molecular mechanisms of photodamage and repair in cyanobacteria
Jeffrey Cameron

C21-6 6:05 PM – 6:30 PM
Structural insights into the light-harvesting and photoprotection mechanism in cyanobacteria
María Agustina Domínguez-Martín

6:45 PM – 7:15 PM Sheraton 4 (4th floor)
Awards Ceremony & Business Meeting (All are invited)

7:30 PM – 9:30 PM Wrigleyville (3rd floor)
Council Meeting & Executive Council Meeting (Invitation only)

7:45 PM –
Sign up for pay-your-own-way dinner (Optional)

ABSTRACTS

SORTED BY LAST NAME

Investigation of Biocompatible Organic Photosensitizers and Development of a Low-Cost, 3D Printed Irradiation System for Reproducible Photodynamic Therapy Experiments

Chris Acquah

Chris Acquah[1], Eric Lee, and Carlos E. Crespo-Hernandez[*]

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Recent efforts in the Crespo group have focused on developing novel biocompatible organic compounds capable of light absorption in the photodynamic therapeutic window from 650 to 850 nm. We have shown that the thionation of organic compounds shifts their absorption spectra while simultaneously enhancing their intersystem crossing efficiencies. In this presentation, I discuss the photochemical properties and excited state dynamics of thio-coumarin and thio-acridone that absorb light in the visible. I will compare the results with those previously obtained in our group for thio-4-(dimethylamino)naphthalamide and thionated Nile Red, which absorb light in the near-infrared region (*J. Am.Chem. Soc.* **2021**, 143, 7, 2676). In addition, I will highlight the development of a cost-effective LED-based illumination system for in vitro photodynamic treatments of cancer cells in multi-well plates (*Phtochem. Photobiol.* **2024**, DOI: 10.1111/php.13878). This innovative system, featuring a 3D-printed design, utilizes commercially available LED lamps across different irradiation wavelengths while ensuring precise temperature control and reproducibility. Comprehensive evaluations encompassing photon flux density, illumination uniformity, and temperature modulation underscore the system's efficacy. Validation studies involving treating mouse mammary breast carcinoma cells using Rose Bengal as a photosensitizer confirm the setup's cost-effectiveness, technical feasibility, and ability to deliver consistent and reproducible irradiation doses to facilitate in vitro investigations in photodynamic therapy.

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Longitudinal non-invasive optical biopsy of keratinocyte cancers to monitor efficacy and response to treatment

Tashmeeta Ahad

Shujian Li[1,3], Sunil Kalia[1,2,4,5], Harvey Lui[1,2], Zhenguo Wu[1,3], Haishan Zeng[1,2,3], Tim K. Lee[1,2,5,6] Jianhua Zhao[1,3], Tashmeeta Ahad[1,2]

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Non-invasive optical imaging offers a novel opportunity for monitoring efficacy and response of keratinocyte cancers to treatment, without the need for multiple surgical biopsies. We are using multimodal microscopy, integrating reflectance confocal microscopy (RCM), two-photon fluorescent (TPF) microscopy and second harmonic generation (SHG) as an alternative to surgical biopsy to monitor tumor cell dynamics after treatment. Patients with superficial keratinocyte carcinomas are assessed at 3-month intervals up to 12-months following treatment. Our preliminary results include 29 patients: 23 had basal cell carcinomas (BCCs) – 15 treated with curettage and electrodessication (C&D), 6 with surgical excision, 1 with photodynamic therapy, and 1 with 5% imiquimod. Additionally, 3 patients had squamous cell carcinomas (SCCs), treated with surgical excision, C&D, and 5-fluorouracil, respectively. 2 patients had actinic keratosis (AKs) and 1 patient had both AK and seborrheic keratosis (SKs); all three were treated with cryotherapy. Identifying features for BCCs included: tumor islands (aggregates of tumor cells) and SCCs: button-hole structures (dilated blood vessels within the dermal papillae that run perpendicular to the skin surface). Other key features include epidermal streaming (elongated keratinocytes arranged in a polarized directions), epidermal pleomorphism (varied keratinocytes cell shape and size at the same depth), and disrupted honeycomb pattern and collagen arrangement). Abnormal features disappeared post-treatment suggesting resolution of BCC/SCCs; this correlated with surgical biopsy results showing no residual malignancy (n=3). Excessive collagen deposition, suggesting ongoing dermal remodeling, was observed as a continuous process during the 12-month monitoring period.

Kendric C. Smith Symposia Lecture

Spatially resolved transcriptomic profiling of melanoma development and progression

Nihal Ahmad

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Solar ultraviolet (UV) radiation is a significant risk factor for developing cutaneous melanoma, a potentially fatal malignancy with a high mutation burden, genetic heterogeneity, and a complex tumor immune microenvironment. Therefore, understanding the mechanisms underlying melanoma initiation and/or progression is crucial for melanoma management. Here, we studied transcriptome changes in melanoma tumors and the immune microenvironment using spatial transcriptomics (NanoString GeoMx) on human melanoma tissue microarrays. Selected clinical tissues included 5 normal, 24 nevi, 31 primary, and 3 metastatic melanomas. Regions of interest (ROIs) in each tissue were based on pathology assessment (H&E) and morphology markers (S100/PMEL (melanoma), CD45 (immune)). Differential gene expression (log2 ±0.75 fold change and adjusted p-value<0.05) and pathway enrichment analyses were performed via the GeoMx Digital Spatial Profiler (DSP) suite. In S100+ cells, we found 617 upregulated/101 downregulated genes in melanoma vs normal skin. Similarly, in CD45+ cells, we found 274 upregulated/82 downregulated genes. In S100+ melanoma cells, the top 10 upregulated genes were SUPT7L, RPL36A, RPS4X, RPL15, RPS13, RPL12, ADAM15, RPL27, RPL35A, TOMM7, and top 10 downregulated genes were ABHD18, RAB31, NCAPG2, GPR135, GAPDHS, HOMER3, SDC2, CHIC2, CDHR1, MEF2B. The top upregulated pathway was ribosome proteins, which are not well studied in melanoma to date. Interestingly, S100A1, HLA-C, CD74, PRAME, and HLA-DRA were the top five genes uniquely upregulated in the melanoma vs nevi group. Overall, these findings are important in understanding the mechanism of melanoma development and

progression, further detailed analyses of our data are currently ongoing.

Old dog, new tricks: Differentiation therapy causes immunomodulation during photodynamic therapy of murine squamous precancers of the skin

Sanjay Anand

Sanjay Anand[1,2,3], Alan Shen[3], Cheng-En Cheng[1], Jacky Chen[3], Tayyaba Hasan[4], and Edward V Maytin[1,2,3,4]

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Photodynamic therapy (PDT) for skin cancer involves application of aminolevulinic acid (ALA) which is converted to protoporphyrin IX (PpIX). Subsequent exposure to visible light induces cell death and long-term immune responses that drive lesion clearance. Here, murine AK lesions generated by repeated UVB exposure of SKH-1 mice were treated topically with either 5-fluorouracil (5FU) or vitamin D (VitD) for three days prior to application of topical ALA, followed by blue light exposure. Local and systemic immune responses (by immunohistochemistry and flow cytometry, respectively) were analyzed at different times after PDT, with or without 5FU/VitD pretreatment. We observed an increased expression of damage-associated molecular patterns (DAMPs) and enhanced recruitment of innate immune cells [neutrophils (Ly6G+) and macrophages (F4/80+)], which was greater in 5FU/VitD treated lesions. While suppression of myeloid-derived suppressor cells (MDSCs; CD11b+ and Ly6G/C+) was observed in lesions treated with 5FU alone or with 5FU+PDT, enhanced infiltration of dendritic cells (CD11c+) was observed in lesions treated with VitD alone or with VitD+PDT. An enhanced infiltration of activated T cells (CD3+) throughout the time course, and of cytotoxic T cells (CD8+) approximately 1-2 weeks post PDT, was observed in 5FU/VitD treated lesions. Also, both 5FU and VitD pretreatment significantly reduced the presence of cells expressing the immune checkpoint marker PD-1, indicative of an anti-tumor immune response that promotes cytotoxic T cell activity in 5FU/VitD treated lesions. Data presented here suggest that PDT combined with either 5FU or VitD may provide additive benefit for skin cancer treatment in the dermatology clinic.

Development of verteporfin nanoparticles for the targeted photodynamic therapy of ovarian cancer

Carla Arnau del Valle

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Ovarian cancer is the fifth most frequent cause of death in women, claiming the highest mortality rate within gynecological cancers.[1] The standard of care for advanced-stage ovarian cancer is surgical debulking and platinum-based chemotherapy, followed by maintenance treatment with PARP inhibitors and/or bevacizumab. Despite these, the majority of women face relapse, resulting in a concerning 5-year survival rate of approximately 30%.[2] To mitigate treatment-associated toxicity while augmenting therapeutic outcomes, targeted therapies emerge as promising avenues. Folate receptor (FR) is overexpressed in over 70% of primary and 80% of recurrent ovarian cancers. Additionally, the expression of FR has been shown to remain high after chemotherapy.[3] Photodynamic therapy (PDT) is a minimally invasive treatment in which administration of a light-activated drug is followed by irradiation at a specific wavelength leading to the production of cytotoxic reactive oxygen species.[4] Verteporfin (VP) is a well-known photosensitizer that presents low aqueous solubility and has been approved by the Food and Drug Administration (FDA) as a liposomal formulation.[4]

Leveraging VP's potential and FR specificity, a novel targeted PDT approach (VP-NPs) emerges for the targeted PDT of ovarian cancer. A novel VP-derived molecule was first developed to enhance encapsulation efficiency into nanoparticles. VP-NPs exhibited increased photoactivity, singlet oxygen production, biocompatibility and uptake by FR-positive ovarian cancer cells relative to the VP-derived molecule alone. Furthermore, VP-NPs were also shown to outperform in PDT efficiency. These findings underscore the potential of our nanoformulation in selectively eradicating ovarian cancer cells via PDT, offering improved biocompatibility, specificity, and therapeutic efficiency.

[1] PDQ Adult Treatment Editorial Board. PDQ Cancer Information Summaries [Internet]. National Cancer Institute (US); Bethesda (MD): Mar 14, 2023. Ovarian Epithelial, Fallopian Tube, and Primary Peritoneal Cancer Treatment (PDQ®): Health Professional Version.

[2] Siegel, R. L., Miller, K. D., Wagle, N. S., Jemal, A. Cancer statistics, 2023. CA Cancer J. Clin. 73, 17–48 (2023).

[3] Vergote, I.B., Marth, C. & Coleman, R.L. Role of the folate receptor in ovarian cancer treatment: evidence, mechanism, and clinical implications. Cancer Metastasis Rev. 34, 41–52 (2015).

[4] Brown, S.B., Mellish, K.J. Verteporfin: a milestone in opthalmology and photodynamic therapy. Expet Opin. Pharmacother. 2 (2), 351-361 (2001).

Novel Sulfur-Containing Auxiliaries as Emerging Tools for Photochemical Transformations and Drug Discovery

Jean-Luc Ayitou Ayitou

A. Jean-Luc Ayitou

Department of Chemistry, University of Illinois Chicago, Chicago, IL, United States.

Sulfur is an earth-abundant element and waste product from petroleum refineries. Several sulfur-containing functionalities have been shown to exhibit unique electron affinities, basicity, nucleophilicity, and photophysics. Furthermore, it is documented that the photophysics of numerous organic chromophores can be modulated with sulfur/thio-functionalities. In our ongoing photophysical investigation of several thio-heterocyclic chromophores, we demonstrated that besides the *sulfur effect*, other intrinsic molecular properties, such as aromaticity, could synergistically influence the photo-excited state of the chromophores of our interest. Furthermore, we employed our thio-heterocyclic systems in Lewis and Brønsted acid-base chemical processes and nucleophilic substitution reactions with activated sp^3C–alkyl/aryl halides. These novel chemical strategies enabled us to create a library of photo- and bioactive-active systems, which we currently use in photodynamic therapy and high-throughput medicinal screenings. My presentation will highlight the photophysics and photochemistry of novel thio-heterocyclic chromophores prepared in our lab. Next, I will detail the use of the chromophores of our interest in several photochemical processes and biological applications.

Synergistic effects of Ficus Carica leaves extract mediated chemo-photodynamic therapy on rhabdomyosarcoma cells

Bushra Aziz

Bushra Aziz [a,b], Ahmat Khurshid [a], Rashid Mahmood [a], Junaid Ahmad Khan [a], Sumbal

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Background: Plant products are a rich source of polyphenols, which have potent antioxidant and anticancer activities. Therefore, their research has become an emerging field in recent decades.

Purpose: This work aimed to evaluate the potential of hydrophobic Ficus Carica (FC) extract to determine whether FC in the presence of low-dose chemo and Aluminium Phthalocyanine (Photosense®) mediated PDT synergistically enhances the treatment efficacy of RD cells or not.

Method: The cytotoxic effect of FC was investigated by MTT reagent. The effect of FC, followed by di-combination with low-dose chemo (doxorubicin-HCl, and dacarbazine), Photosense® mediated PDT, and chemo-Photosense® mediated PDT (tri-combination) were also investigated by MTT reagent. The combination index method is used to identify the synergistic effect of combination therapy by using CompuSyn software based on the Chou-Talalay method.

Results: The dose-dependent effect of FC on cell viability were observed. It was found that the pre-incubation of FC potentiated the anticancer effect as a neoadjuvant agent for doxorubicin-HCl and decarbazine-based chemotherapy, Photosense® mediated PDT, and chemo-PDT (tri-combination) with synergistic effect.

Conclusion: These results suggest a possible thread that the low-dose combination of the therapeutic modalities in the presence of FC remarkably enhances the treatment efficacy in comparison with a single-agent treatment modality. The proposed sequence of FC with chemo and PDT might present better therapeutic outcomes in cancer therapies. FC may also be used in the phyto-PDT to cure cancer in the future.

Protein characterization at the mitochondrial associated membrane (MAM) after exposure to solar ultraviolet radiation

Veronica Bahamondes Lorca

Evelyn Potter[1,2], Veronica Bahamondes Lorca[1], Shiyong Wu[1,3]

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The mitochondria-associated membrane (MAM) provides a dynamic crosstalk between the endoplasmic reticulum (ER) and mitochondria. MAMs are a vital location for cellular processes such as calcium signaling, apoptosis, autophagy, and response to stress. Dysregulation of MAM function has been implicated in several disease processes, including neurodegeneration, cancer, and metabolic disorders. In skin cells, stress from solar ultraviolet (sUV) irradiation exposure has been found to lead to altered expression and location of proteins within both the ER and mitochondria. However, the effect of sUV exposure on the MAM of skin cells and their role on ER and mitochondria alterations is still unknown. In this work, we characterized the changes in expression and spatial localization of the MAM proteins ERLIN1, ERLIN2, GRP75, VDAC1, MFN2, and ATG14. We used HaCaT cells which were exposed to sUV radiation for a single exposure (acute) and for three consecutive days (chronic). Western blot analysis revealed that MFN2 and GRP75 displayed a notable decrease in expression 6 hours post acute exposure. After chronic exposure, there was a significant upregulation of ATG14, ERLIN1, ERLIN2, and VDAC1. All targeted MAM proteins demonstrated a tendency to aggregate around the nucleus following sUV irradiation. These results may indicate a complex cellular effort to balance life and death by either 1) maintaining homeostasis to help cells survive under continuous stress, or 2) initiating an apoptotic response due to irreversible, extreme damage. Further studies will be developed to explore specific mechanisms by which these proteins contribute to the cellular responses to sUV exposure.

Keynote Lecture

Endogenous photosensitizers excited by visible light in skin cells: molecular understanding of the photodamage and photoprotection during and after sun exposure

Mauricio Baptista

Mauricio S. Baptista

Biochemistry Department, Chemistry Institute, Universidade de São Paulo, Brazil

The interaction of sun radiation with the human skin involves several complex phenomena that needs better understanding. Even though our society is used to consider mainly the effects of UV radiation, endogenous molecules also absorb visible light (VL), initiating several types of photosensitized oxidations that deregulates redox homeostasis of the skin and stimulates the accumulation of glycation and lipid peroxidation products. Most worrying is that these products are usually more effective photosensitizers than their respective precursor molecules. In this lecture, I intend to discuss the mechanisms by which the endogenous photosensitizers under VL exposure induce chemical changes in nucleic acids, proteins and lipids, leading to malfunction of several organelles and to the accumulation of mutagenic products, as well as of lipofuscin, which accelerates cell aging and increases substantially the VL phototoxicity. Another consequence of the excess of sun exposure is the degradation of vitamins and of their precursors, causing the disruption of several metabolic and repair processes. The damaging action spectra of VL in skin cells show a peak in the violet/blue region and a decreasing trend towards longer wavelengths. Interestingly, at physiological-relevant doses, red light does not induce significant damage on skin cells, on the contrary, it shows an impressive metabolic burst, explaining some of the beneficial effects of red-light irradiation in medicine. Novel strategies of sun protection will also be discussed during the lecture.

Plant biofluorescence: Insights from betalain-pigmented systems

Erick Bastos

Erick L. Bastos

Departamento de Química Fundamental, Instituto de Química, Universidade de São Paulo, São Paulo, SP, Brazil

The presence of biofluorescence in plants, particularly in areas shielded from direct light exposure, poses a captivating natural phenomenon. This presentation delves into the biofluorescent properties of betalain-pigmented plants and illustrates how simple chemical modifications can lead to the creation

of bioinspired and biobased systems capable of facilitating electron, energy, and information transfer. Our research has revealed that taproots and tubers containing betalains exhibit significantly higher fluorescence quantum yields compared to pigments in solution. We hypothesize that photon piping serves as the primary mechanism for pigment excitation within subterranean tissues. Through the investigation of these natural processes, we have successfully developed biocompatible dyes, a monitorable superoxide generator, and a self-assembling chiral system adept at specific information transfer. This exploration not only sheds light on the fascinating mechanisms behind plant biofluorescence but also highlights the potential applications of these findings in various fields, including biotechnology and materials science.

Long-lasting and safe photoprotection using a skin-bioadhesive technology: A proof of concept with a novel M10 skin-bioadhesive UVA Filter

Juliette Bertrand

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Protection against solar UV radiation is a global public health need due to the increasing incidence of skin cancer over the last decades. Innovating in sunscreen is a challenging research and technology effort. Health authorities and consumers support the use of safe sunscreens that are highly protective, without causing adverse environmental effects. Organic UV filters, while providing cosmetic advantages, require frequent re-application, may penetrate the skin, and may induce ecotoxicity. Based on skin-bioadhesive technology, we developed new organic UV filters that bind to the stratum corneum. Our first filter, M10, was built on diethylamino-hydroxybenzoyl-hexyl-benzoate (DHHB), a UVA filter widely used in European, Asian and South American sunscreens. The efficacy and safety of M10 were evaluated *in vitro* and *ex vivo* using UV spectrum analysis, skin autofluorescence, diffusion cell permeation and Raman confocal spectroscopy. The persistence of photoprotection was analyzed *in vivo* in a clinical study using UVA imaging and FTIR on human volunteers' arms and face. *Ex vivo*, comparison of formulated M10 and DHHB demonstrated superiority of skin-bioadhesive M10 regarding its efficacy and safety. *In vivo*, 63% of M10 UVA photoprotection persisted 6 hours after application. As a human proof of concept of the technology, M10 showed resistance to rubbing, reduced diffusion, a good tolerance and persistence of photoprotection substantially longer than the recommendation to reapply sunscreen every two hours. The development of safe and long-lasting skin-bioadhesive UV filters could be a major advance in photoprotection research that the industry has been seeking over the past 20 years.

Targeting PD-L1 with photoactivable liposomes: Promoting self-penetration through dense collagen and improving immunotherapy in pancreatic cancer

Chanda Bhandari

Chanda Bhandaria, Azophi Moffata, Nimit Shaha, Rolf Brekkenb,[c], Tayyaba Hasand,[e], Jacopo Ferruzzia, and Girgis Obaida*

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Desmoplasia, an excessive production of ECM, is the major factor contributing to the limited drug infiltration, treatment resistance, and limited survival in pancreatic cancer patients. The effectiveness of immunotherapy in pancreatic cancer depends on microsatellite instability which is prevalent in only 1-2% of the patients. Thus, there remains a critical need for rational combinations that improve the survival in pancreatic cancer. In this study, we have developed multifunctional targeted photoactivable liposomes (iTPALs) incorporating liposomal BPD-PC photosensitizers and immune checkpoint blocking -PD-L1 antibodies that can promote delivery and modulate immunotherapy in the desmoplastic pancreatic tumors. iTPALs were able to specifically target and internalize into the PD-L1 expressing murine cancer cells and subsequently improve the phototherapeutic efficacy by 64.5%. Upon 690 nm light irradiation, iTPALs were able to induce immunogenic cell death in CT1BA5 cells. As the formation of the PD-1/PD-L1 axis suppresses the adaptive immune response, iTPALs blocked the PD-1/PD-L1 axis by up to 78.6%. iTPALs effectively reduced collagen density and improved their self-delivery by 5.4-fold in collagen hydrogels. Additionally, *in vivo* studies were done in C57BL/6 mice bearing CT1BA5 tumors where the photodynamic activation of iTPALs reduced collagen density by 49.1% and improved their self-delivery by up to 186.3%. At a single sub-ablative priming dose, the tumor growth was inhibited by 54.1% which resulted in an improvement in survival by 42.9%. As such, these finding enables the future use of rational photodynamic chemoimmunotherapy combinations that prolong survival in pancreatic cancer.

Light manipulation of solid tumors to enable surgery and nanotechnology assisted chemo-immunotherapy

Chanda Bhandari

Chanda Bhandari[1], Nimit Shah[1], Austin Nguyen[1] and Girgis Obaid[1]

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Photochemistry has long been used to ablate solid tumors during photodynamic therapy. In recent years, the collateral effects of photodynamic therapy have been studied in greater detail. Our work focuses on understanding how photochemistry can manipulate the tumor stroma and extracellular matrix, and apply that understanding to improving outcomes in image guided surgery and in chemo-immunotherapy. Our studies incorporate nanotechnology and show how lipid-based nanomedicines can play a particularly powerful role in manipulating the tumor microenvironment. We will discuss the latest advances in light manipulation in solid tumors to augment the diagnostic accuracy of image guided surgery probes, augment responses to chemotherapy by selectively peterbing collagen subtypes, and augmenting chemo-immunotherapy outcomes in pancreatic tumors.

There's plenty of room at the (nano-bio) boundary

Ardemis Boghossian

Ardemis A. Boghossian

Ecole Polytechnique Fédérale de Lausanne (EPFL)

The vast expansion of available synthetic biology tools has led to explosive developments in materials science. The increased accessibility of these tools has pushed the frontier of materials science into the field of engineering biological and even living materials. By coupling the tunable and robust optoelectronic properties of synthetic nanomaterials with the specificity and adaptability of biomaterials, one can re-purpose biology to fulfil needs that are otherwise intractable using traditional engineering approaches.

This presentation highlights applications in sensing and energy technologies that exploit the synergistic coupling of nanobio-hybrid

materials at the boundary. This talk will discuss the development of bio-conjugated single-walled carbon nanotubes (SWCNTs) for near-infrared fluorescence sensing. We discuss recent advancements in applying synthetic biology approaches, such as directed evolution, xeno nucleic acid engineering, and protein mutagenesis, to control the optical properties of these synthetic nanoparticle sensors for a range of applications. This presentation will also discuss complementary efforts in re-purposing biological materials for electronic applications. This talk will focus on developing living electronics, such as fuel cells and photovoltaics, through concomitant genetic re-programming and nanomaterial engineering. These demonstrations exemplify but a few examples of disciplinary bottlenecks we can overcome through anti-disciplinary approaches.

Algal biological responses photo-regulated by using monochromatic LEDs strategy

José Bonomi-Barufi

José Bonomi-Barufi[1], Gabriela Vilvert Vansuita[1], Julia Vega[2], Thaís F. Massocato[1], Bruna Rodrigues Moreira[1], Cândice Maria Boff[1], William da Silva Oliveira[1], Leonardo R. Rörig[1], Félix L. Figueroa[2]

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Radiation can drive metabolic pathways in algae considering photosynthesis and photomorphogenesis. Understanding the proper effect of each radiation quality is focus of action spectroscopy. Action spectra can vary according to the thalli thickness, pigment content or photoreceptor composition. In this way, different strategies can be designed to explain how each radiation wavelength can have effectiveness associated to some specific biological responses. Three alternatives can be utilized, and our research has been focusing into monochromatic one. In this way, organisms are exposed for a time period to different monochromatic radiation wavelengths, considering a range of intensities at each wavelength. We will present recent results focusing micro and macroalgal photosynthesis and bioactive compounds. 13 different monochromatic LEDs were used, covering the radiation range from 400 to 750 nm. In the case of *Haematococcus lacustris*, blue-light peaks in 440-445 nm, green light peaks of 521 nm and red-light peaks from 660-727 nm resulted in a higher concentration of cellular phases mainly containing lutein, while yellow and orange peaks between 565-594 nm resulted mostly in vegetative cellular phases. Results also show that irradiance and cellular phases with carotenoids have a positive correlation. Moreover, the action spectra of electron transport rates measured in *H. lacustris* changed according to the time. Our research is a novelty for understanding radiation regulating responses, allowing a future industrial upscaling and application of specific wavelengths to drive responses of interest.

Genome mapping of CPDs refractory to repair in keratinocytes after acute or chronic UV exposure

Douglas Brash

Douglas E. Brash[1], Alejandro Garcia-Ruiz[1], Karl Kornacker[2], Vijay Menon[1]

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Cyclobutane pyrimidine dimers (CPDs) are the predominant DNA damage generated by UV exposure and are main precursors of DNA mutations in skin cancer. CPDs are repaired by nucleotide excision repair; however, depending on their genomic location, they can be refractory to repair. Genome-wide nucleotide-resolution analysis of refractory CPDs could objectively determine personal past UV exposure and determine the risk of future skin cancer. Acute and chronic UV exposures have correlations to melanoma and carcinoma respectively.

To determine the genomic position of refractory CPDs, human keratinocytes were irradiated with an acute dose of 2000 J/m^2 of nbUVB (~311 nm) and allowed to repair for 7 days, or irradiated with a lower dose of 200 J/m^2 daily for 10 days and then allowed to repair for 7 days. CPDs were located and quantified by adductSeq high-throughput sequencing, based on enzymatic nicking at CPD sites.

Bioinformatic analysis identified thousands of sites with recurrent refractory CPDs, as well as refractory cytosine-deaminated CPDs. Chronic exposure led to over 2- and 35-fold more refractory CPDs and deaminated CPDs, respectively.

CPDs generated immediately after UV irradiation in keratinocytes were concentrated at CPD hyperhotspots, dipyrimidines in promoter CpG islands of skin-expressed genes and associated with ETS transcription factors. In contrast, refractory CPDs resided in non-skin related genes, within kilobase-long regions of the repressive epigenetic marker H3K27me3 specific to skin keratinocytes. This location indicates that refractory CPDs accumulate in a subset of transcriptionally-repressed chromatin regions concealed from transcription coupled repair and global genomic repair despite the prolonged repair time.

Targeted Gold Nanoparticles Enhanced Photodynamic Cancer Therapy

Clemens Burda

Zoey Lockwood,[1] Xinning Wang,[2] Dong Luo,[2] James Basilion,[2] Clemens Burda[1]

[1] Chemistry Department, [2] Radiology, Biomedical Engineering & School of Medicine Case Western Reserve University, Cleveland, OH

An overview will be given of our efforts toward targeted-nanoparticles for efficient drug delivery to tumors and image guided cancer therapy. Our targeted nanostructures are developed using PEGylated gold nanoparticle conjugates, which act as a water-soluble and biocompatible "cages" that allows delivery of a hydrophobic drug to the site of PDT

or enhanced radiotherapy. The dynamics of drug release in vitro and in vivo indicate highly efficient delivery to the tumor site. With the Au NP-conjugates, the drug delivery time required for therapeutic action has been greatly reduced, compared to 2 days for free drug. Examples from our recent research will be presented and discussed.

To patients with advanced cancers, oftentimes combination radiotherapy (RT) and chemotherapy are prescribed to increase their survival chances. However, radiation-related side effects and systematic toxicity caused by chemotherapeutics are unavoidable. To improve the precision and efficacy of concurrent RT and chemotherapy, we have developed a targeted gold nano-system for targeted and enhanced RT and chemotherapy. This approach resulted in enhanced uptake,targeted chemotherapy, and increased efficacy of RT both in vitro and in vivo. Nano-conjugates improve the specificity and efficacy of radiation and chemotherapy, potentially reducing the toxicity of each therapy and making this an attractive new avenue for clinical treatment of advanced cancer therapies.

Tissue tolerability of 233 nm far UV-C light promises a wide range of applications: Latest results from ex vivo experiments

Loris Busch

Loris Busch[1], Daniela F. Zamudio Díaz[1], Silke B. Lohan[1], Anna Lena Klein[1], Kerstin Danker[2],

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The application of far UV-C LEDs to inactivate multi-resistant microorganisms on skin, mucous membranes and wounds as well as to inactivate airborne viruses represents an emerging approach. The high tissue tolerance of far UV-C light is based on its strong absorption and scattering in protein-dense biological membranes. Potential fields of application for far UV-C light include decolonization of the nasal cavity and chronic wounds as well as pre- and intraoperative skin decontamination. Considering the potential use of far UV-C irradiation for the disinfection of public areas, it is crucial to also assess ocular tolerance. For the purpose of risk assessment, we exposed excised human skin, reconstructed human epidermis and mucosa to antimicrobial doses of 233 nm far UV-C light and evaluated them immunohistopathologically for the development of DNA damage. DNA lesions were primarily found on the surface indicating that the stem cells localized in the basal cell layer remain unaffected even when using an artificial wound model. Repair of DNA damage was completed in reconstructed skin models after 24 hours, while damage in reconstructed mucosa was reduced by about 50%. We additionally investigated ocular safety using human donor cornea. Compared to longer wavelengths, a limited penetration of 233 nm into the cornea was also observed here, accompanied by moderate DNA damage in stromal cells. Therefore, far UV-C light with a wavelength of 233 nm is highly versatile due to its skin compatibility and may be used in nosocomial areas and public facilities.

ASP Photon Award Lecture

Form follows function in photodynamic therapy

Theresa Busch

Theresa M. Busch

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Photodynamic therapy (PDT) is a versatile treatment that can be employed with different types of photosensitizing agents to damage diseased tissue through multiple cytotoxic mechanisms. Consequently, PDT "form" is selectable to provide a desired "function" through the judicious choice of protocol, including factors such as photosensitizer type, time interval between photosensitizer administration and light delivery, treatment fluence rate, light dose, etc. In this way, PDT can be designed to integrate with other modalities in filling a therapeutic need. In preclinical models, we develop and study translational protocols in PDT that best integrate with accompanying treatments. Here, we describe several applications of PDT in the surgical setting that exemplify PDT "form" tailored for intended "function." In one example, PDT is delivered after surgical resection of murine mammary carcinoma to eradicate any remaining tumor cells. For optimal translatability, we evaluated brief, surface application of the photosensitizing pro-drug 5-aminolevulinic acid to the surgical bed, prior to its illumination. We demonstrate that a therapeutic effect was produced by very short incubation (10 min) of surgical margins in 5-ALA as part of a protocol which provides optimal clinical convenience. In another example, we evaluated PDT in a model of its delivery to the inflammatory environment created by the large-scale resection of diffuse disease. In this model, PDT-generated antitumor immunity could be attenuated by surgical-induced inflammation, yet rescued by the rational addition of immunotherapy. Through models such as these, we work in the design of clinically favored, therapeutically effective applications in PDT.

Realistic reappraisal of the use of phototherapy in the age of biologics: Psoriasis

Elizabeth Buzney

Elizabeth Buzney

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Phototherapy is the use of ultraviolet light to decrease cutaneous inflammation. It been a very successful means of treating psoriasis since the 1970's, first with broadband UVB and then with narrowband UVB (311-313nm). However, the recent development of medications for severe psoriasis, namely biologics and small molecules, has created a controversy within dermatology as to whether phototherapy still has a role for treatment of psoriasis in this new era. Here we seek to demonstrate the following:

- Phototherapy has shown comparable efficacy (PASI-75 and PASI-90) and rapidity of onset to many biologics and small molecules in treating psoriasis. Quality of life scores have been comparable.
- Phototherapy has fewer contraindications than biologics and small molecules, which are not suitable for every patient. Infrequently, biologics and small molecules pose a risk of serious infection to those with HIV, tuberculosis, or hepatitis. IL-17 inhibitors may exacerbate inflammatory bowel disease or cause mucocutaneous candidiasis. Safety data is limited during pregnancy and lactation. In contrast, phototherapy has very few contraindications, and is safe in children.
- Phototherapy can demonstrate much longer rates of remission than biologics and small molecules, allowing patients to stop treatment altogether for periods of time.
- Targeted phototherapy is particularly useful for patients with localized disease or lesions involving scalp or acral areas.
- Phototherapy is more cost-effective than biologic medications, and can be safely administered at home.
- Phototherapy can be used synergistically with biologic medications.

In summary, given patients' risk profiles and treatment preferences, phototherapy for psoriasis continues to be an essential treatment option.

Photodynamic Priming as a Promising Strategy to Overcome Drug Resistance in Pancreatic Ductal Adenocarcinoma

Fernanda Cabral

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Pancreatic ductal adenocarcinoma (PDAC) ranks as the third leading cause of cancer-related mortality in the United States. While chemotherapy and immunotherapy can be used to treat different cancer types, their efficacy in PDAC may be hindered by the tumor microenvironment (TME). Photodynamic priming (PDP) emerges as a promising strategy, permeabilizing the TME and allowing immune cell infiltration, synergizing with drugs to enhance tumor response. In this study, we investigated combining PDP with sublethal doses of irinotecan, a chemotherapy drug, and an immune checkpoint inhibitor, antiPD-1, to tackle PDAC. Mouse-derived 3D PDAC immune organoids (MDIO) and autologous peripheral mononuclear blood cells (PBMCs) were utilized. PDP, using Visudyne (250 nM) and a red laser (690 nm, and fluence 2 J/cm^2), was combined with irinotecan (4μM) and anti-PD1(3.5 μg/ml). We also assessed the expression of calreticulin (CRT), HMGB1, and PDL-1. Results revealed MDIOs' resistance to both drugs. Remarkably, PDP co-cultured with PBMCs induced substantial cell death (by 70%), indicating PDP immunostimulatory effects. Notably, adding irinotecan and anti-PD1 significantly enhanced treatment efficacy, with the triple combination achieving complete tumor killing. PDP-induced immunogenic cell death (ICD) is evidenced by CRT and HMGB1 increase (by 1.7-fold) alongside significant PDL-1 downregulation (98.5%). This study underscores PDP synergy with irinotecan, promoting ICD and enhancing tumor response to antiPD-1. It presents a promising strategy to overcome chemo and immunoresistance in PDAC, offering the potential for tumor regression, long-lasting antitumor memory, and reduced adverse events. This novel approach provides new hope to patients with limited therapeutic options.

ASP Editor Lecture

Publishing in Photochemistry and Photobiology

Jean Cadet

Jean Cadet

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'Photochemistry and Photobiology', currently part of the Wiley-Blackwell edition group, was established in January 1962 before becoming the official Journal of the American Society for Photobiology (ASP) a few years later. The Journal serves as a reputable platform for publishing scientific advancements across various domains within Photosciences. This encompasses fundamental topics ranging from the initial photophysical and photochemical events triggered by light absorption in isolated molecules and cellular components to the biochemical and biological outcomes. In addition to regular contributions which mostly consist of original research and review articles, the Journal also releases special issues with contributions from invited experts. This involves a wide range of subjects, such as surveys of timely topics, celebrations of scientific events and recognition of outstanding scientists and their achievements. The Editorial Board, comprised of 30 esteemed experts across key domains of Photosciences, plays a pivotal role in in conducting thorough and impartial peer-reviews of the manuscripts, supported by the invaluable and efficient assistance of the Managing Editors. It is worth noting that Wiley has recently implemented an improved manuscript submission system, along with a more attractive format for published articles. These favorable conditions should encourage authors to consider submitting their manuscripts to the Journal, which is welcoming of contributions! This initiative is expected to enhance the appeal of the Journal, as evidenced by its two-year impact factor (IP) that has reached its highest value in 2021 (IP = 3.521) before experiencing a slight decrease last year (IP = 3.3).

A smartphone app for monitoring personal solar dosimetry in multi-subject studies

Piergiacomo Calzavara-Pinton

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Longitudinal multi-subject photobiological studies that require accurate monitoring of the participants' solar exposure are currently challenging and limited. Dosimeters or wearable devices are expensive to acquire and maintain and compliance among users can be low.

Here an innovative digital solution that provides personal solar dosimetry data using only a smartphone (no light sensors or dosimeters) has been investigated. The smartphone app (ExpoDose®, siHealth Ltd) is used to track whole-body exposure to spectral solar radiation. It's based on a patented technology already validated scientifically [1] combining real-time satellite data, radiation transfer modelling and AI-enabled automatic assessment of indoor/outdoor position. The app seamlessly tracks the solar exposure of multiple users for any number of action spectra (e.g., erythema, vitamin D synthesis, UVA) and body sites (e.g. scalp, face), providing the collected data to study investigators via a web-portal.

The results of a 6-month study into the accuracy and practical use of the app will be presented. Solar erythemal irradiance (global horizontal) data collected by the app have been compared to ground station measurements and found to have an R^2 correlation coefficient of 0.90 and a mean absolute error of 21%. The automatic indoor/outdoor detection component has been tested and its detection accuracy ranged from 84% (iOS) to 92% (Android). This demonstrates the accuracy of the app, which, when coupled with its convenience, makes it a tool that could significantly enrichen and diversify the possibilities for epidemiological and photobiological studies.

[1] Young A, Schalka S et al. (2022), Photochem. Photobiol. Sci. 21, 1853

Realistic reappraisal of the use of phototherapy at the age of biologics: atopic dermatitis

Piergiacomo Calzavara-Pinton

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Narrow-band (NB) UVB and UVA1 have been successfully used for the treatment of atopic dermatitis (AD) since the 1980s, but the clinical indications for their use "at the age of biologics" remain to be assessed. From 2013 to 2017, 145 patients underwent a first treatment cycle with phototherapy a tour Dermatology Department, a tertiary referral center for AD patients in Northern Italy. They achieved a median final EASI score of 9.90 with UVA1 and 13.70 with NB-UVB. The rates of patients achieving an IGA score of 0/1 persistent for at least 6 months were 33% with UVA1 and 28% with NB-UVB, and the rates with an EASI90 improvement were 10.9% with UVA1 and 11.0% with NB-UVB. The cut-off baseline EASI values for a good probability to achieve a 0/1 IGA were 24.4 with UVA1 and 24.7 with NB-UVB. A 0/1 IGA persistent for at least 6 months was more likely to be achieved by patients with a history of flares interspersed with periods of mild or no disease. From 2018, we only enrolled patients with the above-mentioned characteristics. The number of treated patients was lower, but the final EASI score, the rate of patients achieving IGA 0/1 persistent for at least 6 months, and EASI90 were significantly higher. Medium-dose UVA1 and NB-UVB phototherapies remain useful for the treatment of AD patients with a baseline EASI score lower than 24.4 and 24.7, respectively, and a medical history of flares followed by prolonged periods of complete or near-complete remission.

Molecular mechanisms of photodamage and repair in cyanobacteria

Jeffrey Cameron

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Cyanobacteria use light energy to perform oxygenic photosynthesis and carbon-fixation. This process is driven by the photosynthetic reaction centers, photosystem I (PSI) and photosystem II (PSII), within the specialized thylakoid membrane system. Previous studies have shown that PSII becomes damaged due to its normal activities and upon acute exposure to excess light of various wavelengths. The steady-state level of PSII in a cell is therefore the result of the relative rates of synthesis, degradation, dilution, damage, and repair/recycling. Understanding how each of these processes are integrated into the cellular response has been difficult using traditional ensemble approaches due to cell-cell heterogeneity. For example, in bulk culture, cells are exposed to a dynamic light environment that is a function of mixing, cell density, and cell state. To overcome this limitation, we have developed an automated imaging approach to film the growth of cyanobacterial cells using long-term, time-lapse, fluorescence microscopy, as well as software to analyze the resulting images. By growing cells in a two-dimensional layer, we avoid cell shading and can generate highly reproducible growth conditions without human intervention (e.g., program conditions and push start button). Using this platform, we can simultaneously analyze the growth and physiology of multiple strains under defined photoautotrophic conditions, including those that induce photodamage. Using these new methodologies that enable single-cell level studies of photodamage, we identified and characterized new cellular structures, photoendosomes, that we propose are involved in a photodamage-induced thylakoid membrane repair pathway.

Functionalization of Protoporphyrin IX, experiments and computational modeling

Omar Castillo Gutierrez

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Photosensitizers (PS) are ubiquitous molecules in nature and in non-native settings such as photodynamic therapy (PDT). PS owe their potential biomedical utility to their unique absorption and energy transfer properties. One of the major components utilized in PDT is protoporphyrin IX (PPIX). A limiting factor of utilizing PPIX is its high hydrophobic nature, that results in aggregation at physiological pH values. Therefore, if utilized in PDT, PPIX usually requires delivery systems (liposomes, proteins, etc.), or metabolic precursors. Our lab has previously worked with self-assembly of β-lactoglobulin (BLG) and protoporphyrin. Here we propose a novel chemical modification of PPIX which results in reactivity between its propionic tails and cysteine. This selectivity can be utilized in binding with BLG due to the proteins only free cysteine residue. This artificial protein:PS complex provides a non-toxic delivery system that can be coupled with nanoparticles to create a multifunctional nanosystem with increased photoactivity. Here we present spectroscopic results and their computational simulations utilizing *ab initio* density functional theory and their time dependent components of the precursor and the modified photosensitizers. We evaluate the effects of the modification in either photophysical or photochemical activity. We also investigate its application in regard to PDT by assessing whether this system has enhanced cytotoxic properties on triple negative breast cancer cells (TNBC) upon laser irradiation.

Enabling technology for precision, image-guided photodynamic therapy of oral lesions

Jonathan Celli

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Clinical results of photodynamic therapy (PDT) using aminolevulinic acid (ALA) induced protoporphyrin IX for superficial early cancers and pre-cancerous oral lesions have been excellent. It has been shown that complete tumor response can be achieved even in a single treatment with minimal pain or discomfort and which spares patients from the potentially significant side effects of surgery and radiation delivered to the oral cavity. Yet despite clinical need, adoption remains limited to a few practitioners with expertise in laser medicine. Here, to address unmet need for enabling PDT technologies for the oral cavity we report the development of intraoral light delivery and imaging systems that enable integration of PpIX fluorescence detection for treatment guidance and monitoring of photobleaching as a dosimetry surrogate during light delivery. We present clinical results from a system using a fiber coupled LED-based light engine combined with semi-custom 3D printed intraoral applicators, and also report preclinical testing of new hardware using an integrated device with multimodel imaging and PDT light delivery from the same smartphone-coupled handheld intraoral device. This hardware allows monitoring of photosensitization and photobleaching during treatment correlates strongly with dose deposited, and outcome. Combined with ongoing software development for treatment planning and monitoring this system provides a platform for intraoral PDT guidance from start to finish

with promise to bring PDT for oral lesions into practical clinical implementation.

The molecular basis of phycobiliproteins having red-shifted absorption beyond 700 nm

Min Chen

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Phycobilisomes absorb green and orange light, complementing chlorophyll absorbance. In many cyanobacteria, the composition of phycobilisomes can be changed to accommodate the prevalent light-wavelengths in the environment, also named as chromatic acclimation. The newly discovered chlorophyll *f*-producing cyanobacteria use red-shifted phycobiliproteins to accommodate the chlorophyll *f*-binding photosystems. The red-shifted phycobiliproteins isolated from *Halomicronema hongdechloris*, having red-shifted absorption of 712 nm, consist of allophycocyanin core subunits and their encoding genes are localised in the far-red-light photoacclimation (FaRLiP) gene cluster. The single particle analysis demonstrated that a double disk assembly of 120–145 Å is present, with two α/β allophycocyanin trimers fitting into two separated disks. Recently, we isolated an allophycocyanin heterodimer having absorption maximum of 730 nm from *H. hongdechloris* grown under far-red light conditions. This allophyocycnin heterodimer is made of AP-B and ApcB, encoded by genes localised outside of the FaRLiP gene cluster, but is only detected from far-red light grown cells. Using an *in vitro* reconstitution *E. coli* system, we found the chromophylated Ap-B showed two absorption peaks and the red-shifted absorption centred at ~686 nm. Interestingly, the heterodimer of AP-B/ApcB demonstrated absorption of 730 nm and fluorescence emission peak at 740 nm. This observation indicated that the heterodimer of AP-B/ApcB likely functions as energy terminal emitter for chlorophyll *f*-binding protein complexes. Using site mutagenesis methods, we have predicted the chromophore binding dockets, supported by structural models. The key residues contributing the shifted spectral properties will be discussed, providing the structural and functional elements of photoacclimation and chromatic adaptation.

Functional significance of squamous cell carcinoma antigen 2 (SCCA2) in human melanoma

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Cutaneous malignant melanoma (CMM) is a potentially fatal cancer associated with ultraviolet radiation (UV) exposure. A detailed understanding of molecular events triggering the development and progression of CMM could lead to novel strategies for its management. Squamous cell carcinoma antigens (SCCA1/2) are markedly elevated in UV-irradiated epidermis and suppress UV-induced apoptosis in keratinocytes. SCCA2 has also been implicated in tumor evasion of host immune responses. However, the functional significance of SCCA2 in CMM progression and immunobiology remains unknown. Using The Cancer Genome Atlas data we found that SCCA2 is overexpressed and significantly associated with lower survival of melanoma patients. We also found that SCCA2 is overexpressed in multiple melanoma cell lines compared to normal melanocytes. CRISPR-knockout of SCCA2 in A375 melanoma cells significantly decreased proliferation. Conversely, forced overexpression of SCCA2 in SK-MEL-2 and SK-MEL-28 cells significantly increased proliferation. To determine immunoregulatory mechanisms associated with SCCA2, we performed differential gene expression (DEG) analysis of 770 immune-related genes using NanoString nCounter technology and identified 91 DEGs in SCCA2-knockout Hs294T cells (adjusted $p<0.05$, 1.5-fold cutoff). nSolver advanced analysis showed TRIM48, a tumor suppressor gene, as the top-upregulated gene, and SIGLEC6, a gene shown to promote tumor immune escape, as the top down-regulated gene. Interestingly, interleukin-10 signaling, including genes such as CCL2, CXCL8, PTGS2, TIMP-1, and TGFB1, was negatively enriched, suggesting SCCA2 could control tumor regulatory cytokines. These findings suggest a potential oncogenic role of SCCA2 in CMM. However, additional studies are needed to determine its potential as a therapeutic target for melanoma management.

Biocompatible Organic Photosensitizers for Cancer Treatment

Carlos E. Crespo-Hernández

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Photodynamic therapy (PDT) is a clinically approved, noninvasive cancer treatment that involves administering a photosensitizer (PS) and light to the affected area. The current range of photodynamic therapy agents is limited, and there is a pressing need for cost-effective, organic photosensitizers that can offer improved efficacy under multiple photosensitization mechanisms. In this talk, I will present some of the recent advances made by our group in developing biocompatible all-organic PSs that exhibit tunable absorption spectra from the ultraviolet-A (UVA) to the near-infrared (IR) regions of the electromagnetic spectrum. Several of these PSs exhibit excellent PDT efficacy against monolayers of human epidermoid carcinoma, melanoma, cervical, and human epithelium cancer cells, regardless of the oxygenation status (i.e., under both normoxic and hypoxic conditions), when applied in vitro with a low dose of light.

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Synthesis of Novel Photo-Active Indolizines & Azepines as Potential Candidates for Synergistic Medicinal Applications

Ravi Kishore Dakoju

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In recent years, photodynamic treatments (PDT) have continued to gain increasing attention as an effective treatment against several cellular abnormalities. Compared to other treatments, PDT can be adopted with fewer side effects. PDT's process relies on the formation of reactive oxygen species (ROS), via electron transfer (type I) or energy transfer (type II), which subsequently alter the potential of the mitochondrial membrane and induce the death/apoptosis of cancer cells. Contemporary PDT research has primarily focused on the synthesis and photophysical characterization of new photosensitizers. Additionally, a photosensitizer's effectiveness is contingent upon a variety of factors, including the kind of target cells and

their oxygenation condition, as well as its capacity to preferentially enter the sick tissue it is intended to treat and the wavelength at which light activation occurs. In this context, site-selected sulfur-substituted nucleobases have emerged as a promising class of heavy-atom-free organic biomolecules for preclinical and clinical PDT applications. In this line, we have designed thio-heterocycles infused with bioactive indolizine and azepine moieties as potential candidates for synergetic applications in the treatment of various malignancies. Expectedly, the thio-functionality in these molecules will allow us to use these novel systems as type II photosensitizers for PDT applications. Thus, the thio-containing indolizine and azepine derivatives could be used as potential candidates for synergetic treatments of various malignancies.

My presentation will detail the synthesis of novel indolizine and azepine derivatives with attractive photophysical and biological activities. I will also highlight our preliminary bio-assay investigations using the new molecular systems.

Photochemistry of Sulfondiimines

Paul Danyi

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Sulfondiimine, an aza analog of sulfone and sulfoximines has recently gained much attention in medicinal chemistry and agrochemicals due to its unique functionalization. However, because of the complexity in structure and instability of its intermediates, this compound is least explored by researchers. Recently few synthetic pathways have emerged in literature leading to the successful preparation of diaryl and dialkyl Sulfondiimines. Though these methods are reliable, poor reaction yields, issues of the explosion, and toxicity of starting materials make their preparation challenging. In addition, mechanistic insight into sulfondiimine reactivity has not been studied, and that may affect their synthetic outcome.

Nitrenes are well-known for their benefits in synthetic processes, including insertion reactions, hydrogen abstraction, rearrangement, and even photoaffinity labeling in biological pathways. It is anticipated that nitrene, the intermediate of sulfondiimine, will be produced by the photodegradation of the corresponding sulfondiimine. Singlet and triplet state nitrenes have been known for a while in literature through the photolysis of phenyl azide. Recently, the photochemistry of N-phenyl Sulfoximine has been investigated which leads to the dual release of atomic oxygen and phenyl nitrene in the triplet and singlet state respectively called the Bolm-McCulla reaction.

Although this is known, the photochemistry of sulfondiimine has not been investigated but most likely a significant contributor to the creation of nitrene. Investigating the reactive intermediates of sulfondiimine might be an excellent approach to understanding their reaction mechanism, which may help develop a productive way to synthesize them. Presently, we are exploring the photochemistry of some diaryl and dialkyl sulfondiimine and characterizing their photo-intermediates and products.

The cutaneous photosensitive system and its role in physiological and pathological processes of the skin

Leonardo de Assis

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The skin, the largest organ of the body, is not just a protective barrier but also plays a crucial role in metabolic processes. At the core of the sensory functions of the skin is its photosensitive system, capable of detecting, integrating, and responding to environmental cues such as light. A key element of this sophisticated system is the diverse family of opsins. These photoreceptive proteins are sensitive to a broad spectrum of light wavelengths, spanning the entire visible spectrum. Expression of opsins has been detected in fibroblasts, keratinocytes, and melanocytes and is responsible for a wide range of physiological responses in these cells. Recent research has unveiled that opsins can sense temperature changes, adding another layer to their functionality. Intriguingly, light- and thermo-independent functions of opsins have also been reported, thus showing a more complex function of opsins than initially thought. These proteins are also significantly involved in the pathogenesis of skin diseases, notably melanoma, indicating their critical role in health and disease. In my presentation, I will explore the latest breakthroughs concerning opsins in the skin, examining their impact on physiological conditions and disease states. The talk will aim to provide a thorough understanding of this fascinating class of proteins, highlighting their potential implications in dermatology and therapeutic development.

Phototherapy in Dermatology: past, present and future

Chiara Aurora Delrosso

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Phototherapy represents, in Dermatology, an important therapeutic sector which has progressively acquired a specific application space. The use protocols provide complete knowledge of the effects of non-ionizing REM on the skin, from a physiological and pathophysiological point of view as well as the effects on the immune system. The irradiation sources, modular and integrated into computer systems, have allowed for more in-depth knowledge in the therapeutic field and in the prevention of immediate or late side effects.

PHOTOTHERAPEUTIC TECHNIQUES

1) Systemic photochemotherapy (PUVA): irradiation with UVA after the use of substances from the psoralen family, introduced orally.
2) Topical photochemotherapy: (Balneo-PUVA therapy): immersion of the body in a bathtub containing 8-MOP at 0,5% in an alcoholic solution; (Gel-PUVA therapy): 8-Methoxypsoralen at 0.05% in gel excipient.
3) Narrow band UVB phototherapy. Spectrum: 313 nm +/- 2 nm.
4) Combined UVA-UVB narrow band phototherapy
5 Phototherapy and topical or systemic drugs
6) Broadband UVB phototherapy. Spectrum: 290-315 nm.
7) UVA 1 phototherapy. Spectrum 340-400 nm.
8) PUVAsol therapy: administration of 8-MOP and exposure to sunlight.

DERMATOSES THAT CAN BENEFIT FROM PHOTOTHERAPY

- Psoriasis
- Parapsoriasis
- Guttate parapsoriasis
- Mycosis Fungoides stage IA, IIA IB
- Lymphomatoid papulosis
- Atopic dermatitis
- Benign summer lucitis
- Polymorphic lucite
- Solar urticaria
- Actinic reticuloid

- Erythropoietic protoporphyria
- Hidroa vacciniforme
- Actinic pruritus
- Vitiligo
- Alopecia areata
- Contact Eczema
- Lichen Ruber Planus
- Chronic urticaria
- Mastocytosis
- Granuloma annulare
- Itching
- Itching in chronic kidney disease
- Itching in HIV+ subjects
- Morphea
- Graft-versus-host rejection disease.
- Sneddon Wilkinson sub-cornea pustulosis
- Biliary cirrhosis.

Specific considerations will follow about critical and debated aspect of phototherapy: the potential risk of skin cancer.

PHOTODYNAMIC THERAPY: FROM 2008 TO 2023, OUR EXPERIENCE.

Giorgio Delrosso

Delrosso Giorgio [(a)], Delrosso Chiara Aurora [(b)].

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Photodynamic therapy consists of a treatment used in the oncology field that uses three essential components:

- A Photosensitive Substance
- The Light
- Tissue Oxygen.

Topical Photodynamic Therapy, i.e. ALA-PDT, uses protoporphyrin IX (PpIX) as a photosensitiser. This molecule is synthesized in the site that has to be treated from a pharmacological precursor, which is not in itself photosensitising, the 5 AMINO-LEVULINIC ACID (5-ALA), an intermediate product of our cells. This is activated by a red light between 580 and 630 nm or, for intraepithelial lesions, also by a violet-blue light between 400 and 415 nm. Every cell in our body is able to synthesize protoporphyrin IX starting from 5-ALA: through skin absorption of the administered molecule, 5-ALA is taken up more by tumor cells than normal cells, which increase their synthesis of Pp IX.

SKIN NEOFORMATIONS TREATED

- Actinic keratoses
- Superficial basal cell carcinomas
- Nodular basal cell carcinomas (with a thickness less than 2 mm or for which other available, therapies are not indicated
- Bowen's disease
- Extramammary Paget's disease

METHODS

Methyl aminolevulinate cream, (as hydrochloride) equivalent to 16.0% methyl aminolevulinate; activating source: Aktilite R 128 LED-display lamp with emission at 633 +/-5 nm; light dose: 37 J cm².

5-aminilevulinic acid in ointment at a concentration of 10%.; activating source: red light LED lamp, wavelength 632 nm; light dose on the skin: 200mW/cm2.

The authors describe the characteristics of the method and the results obtained in the treated skin lesions.

UVB radiation induces multiple types of inflammatory necrotic cell death in human epidermal keratinocytes

Mitch Denning

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Ultraviolet B (UVB) radiation is the main causative agent for the ~5.5 million new cases of skin cancer diagnosed each year in the United States. UVB radiation causes skin cancer through two main mechanisms: DNA mutagenesis and skin inflammation. We have an incomplete understanding of UV-induced skin inflammation mechanisms. Necrotic cell death has been implicated in UVB inflammation due to release of cellular contents including damage-associated molecular patterns. Multiple types of necrotic cell death have been reported for UVB phototoxicity, including ferroptosis, pyroptosis, and necroptosis. To define the types of necrotic cell death induced by UVB radiation, we exposed normal human keratinocytes to 20 mJ/cm² UVB radiation and cultured them in the presence of the cell-impermeable nucleic acid stain propidium iodide. Live cell imaging experiments were conducted to monitor both morphological cell death and plasma membrane rupture by propidium iodide uptake, indicative of necrosis. UVB induced apoptosis, necrosis, and secondary necrosis (apoptosis followed by necrosis) in individual keratinocytes, indicating profound heterogeneity in cell death responses to UVB radiation. Immunofluorescence analysis of necrotic signaling molecules revealed that UVB induced both phospho-MLKL(S358) clustering on the plasma membrane, as a necroptosis marker, and ASC, as a pyroptosis marker, in distinct cell subpopulations. The general caspase inhibitor zVAD was able to inhibit the UVB-induced mRNA of levels of multiple cytokines (IL-1β, IFN-γ, IL-18), suggesting that the inflammasome was involved in their synthesis. These results indicate the UVB induces a diverse array of pro-inflammatory, necrotic cell death subroutines in human epidermal keratinocytes.

Structural insights into the light-harvesting and photoprotection mechanism in cyanobacteria

María Agustina Domínguez-Martín

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Phycobilisomes (PBS) are the elaborated light-harvesting antennas in cyanobacteria. To balance the harvesting of light energy against the risks of photodamage, many cyanobacteria

have evolved a photoprotective mechanism that relies on the interaction between a photoreceptor, the Orange Carotenoid Protein (OCP), and the PBS. Here we present four cryo-electron microscopy structures, with and without OCP, of the 6.2 MDa PBS from the model organism *Synechocystis* PCC 6803 at overall resolution 2.1-3.5 Å. The structures revealed the existence of three different conformational states of the antenna, two previously unknown, for the unquenched PBS. We found that two of the rods can switch conformation within the complex, suggestive of a potentially new type of regulation. We also discovered a novel linker protein, named ApcG, that binds to the membrane facing side of the PBS. In addition, the structure of the PBS-OCP complex shows four 34 kDa OCPs organized as two dimers quench the PBS. The complex also reveals for the first time, the structure of the active form of the OCP, revealing an β60 Å displacement of its regulatory C-terminal domain. Finally, we elucidate energy transfer pathways based on structural and spectroscopic properties. These results provide detailed insights into the cyanobacterial light-harvesting and place a foundation for future bioengineering applications.

Reference

Domínguez-Martín, M.A., Sauer, P.V., Kirst, H. *et al.* Structures of a phycobilisome in light-harvesting and photoprotected states. *Nature* **609**, 835–845 (2022). https://doi.org/10.1038/s41586-022-05156-4

Unblinded by the Light: Photobiomodulation for the Treatment of Retinal Injury and Disease

Janis Eells

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Aging and age-related retinal disease have been associated with mitochondrial dysfunction. Photobiomodulation (PBM) induced by far-red to near-infrared light has been documented to restore the function of damaged mitochondria, upregulate cytoprotective factors and promote cell survival. We report on investigations testing the hypothesis that a brief course of FR/NIR PBM treatment would preserve mitochondrial integrity and attenuate photoreceptor loss in rodent models of mitochondrial injury and degenerative retinal disease. Studies were conducted in rodent models of methanol-induced retinal toxicity, retinitis pigmentosa and AMD. Animals were treated with 670 nm or 830 nm light (180s; 25mW/cm2; 4.5J/cm^2) using a light-emitting diode array (Quantum Devices, Barneveld, WI). Sham-treated rats were restrained, but not treated with FR/NIR light. Retinal metabolic state, function and morphology were assessed measurement of mitochondrial redox (NADH/FAD) state by 3D optical cryo-imaging, electroretinography (ERG), spectral-domain optical coherence tomography (SD-OCT), and histomorphometry. PBMt preserved retinal metabolic state, retinal function, and retinal morphology in PBM-treated animals. Scotopic ERG responses over a range of flash intensities were significantly greater in PBM-treated rats compared to sham controls. SD-OCT studies and histological assessment showed that PBM preserved the structural integrity of the retina. These findings demonstrate a direct effect of PBM on retinal mitochondrial redox status in retinal injury and disease. They show that chronic proteotoxic stress disrupts retinal bioenergetics resulting in mitochondrial dysfunction, and retinal degeneration and that therapies normalizing mitochondrial metabolism have potential for the treatment of retinal degenerative disease.

Narrowband UVB phototherapy in the management of cutaneous human papillomavirus infection

Zhahedia-Zhaythseff Fort

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Human papillomaviruses (HPVs) are double-stranded DNA viruses that cause solid tumors and cancers in all human organ epithelial tissue. HPVs sort into 5 genera with a total of approximately 150 species. Infection occurs when the virus accesses basilar epidermal cells. The viral oncoproteins E6 and E7, then inhibit the Rb and p53 tumor suppressor pathways, resulting in HPV-related cancers in a variety of different organ systems. HPV-related lesions are typically managed procedurally or with pharmacotherapies; these treatment modalities are mostly non-specific and largely rely on physical or cytotoxic ablative methods or the induction of cell-mediated immunity. However, latent HPV can remain in the surrounding tissue or may overcome the induced immunity, resulting in locoregional recurrences that are commonly associated with most modalities. nbUVB is a promising newly proposed treatment modality to inactivate residual virus in the tissue of resistant HPV disease. There is a recent publication of the successful treatment of resistant HPV infection on the face of a pediatric patient with a treatment course of 300 mJ/cm^2 TIW fractionation over four weeks for a cumulative nbUVB absorbed surface dose of 36,000 mJ/cm^2.

Controlling Photosensitized-Singlet Oxygen Generation with Acyclic Cucurbituril-like Containers

Denis Fuentealba

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Photodynamic therapy (PDT) of cancer is based on the inactivation of cancer cells or bacteria through the generation of singlet oxygen and other reactive oxygen species (ROS), which readily oxidize proteins, lipids and DNA leading to cell death. One of the strategies used to enhance the generation of ROS and protect the photosensitizers from early decomposition is their complexation with supramolecular host systems.[1] For that purpose, we have previously used cucurbit[n]urils (CB[n]s, n = 5, 6, 7, 8, 10), a family of macrocycles that has gained attention in the field of PDT due to their capacity to modify the photochemical properties of photosensitizers in a controlled fashion. Moreover, different CB complexes can be used to switch ON or OFF the generation of singlet oxygen.[2] Recently, we have investigated the use of acyclic cucurbituril-like containers, which show extraordinary capabilities to control the singlet oxygen. Phototoxicity studies in vitro using 2D tumoral cell cultures will be discussed.[3,4]

References

1. N. Mariño-Ocampo et al, 2023. Recent photosensitizer developments, delivery strategies and combination-based approaches for photodynamic therapy. Photochem. Photobiol., 99, 469.
2. J. Robinson-Duggon et al, 2017. Supramolecular reversible ON-OFF switch for singlet oxygen using cucurbit[n]uril inclusion complexes. J. Phys. Chem. C, 121, 21782.
3. D. Guerra Díaz et al, 2023. Extraordinary control of photosensitized singlet oxygen generation by acyclic cucurbituril-like containers. J. Phys. Chem. B, 127, 3343.
4. S. Day et al, 2024. Supramolecular complex of tetracationic porphyrin with acyclic cucurbituril-like container induces quantitative singlet oxygen generation. Phototoxicity studies in vitro in MCF-7 human breast cancer cells. J. Photochem. Photobiol. A, 449,115388.

Abstracts

ASP New Investigator Award Lecture

Fluoresent proteins understanding, design, and applications.

Juan Pablo Fuenzalida Werner

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Group Leader, Chair of Biogenic Functional Materials, Technical University of Munich, Schulgasse, Straubing, Germany. (Until August)
Associate professor, Department of Chemistry, the University of Navarra (From September 2024).

Fluorescent proteins (FPs) as labels and sensors have transformed biology and are being increasingly incorporated into material science. In a groundbreaking work, we developed the first reversibly photo-switchable sensor protein family and elucidated its molecular mechanisms, emphasizing the critical interaction between the fluorescent protein's core barrel structure and a $Ca2^{+}$ receptor component.

Despite these advances, FPs have limitations in non-biological environments and lack resilience under unnatural stress conditions. Addressing this, we introduced a genetically encoded macro-oligomerization strategy that enhances FP protein-protein interactions through electrostatic control, applicable across various FPs. These macro-oligomers maintain stability for months in organic solvents and harsh conditions, making them suitable for integration into non-aqueous polymer-based materials. Additionally, our engineering approach produced highly supercharged FPs (+22) that retain photoluminescence and thermal stability like their native counterparts, forming self-assembled FP-apoferritin cocrystals within a silicone matrix.

Finally, we have demonstrated that all classes of FPs can emit circularly polarized light (CPL), achieving unprecedented CPL brightness among organic emitters. Our findings reveal that the CPL signal in β-barrel FPs is inherently linked to the chromophore's polarity, degrees of freedom, and the presence of exciton coupling and thus can be genetically controlled in the future.

Environmental Circadian Disruption Aggravates UVB-induced Skin Cancer Progression in Mice

Shobhan Gaddameedhi

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The circadian rhythm synchronizes with daily environmental cues to align itself with the Earth's day-night cycle. Unfortunately, night schedules linked to certain professions and lifestyle choices disrupt this dynamic and have been linked to an increased risk of cancer. Solar ultraviolet-B (UVB) radiation is a major source of exogenous DNA damage and a known driver of skin carcinogenesis. However, the combined impact of circadian disruption and UVB exposure on daily rhythmic behavior and skin carcinogenesis outcomes is unknown. We hypothesize that circadian disruption exacerbates UVB-induced skin carcinogenesis through epidermal genomic instability.

Our experiments include SKH-1 hairless mice under two conditions: healthy (Light-Dark 12h;12h, LD 12:12) and environmentally disrupted (chronic jetlag, CJL) circadian rhythms. Both groups were exposed to a sub-erythemal dose of UVB (35.3 mJ/cm^2) three times a week for 27 weeks to induce skin cancer. Locomotor activity rhythms, tumor multiplicity, and tumor progression were recorded throughout the experiment. Tumors were graded by histopathology. Molecular-level effects of CJL and UVB were investigated using immuno-slot blot, Western blot, cytokine array, and qRT-PCR experiments.

LD 12:12 mice had consistent 24-h locomotor and molecular circadian rhythms, whereas CJL mice presented significantly dysregulated rhythmicity. CJL mice additionally experienced increased skin tumor burden with higher histological grades in both sexes and reduced median survival by 3-5 weeks. Molecular data revealed reduced DNA repair capacity, upregulated pro-inflammatory cytokines, increased oxidative stress, and increased proliferation and angiogenic activity. Ongoing experiments will determine epigenetic, transcriptomic alterations, and critical driver mutations in tumors within UVB and CJL conditions.

Photosensitizing effect and binding of Toluidine Blue on Human Serum Albumin

Melannie Garcia

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Cancer is a chronic disease that represents one of the greatest challenges for medicine today. Photodynamic therapy (PDT) has emerged as a promising strategy in the treatment of this disease, combining the administration of photosensitizers (PS) and light irradiation to generate reactive oxygen species (ROS) that induce the selective death of cancer cells.[1] HSA plays an important role in the distribution of drugs in the circulatory system so it is crucial to investigate the interaction of photosensitizers with plasma proteins such as human serum albumin (HSA) to understand and improve the efficacy of PDT.[2]

In this investigation toluidine blue (TBO^{+}) and derivatives, mono (d-TBO^{+}) and doubly demethylated (dd-TBO^{+}),[3,4] was studied and their association with HSA was explored by steady-state fluorescence in comparison with competing drugs, ibuprofen and warfarin, with PSs. Similarly, supramolecular encapsulation within curcubiturils was performed to evaluate their effect in their fluorescence and singlet oxygen generation.[5,6]

The results showed that the demethylation process influences the binding with HSA, as well as their fluorescence quantum yield and singlet oxygen generation. Similarly, the supramolecular encapsulation was affected depending on the derivative. This study provides a deeper understanding of the interaction between PSs and HSA for the development of PDT applications.

These results contribute to the development of future research in therapeutic approaches.

References

[1] `Agostinis, P., et al.ilson, B. C., & Golab, J. Cancer J. for Clinicians, 61(4), 250-281. https://doi.org/10.3322/caac.20114 (2011)

[2] Sharma AS, et al. J. Of Lum.151:206-218. doi:10.1016/j.jlumin.2014.02.009 (2014)

[3] Robinson-Duggon, J. et al. J. Phys. Chem. A, 123:4863 (2019).

[4] Otero-González, J. et al. Photochem Photobiol., 00: 1-10. doi:10.1111/php.13882 (2023).

[5] Robinson-Duggon, J. et al. J. Phys. Chem. C, 121:21782 (2017).

[6] Robinson-Duggon, J. et al. J. Photochem. Photobiol. B, Biol., 223:112284 (2021).

Genome mapping of CPDs refractory to repair in keratinocytes after acute or chronic UV exposure

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Cyclobutane pyrimidine dimers (CPDs) are the predominant DNA damage generated by UV exposure and are main precursors of DNA mutations in skin cancer. CPDs are repaired by nucleotide excision repair; however, depending on their genomic location, they can be refractory to repair. Genome-wide nucleotide-resolution analysis of refractory CPDs could objectively determine personal past UV exposure and determine the risk of future skin cancer. Acute and chronic UV exposures have correlations to melanoma and carcinoma respectively.

To determine the genomic position of refractory CPDs, human keratinocytes were irradiated with an acute dose of 2000 J/m^2 of nbUVB (~311 nm) and allowed to repair for 7 days, or irradiated with a lower dose of 200 J/m^2 daily for 10 days and then allowed to repair for 7 days. CPDs were located and quantified by adductSeq high-throughput sequencing, based on enzymatic nicking at CPD sites.

Bioinformatic analysis identified thousands of sites with recurrent refractory CPDs, as well as refractory cytosine-deaminated CPDs. Chronic exposure led to over 2- and 35-fold more refractory CPDs and deaminated CPDs, respectively.

CPDs generated immediately after UV irradiation in keratinocytes were concentrated at CPD hyperhotspots, dipyrimidines in promoter CpG islands of skin-expressed genes and associated with ETS transcription factors. In contrast, refractory CPDs resided in non-skin related genes, within kilobase-long regions of the repressive epigenetic marker H3K27me3 specific to skin keratinocytes. This location indicates that refractory CPDs accumulate in a subset of transcriptionally-repressed chromatin regions concealed from transcription coupled repair and global genomic repair despite the prolonged repair time.

Chemical and morphological markers for melanin aging: Part 1

Gisele George

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Melanins perform diverse and important functions in skin and retina. Retinal pigment epithelial (RPE) cells make melanosome particles (MPs) by integrating melanin with multiple proteins, which absorb incoming light that passes all tissues anterior. Due to the functions and anatomy of RPE cells, the aging process leads to complex photo-oxidative products that are detrimental to cell viability, and thus the physiology of the retina. Here we examined the effects of simulated aging on the individual MP and compare them to synthetic melanin that does not contain protein. Circular dichroism, confocal microscopy, and total internal reflection fluorescence microscopy were used to identify chemical and structural changes that occurred when synthetic and natural isolated MPs were artificially aged using light (white and blue) and mild oxidation (hydrogen peroxide), as well as mild hyperthermia treatment. Identifying markers of melanin aging will be helpful in devising modalities for protection and recovery from photo-oxidation in the retina.

Inactivation of C. auris via radiation (far-UVC up to blue light)

Anna-Maria Gierke

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In recent years, the number of patients infected with antimycotic-resistant fungi has increased. In this regard, WHO published a priority list of pathogenic fungi in 2023, with *Candida auris* and *Candida albicans* listed in the group with the highest priority. In this study, fungal photoinactivation at different wavelengths (222 – 450 nm) has been investigated for *Candida auris* and *Saccharomyces cerevisiae* as a potential *C. auris* or *C. albicans* surrogate. The investigations were carried out using suspensions. In addition, results of studies using similar experimental conditions for *C. albicans* were compiled. Here, the inactivation curves of *C. auris* and *S. cerevisiae* converge at UVA up to 450 nm and are almost equally at 222 and 254 nm. At all wavelengths, except 222 and 254 nm, *S. cerevisiae* is more sensitive than *C. auris* to the radiation. The median values of log 1 reduction doses for *C. albicans* at 222 and 254 nm are approximately two times higher than *C. auris*. All yeasts analyzed exhibit increasing photosensitivity with decreasing wavelength, whereby each inactivation curve determined could be presented by a linear fit in the semi-logarithmic representation. In addition to comparisons with other yeasts and studies, new data on inactivation of *C. auris* could be obtained for different wavelengths. Based on available data, *S. cerevisiae* is not a suitable surrogate for *C. albicans*. By comparing the log 1 reduction doses, *S. cerevisiae* is a possible surrogate for *C. auris* when irradiated at 222, 254, 302 and 450 nm.

Anti-PDT and pro-tumor effects of nitric oxide in photodynamic therapy: an update

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Low level nitric oxide (NO) produced by inducible nitric oxide synthase (iNOS) in many malignant tumors is known to support survival and proliferation of tumor cells. NO can also induce or enhance resistance to anti-tumor therapies, e.g. platin-based chemotherapies, radiotherapies, and photodynamic therapy (PDT). Many PDT photosensitizers are amphiphilic, e.g. protoporphyrin-IX (PpIX), and tend to localize in membranes of cancer cells, making them susceptible to photodamage via chain lipid peroxidation (LPO). Early studies with model membranes, e.g. PpIX-sensitized liposomes (LUVs), revealed that NO from a chemical donor (SPNO) could inhibit LPO build-up after irradiation by intercepting chain-carrying lipid peroxyl/oxyl radical intermediates. Subsequent experiments with breast cancer cells sensitized with 5-aminolevulinic acid (ALA)-induced PpIX that had diffused from mitochondria to

plasma membrane showed that SPNO, by suppressing LPO, protected these cells against necrotic photokilling. More recent studies demonstrated that a variety of human cancer lines (breast, prostate, glioblastoma) sensitized in mitochondria with ALA-induced PpIX use stress-upregulated iNOS/NO to resist apoptotic photokilling. Cells surviving treatment exhibited a striking NO-dependent increase in proliferative, migratory, and invasive aggressiveness. Such responses were also observed in non-targeted bystander cells, demonstrating a remarkable "feed-forward" effect of targeted cell NO. All described negative effects of iNOS/NO were suppressed by BET inhibitor JQ1, which effectively blocked iNOS transcription. When used as adjuvants, BET inhibitors could greatly improve clinical PDT efficacy. Our findings should increase awareness that tumor iNOS/NO, unless suppressed, will not only antagonize PDT, but also increase surviving cell aggressiveness.

Structure-function relationships of far-red light-absorbing allophycocyanins

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Cyanobacteria and red algae contain phycobiliproteins that absorb light and transfer energy to the photosystems of oxygenic photosynthesis. During acclimation to shade and filtered light conditions, some cyanobacteria express paralogs of the phycobiliprotein, allophycocyanin, that strongly absorb far-red light (FRL) to drive photochemistry. To uncover the molecular bases of this, we have used cryogenic electron microscopy to reveal the structure-function relationships of two FRL-absorbing allophycocyanin complexes. In one case, FRL-allophycocyanin subunits assemble as helical nanotubes rather than typical toroids and are most likely anchored to photosystem I via a chlorophyll-containing, transmembrane protein, IsiX. In the second case, FRL-absorbing allophycocyanin subunits assemble as toroids and form cylindrical cores, the terminal emitters of which are found on one side of the cylinder that likely binds near photosystem II. Structural and spectroscopic characterization provide insight into the molecular bases that allow phycocyanobilin, the chromophore bound by allophycocyanin, to absorb FRL. The results expand the known diversity of light-harvesting proteins in cyanobacteria.

Polylactic Acid/Photosensitizer-Based Filament for the Design of Light-Activatable 3D-Printed Antimicrobial Platforms

Jesus Gomez

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By generating reactive oxygen species (ROS), light-activated materials that integrate biopolymers like polylactic acid (PLA) and photosensitizers (PS) present a promising approach to develop antimicrobial materials. Additionally, self-sterilizing polymers can be attained through 3D printing blends of PLA and biocidal additives using fused deposition modeling. However, to the best of our knowledge, there have been no reports of 3D-printed platforms extruding filaments composed of PLA and a combination of dyes. We believe this approach favors ROS sensitization over a single fluorophore strategy by collecting more photons of multiple wavelengths. Here, we successfully prepared different composites by extruding PLA with Zn phthalocyanine, Rose Bengal, aspartate (chemoattractant for bacteria), and $NiSO_3$ (chemorepellent for bacteria) mixture into filaments. The materials were then used to produce various objects with noteworthy photodynamic properties. Upon irradiation of the composites with light, the production of cytotoxic singlet oxygen was assessed using an indirect (chemical trap) methodology. Furthermore, fluorescence microscopy studies at the single-cell level of bacteria anchored to the surface of the materials showed the elimination of microbes after 30 minutes of light exposure. This sets the stage and opens new venues for a cost-effective and straightforward design of sustainable 3D materials for light-mediated microbial elimination.

Flavoprotein Photoreceptors Through the Quantum Mechanical Looking Glass

Samer Gozem

Samer Gozem

Department of Chemistry, Georgia State University, Atlanta, GA, USA

Flavins (vitamin B2 derivatives) are famously cofactors in various oxidoreductases, transferases, lyases, isomerases, and ligases. However, after absorbing blue or UV light, flavins are also remarkably versatile cofactors in their electronically excited state. Several families of flavoprotein photoreceptors (LOV, BLUF, and CRY) mediate light sensing and response in organisms. We develop and apply computational spectroscopy and photobiology tools and have been applying them to study how flavoproteins tune the spectroscopy, photophysics, and photochemistry of their flavin cofactor. I will introduce three such tools: A user-friendly Franck-Condon factor tool (ezFCF) [1], Electrostatic tuning maps [2-3], and average protein electrostatic configurations (APEC) [4-5]. The latter is a hybrid quantum mechanical / molecular mechanical (QM/MM) approach that performs multi-configurational quantum chemical computations in an ensemble of protein structures obtained from molecular dynamics simulations [3-4]. The first part of my talk will serve as a pedagogical account of computational spectroscopy and photobiology, while the second part discusses the application of the three tools above to problems in the spectroscopy of flavoproteins.

References

1. Gozem, S.; Krylov, A.I; *WIREs Comp. Mol. Sci.* **2021**, *12*, e1546.
2. Y. Orozco-Gonzalez; M.P. Kabir; S. Gozem, *J. Phys. Chem. B.* **2019**, *123*, 4813.
3. M.P. Kabir; Y. Orozco-Gonzalez; S. Gozem, *Phys. Chem. Chem. Phys.* **2019**, *21*, 16526.
4. B.D. Dratch; Y. Orozco-Gonzalez; G. Gadda; S. Gozem, *J. Phys. Chem. Lett.*, **2021**, *12*, 8384.
5. M.P. Kabir; D. Ouedraogo; Y. Orozco-Gonzalez; G. Gadda; S. Gozem, *J. Phys. Chem. B*, **2023**, *127*, 1301.

Singlet Oxygen Oxidation of a Phenol at the Air/Solid Interface of a Nanoparticle: Hydrophobic Surface Increases Oxophilicity

Alexander Greer

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Although silica surfaces have been used in organic oxidations for the production of peroxides, studies of airborne singlet oxygen at interfaces are limited and have not found widespread advantages. Here, with prenyl phenol coated silica and delivery of singlet oxygen ($^1O_2$) through the gas phase, we uncover significant selectivity for dihydrofuran formation over allylic hydroperoxide formation. The hydrophobic particle enables prenyl phenol to reach a dihydrofuran product. In contrast, hydrophilic particles cause prenyl phenol to produce allylic hydroperoxide, due to phenol OH hydrogen bonding with SiOH surface groups. Mechanistic insight is provided by air/nanoparticle interface coated with the prenyl phenol, in which product yield were 6-fold greater on the hydrophobic nanoparticles compared to the hydrophilic nanoparticles and total rate constants (ASI-k_t) of $^1O_2$ were 13-fold greater on the hydrophobic vs hydrophilic nanoparticles. A slope intersection method (SIM) method was also developed that uses the airborne $^1O_2$ lifetime ($\tau_{airborne}$) and surface-associated $^1O_2$ lifetime (τ_{surf}) to quantitate $^1O_2$ transitioning from volatile to non-volatile and surface boundary (surface···$^1O_2$). Further mechanistic insight on the selectivity of the reaction of prenyl phenol with $^1O_2$ was provided by DFT calculations.

ASP Research Award Lecture

Using Photochemistry to Help Solve Problems in Photomedicine and Photobiology

Alexander Greer

Alexander Greer[1–3]

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Today's lecture will focus mainly on applied and fundamental aspects in the photosciences. First, the development of a hand-held fiber device will be described which delivers singlet oxygen but not sensitizer by a superhydrophobic-tip. Red light emitted by the fiber tip is transmitted through the backside of a polydimethylsiloxane strip before irradiating a verteporfin coating facing a biofilm-covered tooth or gingival surface. The device shows promising results based on a Wistar rat model of periodontitis in effectively killing *P. gingivalis*, while promoting healing and minimizing tissue damage and inflammation. Secondly, a photoconversion of heptamethine cyanine to trimethine cyanine will be described that involves singlet oxygen and subsequent 4-carbon truncation through a retro-Diels-Alder process for a potentially useful photobluing optical tool. Thirdly, experimental and theoretical results will be described on fundamental aspects in controlling and amplifying the production of reactive oxygen intermediates. Results will be highlighted from our collaborations with the groups of Alan Lyons (College of Staten Island), Tayyaba Hasan (Harvard Medical School), Martin J. Schnermann (National Cancer Institute), and Andrés M. Durantini (Southern Illinois University Edwardsville). Lastly, my fulfilling journey in serving the ASP over the past 6 years will be mentioned; the society reached its 50th anniversary in 2022, yet I had not anticipated that I would serve as president almost exactly overlapping the COVID pandemic.

Mechanistic Underpinnings of Phototoxicity: Studies of Post-Illumination Damage Effects

Alexander Greer

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Basic photochemistry that leads to post-illumination damage in phototherapy presents a major challenge in research. A better understanding of complex photochemical processes is therefore urgently needed. Our group is excited to help provide mechanistic insights to sort out the reactive oxygen intermediates in photooxidation reactions. A crucial step is to solve sequential light and post-illumination processes causing biological damage and dysfunction, which are often mechanistically inaccessible. Our group utilizes both experimental and theoretical methods to research fundamental aspects in the photosciences, including a focus on controlling and amplifying the production of reactive oxygen intermediates. Our research has provided synthetic and mechanistic studies that facilitate the deconvolution of photochemical processes, a vital component to the improvement of fundamental and medical understanding.

Practical Aspects in the Study of Biological Photosensitization Including Reaction Mechanisms and Product Analyses: A Do's and Don'ts Guide

Alexander Greer

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The interaction of light with natural matter leads to a plethora of photosensitized reactions. These reactions cause the degradation of biomolecules, such as DNA, lipids, proteins, being therefore detrimental to the living organisms, or they can also be beneficial by allowing the treatment of several diseases by photomedicine. Based on the molecular mechanistic understanding of the photosensitization reactions, we propose to classify them in four processes: oxygen-dependent (type I and type II processes) and oxygen-*in*dependent [triplet-triplet energy transfer (TTET) and photoadduct formation]. In this poster, these processes are presented by considering a wide variety of approaches including time-resolved and steady-state techniques, together with solvent, quencher, and scavenger effects. The main aim of this survey is to provide a description of general techniques and approaches that can be used to investigate photosensitization reactions of biomolecules together with basic recommendations on good practices. Illustration of the suitability of these

approaches is provided by the measurement of key biomarkers of singlet oxygen and one-electron oxidation reactions in both isolated and cellular DNA. This poster provides for an educational review that is mostly addressed to students and beginners, and we hope will help establish good standard practices, with clear hints on how to succeed in the study of the photosensitized oxidation reactions.

Theoretical Investigation of Optical and Nonlinear Optical (NLO) Properties of X@ZnPc Complexes

Alexander Greer

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Intermolecular interactions of zinc phthalocyanine with neutral metal atoms (Li, K, and Na), as well as corresponding cations (Li^+, K^+, and $Na^{+)}$ and related anions (F^- and CN^-) were examined using the density functional theory (DFT) with B3LYP and the 6-311++G(d,p) basis set. The optical activity of the zinc phthalocyanine is found to be strongly influenced by this series of atoms and ions. Interaction of zinc phthalocyanine with the metals and ions are exothermic, in which the Li^+ has bears the greatest Gibbs free energy, enthalpy and adsorption energy. The calculated results show that the metals and ions strongly affect polarizability and the first hyper polarizability of the zinc phthalocyanine. Among the neutral atoms, the potassium atom had the most significant effect and led to an increase in the first super-polarizability to almost 11415.594 au compared to other atoms. The computed results indicate that zinc phthalocyanine complexes are reasonable candidates as nonlinear optical (NLO) compounds due to stability and NLO increases.

Vaccination against the tumor vasculature, an ideal strategy for anti-cancer combination strategies.

Arjan Griffioen

Arjan W. Griffioen[1,2]

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Photodynamic therapy (PDT) induces strong angiogenesis signals, limiting it for oncological purposes. Combination of PDT with angiogenesis inhibition may therefore be an ideal strategy. However, angiogenesis inhibitors have only moderate effects in the clinic. We developed a first-of-its-kind strategy to inhibit angiogenesis, through vaccination against the tumor vasculature. This strategy inhibits angiogenesis and stimulates the immune system by enhanced infiltration and inhibition of immune checkpoint molecules, without any side effects. We identified specific and exclusive targets in the tumor vasculature, one of them is extracellular vimentin (eVim). Using our iBoost technology of conjugate vaccination against eVim, we observed tumor growth inhibition in breast- and colon carcinoma-, as well as melanoma- and glioblastoma mouse models. In a clinical study in canine patients, this strategy led to an objective response rate of 100% of dogs, while overall survival doubled. This vaccination strategy is currently developed for testing in phase I clinical study in patients with bladder cancer. The combination of this vaccination strategy with immune checkpoint inhibition led to synergistic responses. Combination with PDT has still to be performed.

Photoinitated Release of Oxygen and Nitrogen Gases and Potential Applications of Gas Release in Biomedical Applications

Anna Gudmundsdottir

Anna Gudmundsdottir

Photodynamic crystals can convert light into mechanical energy which may play a role in mechanically tunable components for actuation and energy harvesting applications. Recent findings highlight the flexibility of organic crystals, expressed as bending, curling, hopping or twisting, when subjected to external stimuli, *e.g.* light or pressure. For example, crystals of azido compounds result in the release of N_2 gas upon irradiation prompting a similar photodynamic response. In contrast, we demonstrated that crystal engineering can be used to design specific azido aryl crystals that are stable towards light. Upon exposure to light, these crystals remain intact, but depending on their structure the surfaces turn orange, dark red or purple. The crystal stability was such that patterns could be drawn on the surface using laser etching techniques and visualized using confocal microscopy. Confocal Raman microscopy was used, before and after irradiation, to identify the chemical reaction taking place on the crystal surfaces. We have extended these efforts to study release of oxygen from crystals, which can be used to deliver oxygen in application.

Extending the Erythema Action Spectrum to Include the Far-UVC

Natalia Gutierrez-Bayona

Natalia E. Gutierrez-Bayona, Camryn Peterson, Raabia Hashmi, Manuela Buonanno, Igor Shuryak, Norman J. Kleiman, David J. Brenner, David Welch*

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Guidance on UV exposure limits is vital for public health safety as it aims to minimize harmful effects while allowing for beneficial exposure. National and international organizations, such as The American Conference of Governmental Industrial Hygienists (ACGIH), play crucial roles in the establishments of these guidelines. They consider the risk of acute effects (e.g., erythema) and long-term effects (e.g., skin cancer) in determining exposure limits, termed Threshold Limit Values (TLVs). TLVs specify the dose a person can safely receive during an 8-hour workday and 40-hour workweek without skin or eye injuries. This determination relies on action spectra which is a method used to quantify the effectiveness of each wavelength at eliciting specific biological effects. In response to the growing interest in using far-UVC (200-235 nm) radiation for controlling the spread of airborne pathogens, recent arguments have emerged for revisiting exposure limits for wavelengths below 250 nm after the thresholds set for 222 nm and 207 nm were demonstrated to be overly conservative. In response to this, ACGIH acted in 2022 and increased the TLVs for wavelengths below 240 nm. While there is much evidence suggesting that these new threshold limits are safe, the standard erythema action spectra have not been extended below 240 nm. This study assists in expanding the erythema action spectrum to far-UVC wavelengths using hairless albino mice model by reporting new skin threshold doses from 200 to 270 nm using narrow bandwidth exposures in 5 nm increments.

C/EBPβ mediates keratinocyte apoptosis after UVB-induced DNA damage via regulation of the innate immune inflammatory response and extrinsic apoptosis

Jonathan Hall

Emma E. Tobin[1,2], Ayushma Sharma[1], Sophia M. Gray[1] and Jonathan R. Hall[1,2,3]

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In addition to activation of canonical DNA damage responses including cell cycle checkpoints and DNA repair, recent studies indicate that DNA damage can also activate the innate immune response.

The host innate immune response mediated by type I interferons (IFN-I) is widely recognized for its critical role in preventing infection of viruses and other pathogens. Recent studies suggest this same IFN system can also mediate diverse cellular and biological responses such as proliferation, apoptosis, senescence, and the DNA damage response. Our previous studies have reported that CCAAT/enhancer-binding protein-β (C/EBPβ), a basic leucine zipper transcription factor is a suppressor of epidermal keratinocyte apoptosis in response to UVB-induced DNA damage and that C/EBPβ is required for UVB-induced skin tumor formation. RNAseq and pathway analysis of UVB-treated C/EBPβ knockout epidermis and primary keratinocytes revealed enrichment of inflammatory signaling pathways, including the IFN-I pathway as the most highly enriched pathway. Numerous IFN-I stimulated genes were upregulated including genes that regulate extrinsic apoptosis. Ingenuity pathway analysis revealed the cell death inducing inflammatory cytokine, tumor necrosis factor (TNF) as one of the most significant upstream regulators activated in UVB exposed C/EBPβ knockout keratinocytes. UVB exposed C/EBPβ knockout keratinocytes displayed increased expression of TNF and enhanced activation of markers of extrinsic apoptosis that was dependent on the interferon α/β receptor and TNF. Our results indicate that the loss of C/EBPβ enhances activation of a noncanonical UVB DNA damage response pathway involving the IFN-I pathway, TNF, and classic DNA damage response proteins to induce keratinocyte cell death.

A Realistic reappraisal of the use of Phototherapy at the age of biologics: Vitiligo

Iltefat Hamzavi

Iltefat Hamzavi

Senior Staff Physician, Multicultural Dermatology Center and Henry Lim Photomedicine Unit, Dept of Dermatology, Henry Ford Hospital, Detroit Michigan

Progress in the basic science and pathophysiology of vitiligo is leading to new biologic and small molecules that have the potential to dramatically improve the clinical results of patients with this disfiguring condition. Phototherapy has been a mainstay of the treatment of vitiligo but can its role be replaced by these new treatments? Studies will be reviewed comparing new JAKi to combination therapy with phototherapy to phototherapy alone. These studies can help clarify what role phototherapy will have going forward.

Activatable photoimmunotherapy to target cancer cells, spare T cells, and engage anti-tumor immunity

Rebecca Harman

Rebecca Harman[1,2], Eric M. Kercher[1,2], Ryan T. Lang[1,2], Mohammad Ahsan Saad[3], Sudip Timilsina[1,2], Tayyaba Hasan[3,4], Bryan Spring[1,2]

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Tumor-targeted, activatable photoimmunotherapy (taPIT) uses a cancer cell-targeted antibody conjugated with quenched photosensitizers used for photodynamic therapy (PDT) to deliver targeted PDT to cancer cells (via antibody internalization and subsequent quenching reversal) while sparing neighboring off-target cells, including T cells, and to prime chemotherapy and immunotherapy. Preserving and increasing the number of T cells in and around the tumor is a crucial treatment goal, as intra-tumoral T cell presence is an important predictor of outcome in many cancers and can be an indicator of response to immunotherapy. In an immunocompetent pancreatic cancer mouse model, we analyzed live-animal *in vivo* hyperspectral microendoscope images and *ex vivo* immunohistochemistry-stained slices pre- and post-PDT to show that the number of CD3+CD4+ and CD3+CD8+ T cells at the tumor site increases significantly post-PDT. In an *in vitro* T cell—cancer cell 3D Matrigel model, taPIT spared 25% of the local T cells, 5 times more than conventional PDT. In a 2D cancer cell—peripheral blood mononuclear cell (PBMC) coculture, taPIT spares lymphocytes, including T cells, while drastically reducing cancer cells. In a 3D Matrigel dome model combining ovarian cancer spheroids and PBMCs, an additive effect of cancer cell-taPIT combined with antibody-mediated immune cell killing of cancer cells is observed in both overall cancer cell viability and the depletion and disruption of tumor spheroids. Collectively, these experiments will help to optimize local and distal anti-tumor immune stimulation.

Epitranscriptomic mechanisms of UV-induced inflammation and immune modulation

Yu-Ying He

Gayoung Park, Zizhao Yang, Yu-Ying He

Department of Medicine, Section of Dermatology, University of Chicago

In addition to DNA damage and mutagenesis, UVB radiation also induces inflammation and immune suppression. Previously we have shown that UVB radiation-induced inflammation promote skin tumorigenesis, which is mediated via autophagy. Recently we have shown that METTL14, the cofactor for the N^6-methyladenosine (m^6A) RNA methyltransferase complex and a target for autophagy, regulates the repair of UVB-induced DNA damage lesions via promoting m^6A-dependent translation and suppresses skin tumorigenesis. To determine whether m^6A RNA methylation also plays an active role in UVB-induced inflammation and immune alteration, we assessed the consequences of skin-specific METTL14 deletion in UVB-induced inflammation and immune alteration in mice. Flow cytometric analysis showed that heterozygous skin-specific METTL14 deletion increased the percentage of total dendritic cells (DC) and $CD11b^+$ DCs in the skin under baseline condition, while it decreased the percentage of $CD103^+$ DCs. However, it did not affect other immune cells in the skin. Next, we analyzed the effect of heterozygous skin-specific METTL14 deletion on the systemic immune system in the spleen and blood. Skin-specific METTL14 deletion increased spleen weight following chronic UVB irradiation, while it did not affect immune cells analyzed in the spleen. However, in the blood, heterozygous skin-specific METTL14 deletion increased the percentage of Treg cells under baseline condition and $CD8^+$ T cells following UVB irradiation and decreased the percentage of $CD4^+$ T cells under baseline condition. Our findings demonstrate that heterozygous skin METTL14 deletion altered skin immune profiles and systemic

inflammatory and immune profiles in response to UVB irradiation.

Kendric C. Smith Symposia Lecture

Engineering nanomaterial characteristics for cancer photodynamic therapy

Huang Chiao Huang

Huang-Chiao Huang

Fischell Department of Bioengineering, University of Maryland, College Park, Maryland, USA

Photodynamic therapy (PDT), a globally approved photochemistry-based process, relies on light activation of photosensitizers to induce cytotoxicity, offering unique opportunities in molecular, cellular, and tissue engineering. Utilizing creative nanoengineering techniques, photosensitizers and secondary treatments can be encapsulated optimally. Light activation of these materials facilitates response-based therapeutic design, diagnostics, and therapy monitoring, with light-triggered release enhancing control over timing and location. Despite PDT's depth-limited cytotoxic effects, photodynamic priming (PDP) extends its reach by preparing the microenvironment for adjuvant therapies. Some PDP events, including vasculature permeabilization and overcoming chemoresistance, will be discussed, along with mechanistic sensitization to adjuvant therapies. Additionally, this presentation will delve into image-guided methods for PDT personalization. Notably, the photosensitizing materials used in PDT also possess fluorescence, enabling real-time adjustment of the therapy. Overall, this talk will offer an overview of photosensitizing nanomaterials and their pivotal role in advancing PDT/PDP for effective cancer management.

Wavelength-dependent variation of UVR-induced mutation signatures

Hironobu Ikehata

Hironobu Ikehata

Department of Medical Biochemistry, Tohoku University Graduate School of Medicine, Sendai, Japan

UVR has genotoxicity for the skin mainly through the production of specific photolesions such as cyclobutane pyrimidine dimers (CPDs) and pyrimidine(6-4)pyrimidone photoproducts, and can induce specific mutations called "UV signature" in the exposed skin genome (Brush et al., 1991, PNAS). The UV signature mutation is specified as C to T base substitutions at dipyrimidine sites, that are known to be induced mainly through error-free bypass of a cytosine-deaminated CPD by the translesion DNA synthesis polymerase h (You and Pfeifer, 2001, JMB). I studied UVR-induced mutation signatures using mice transgenic with bacterial lacZ gene to characterize mutations in the skin. I irradiated various UVR wavelength bands and confirmed the induction of the UV signature in mouse skin irrespective of UVR wavelengths, and found that the mutations occurred preferably at 5'-TCG-3' sites, well consistent with the preferable CPD deamination at the same site as reported previously (Cannistraro and Taylor, 2009, JMB). I further detected a wavelength-dependent variation of the TCG preference, that was enhanced as the UVR wavelength gets longer, resulting in exclusive occurrences at the site in the UVA range. I have named this UV-signature mutation at the TCG site as the "UVA signature" and proposed as its induction mechanism the preferable formation of CPDs at sites associated with methylated CpG motif by UVA (Ikehata et al., 2018, PPS). We can observe a typical mixture of the conventional "UV signature" and the newly recognized "UVA signature" in the mutations induced by sunlight, that is also called "solar-UV signature".

New photochemistry of microbial rhodopsins revealed by time-resolved spectroscopy

Keiichi Inoue

Keiichi Inoue

Microbial rhodopsins are photoreceptive membrane proteins found mainly in unicellular microorganisms, containing the all-trans-retinal chromophore. Channelrhodopsins (ChR) are light-gated ion channels in which a channel pore within the protein opens after the all-trans-to-13-cis photoisomerization of the retinal chromophore. We investigated the structure of the retinal chromophore in photointermediate states using time-resolved resonance Raman spectroscopy, employing a new optical system with acousto-optic modulators (AOMs). Our results revealed a highly twisted structure of the retinal in ChR, which is not known in other microbial rhodopsins. The dynamics of the retinal twisting/relaxation and channel opening/closing were closely correlated, and the twisting maximized in the channel-open state, indicating that the channel opening of ChR is driven by the twisting of the retinal chromophore.

We recently identified a new outward proton pumping rhodopsin, Kin4B8, which binds a carotenoid molecule, lutein, on the protein surface. The secondary lutein chromophore has strong absorption peaks at wavelengths shorter than those absorbed by retinal. Kin4B8, when bound to lutein, exhibits a strong transient absorption signal under blue-light excitation, which is weakly absorbed by the retinal chromophore, indicating that the absorbed photon energy is transferred from the lutein to the retinal to initiate the retinal isomerization and the subsequent proton-pumping photocycle. Intriguingly, the efficiency of energy transfer increases when the lutein's higher vibrational peak is excited. This phenomenon is not observed in xanthorhodopsin, which binds a different carotenoid, salinixanthin (SXN), and exhibits uniform energy transfer efficiency across the excitations of all vibrational peaks of SXN.

Photochemistry of N-Aryl and N-Alkyl Dibenzothiophene Sulfoximines

Alexis Iverson

Alexis J. Iverson[1], John C. Throgmorton[1], and Ryan D. McCulla*

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Upon irradiation with UV-A light of a suitable wavelength, *N*-phenyl dibenzothiophene sulfoximine has been shown to generate phenyl nitrene and dibenzothiophene *S*-oxide. Subsequent irradiation of dibenzothiophene *S*-oxide results in the release of triplet atomic oxygen. Thus, *N*-phenyl dibenzothiophene presents a rare dual-release capability in its photochemistry. In this study, *N*-substituted dibenzothiophene sulfoximine derivatives undergo UV-A irradiation, facilitating a comparative analysis of their photochemistry and quantum yield of dibenzothiophene *S*-oxide production to the parent sulfoximine, *N*-phenyl dibenzothiophene sulfoximine. A series of *N*-aryl and *N*-alkyl derivatives of dibenzothiophene sulfoximine were synthesized, and their photolysis reactions were examined to observe the influence of the substituent on the quantum yield. The introduction of electron-withdrawing *N*-aryl substituents is demonstrated to increase the quantum yield of dibenzothiophene *S*-oxide production, whereas introducing electron-donating *N*-aryl substituents decreases the quantum yield. Photolysis of *N*-alkyl substituents resulted in a slight reduction of the quantum yield or did not lead to an increase. Furthermore, the quantum yield was not influenced by branching and steric hindrance effects associated with the *N*-alkyl substituents. These results suggest that the observed photolysis reactions were influenced by the electronic modulation of the sulfoximine bonds through functionalizing the imine moiety.

Near-infrared photoimmunotherapy of cancer cells and cancer-associated fibroblasts

Jiefu Jin

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Near-infrared photoimmunotherapy (NIR-PIT) is an emerging targeted cancer therapy in which a water-soluble, photo-stable, NIR phthalocyanine dye IR700, is conjugated to an antibody to target cancer cells or pro-tumorigenic cells. The antibody conjugate specifically binds to the target on the cell membrane, causing membrane damage after NIR light exposure. NIR-PIT using cetuximab-IR700 to treat inoperable recurrent head and neck cancer patients is currently in a phase 3 international multicenter clinical trial. In September 2020, the first drug and the laser system for human use, cetuximab-IR700 and a 690nm laser system, were conditionally approved and registered for clinical use by the Pharmaceuticals and Medical Devices Agency in Japan. Our group has gained extensive experience and expertise with NIR-PIT and successfully expanded NIR-PIT approaches to target a variety of key components or processes in cancer. Over the past decade, we have successfully demonstrated the effectiveness of NIR-PIT in selectively eliminating CD44-expressing breast cancer cells, EGFR and CD44-expressing epithelioid sarcoma cells, PD-L1 expressing ovarian cancer cells, Gr1 expressing myeloid-derived suppressor cells, and FAP-α expressing cells in a variety of preclinical mouse models. In this presentation, we will mainly present and discuss our NIR-PIT efforts centering around three important cell membrane receptors, CD44, EGFR and FAP-α, which are ubiquitous targets in many cancer types. We will present the selection, preparation and characterization of high-affinity antibody conjugates for each target, and data from cellular and animal studies evaluating the specificity and effectiveness of NIR-PIT using genetically engineered cells overexpressing the target of interest.

Chemical and morphological markers for melanin aging: Part 2

Jasmyn Johnson

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Melanins perform diverse and important functions in skin and retina. Retinal pigment epithelial (RPE) cells make melanosome particles (MPs) by integrating melanin with multiple proteins, which absorb incoming light that passes all tissues anterior. Due to the functions and anatomy of RPE cells, the aging process leads to complex photo-oxidative products that are detrimental to cell viability, and thus the physiology of the retina. Too often this process leads to age-related macular degeneration. Here we examined the effects of simulated aging on the individual MP and compared them to synthetic melanin that does not contain protein. Electron microscopy and time-correlated single photon counting (TCSPC) fluorescence lifetime measurements were used to identify chemical and structural changes that occurred when synthetic and natural isolated MPs were artificially aged using light (white and blue) and mild oxidation (hydrogen peroxide), as well as mild hyperthermia treatment. Identifying markers of melanin aging or dysfunction will be helpful in devising modalities for protection and recovery from photo-oxidation in the retina.

Structural basis and molecular mechanism of B_{12}-based Photoreceptor CarH

Nikolas Kambitsis

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*Equal contributions

CarH is a recently discovered B_{12}-based bacterial photoreceptor that acts as a light-dependent transcriptional repressor. In the presence of the co-enzyme B_{12} (5′-deoxyAdenosylcobalamin, AdoCbl), CarH proteins form a dimer of dimers in dark. The resulting tetrameric assembly binds to DNA, blocking transcription of genes involved in carotenoid biosynthesis. When exposed to light, the coenzyme B_{12} undergoes photolytic cleavage. The ensuing protein conformational changes ultimately result in the dissociation of the CarH-DNA complex, allowing transcription to proceed.

Static crystallography studies have shown that the CarH coenzyme B_{12} complex forms a stable tetramer that binds directly to DNA. However, the molecular mechanisms of CarH and light-induced dissociation of the CarH-DNA complex remain elusive. Using dynamic crystallography and photoactive CarH crystals, we have obtained direct observations of the initial structural events associated with B_{12} photolysis at the chromophore site. To capture large light-induced structural changes leading up to the CarH-DNA dissociation, we harness single particle cryoEM to interrogate the conformational states of the CarH-DNA complex in solution and its light-induced structural response. Guided by serial spectrometry and chromatography performed under different light illumination, we aim to elucidate the light-induced conformational changes during the dynamic process following the B_{12} photolysis.

B_{12} is an important enzyme cofactor involved in many fundamental physiological processes in living organisms. CarH features a natural photo-switch that regulates gene expression by exploiting the unique photochemistry of B_{12}. Understanding the structural basis and molecular mechanism of light activation in this B_{12}-based photoreceptor is crucial for developing optogenetics and biomedical applications.

Ultraviolet C (UVC) irradiation induces regulatory T cells in skin and lymph nodes

Yoshifumi Kanayama

Yoshifumi Kanayama, Akimichi Morita

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UV light has been shown to act as a regulator of the immune system. In a mouse model of contact hypersensitivity, UV irradiation has been found to induce immune tolerance in an antigen-specific manner by promoting the generation of regulatory T cells (Tregs). UVB-irradiated skin and draining lymph nodes show an increase of Tregs. However, it is yet to be determined what specific characteristics UV-Tregs possess and what the optimal conditions are for their induction.

To investigate the induction of UV-Tregs, we focused on wavelengths ranging from UVC to UVB. After shaving, we use a monochrometer to irradiate the back skin of C57BL6 mice at 240, 260, 280, and 300nm with 1MED and 3MED. Irradiated skin and lymph nodes in the axilla and groin are analyzed after radiation exposure. UV

irradiation at 240 and 260nm induced Foxp3+ T cells, as shown by flow cytometry analysis of lymph nodes at day 5 and 7 after treatment, compared to control mice. We observed cluster formations by dendritic cells (DCs) and UV-Tregs at days 3 and 7 after irradiation using immunofluorescence images. We have conducted an experiment that confirms UVC irradiation expands UV-Treg induction with DC stimulation. We are now analyzing bulk RNA-sequencing data of CD4+ T cells from lymph nodes after 3 MED. This analysis will help us understand the fluctuation of immune-associated gene expression and identify changes of UV-Tregs in functional gene expression. To evaluate the "Tregness" of each condition, we plan to apply non-negative matrix factorization to the RNA-seq data.

Magical Power of Optogenetics Tools in Subcellular Signaling Interrogation-Statins and other Tales.

Ajith Karunarathne

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Prenylation is an irreversible post-translational modification of proteins that are involved in many physiological and pathological processes. During prenylation, either a 15-C farnesyl or a 20-C geranylgeranyl isoprenyl lipid is covalently attached to the carboxy-terminal *Cysteine* residue in the CaaX motif that determines the type of prenylation. Isoprenyl Lipids are synthesized by the pathway that produces Cholesterol, the mevalonate (HMG-CoA reductase) pathway. Cholesterol-lowering medications (statins) target the rate-limiting HMG-CoA reductase enzyme. We previously showed that statins significantly disrupt the membrane localization and signaling of G protein βγ in a Gγ subtype-dependent manner. Here, we elucidate the molecular processes that regulate the efficacy of G protein g prenylation primarily using optogenetic signaling interrogations. We also show engineered opsin GPCRs to control endomembrane G protein signaling exclusively.

Investigation of photoactive metallodrugs as antimicrobials

Gurleen Kaur

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Photodynamic inactivation (PDI) is a strategy for tackling bacterial infections by exploiting light-molecule interactions. Conventional antimicrobials work by blocking steps in a metabolic pathway that are crucial for the survival of pathogens. Over time bacteria can evolve to mount resistance against these mechanisms, rendering the antibiotics ineffective. Therefore, it is advantageous to have complementary approaches in our arsenal against antibiotic resistant bacteria. PDI utilizes an otherwise nontoxic drug, called a photosensitizer (PS), which can be activated with light in the presence of oxygen to become a powerful antibacterial agent. The premise behind PDI is that PS activation with a certain wavelength of light creates an excited triplet state of the PS that can then sensitize primarily cytotoxic singlet oxygen but also other reactive molecular species (RMS). The immediate burst of relatively nonspecific RMS offers a way to treat bacteria that have already developed resistance to traditional antibiotics. We are investigating certain metal complex classes as PDI agents against some of the most resistant bacteria. This presentation will highlight metal-based PSs as potential light-responsive antimicrobials that offer alternate modes of cytotoxicity.

Adapting traditional drug discovery approaches for identifying optimal photosensitizers for photodynamic inactivation of resistant bacteria

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Despite the revolution in antibiotic drug discovery over the past century, infections still have a huge impact on human health across the world. Conventional antimicrobials that block key steps in microbial metabolic pathways are considered as the first line of defense to treat these infections. Unfortunately, the emergence of antimicrobial resistance (AMR) has created an urgent need to develop alternate strategies. One alternative is photodynamic inactivation (PDI) of bacteria. PDI utilizes an otherwise nontoxic drug, called a photosensitizer (PS), which can be activated with light in the presence of oxygen to generate reactive molecular species (RMS) that destroy microorganisms. The premise is that the immediate burst of relatively nonspecific RMS offers a way to combat resistance mechanisms. This presentation will highlight the discovery and development of different PS classes for PDI, including natural products with historical significance. It will also discuss the challenges and opportunities of PDI screening methods and the importance of standardized approaches and biological replicates using natural product PSs and extracts obtained from plant and fungal sources that show activity against AMR strains.

Integrative analysis of transcriptome and DNA methylation to identify potential epigenetic targets in poorly differentiated cutaneous squamous cell carcinoma

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Cutaneous squamous cell carcinoma (cSCC) is the second most common cancer in the United States. Poorly differentiated cSCCs have a higher risk of distant metastasis and death than well differentiated cSCCs. Thus, it is of great importance to identify potential therapeutic targets that contribute to aggressiveness of poorly differentiated cSCCs. To profile gene expression and DNA methylation in cSCCs, we performed RNA-seq and reduced representation bisulfite sequencing (RRBS) using normal skin (n = 6), well differentiated cSCCs (n = 6), and poorly differentiated cSCCs (n = 6). Well- and poorly differentiated cSCCs shared ~50% of differentially expressed genes (relative to normal skin), with upregulation of immune checkpoint molecules (PD-L1 and B7-H3). We identified the genes whose expression and promoter DNA methylation were commonly changed in both well- and poorly differentiated cSCCs. Among these, 111 downregulated and 97 upregulated genes were associated with hypermethylated and hypomethylated regions, respectively, within ±1 kb of their transcription start sites. These downregulated and upregulated genes were enriched in pathways in cancer and regulation of vesicle-mediated transport, respectively. We also identified a separate set of genes whose expression and methylation changes were specific to poorly differentiated cSCCs. Among them, 86 downregulated and 26 upregulated genes were associated with hypermethylation and hypomethylation of their promoter regions, respectively. Along with recently reported prognostic markers for metastatic risk (CDSN and SPNS2), the genes specifically downregulated in poorly differentiated cSCCs were enriched in fatty acid metabolism pathways. Further investigations are needed to validate these potential epigenetic targets and biomarkers in poorly differentiated cSCCs.

REV-ERB inhibition impacts gene expression and UV responses in keratinocytes and human skin

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Circadian rhythms impact many aspects of physiology and disease risk, including in the skin. For example, DNA repair and skin cancer development are known to be influenced by the time of day of UVB exposure in mice. To explore the use of pharmacological agents that target circadian clock proteins to modulate and potentially improve responses to UV light, we treated cultured keratinocytes and human skin with the cryptochrome inhibitor KS15 and REV-ERB antagonist SR8278. We find that SR8278 has a more dominant effect than KS15 on keratinocyte proliferation and in protecting cells against UVB radiation. However, most of the protective effect of SR8278 appears to be due to direct absorption of UVB wavelengths that limits the generation of canonical UV photoproducts in genomic DNA. Little effect of SR8278 on XPA expression or DNA repair was observed. Unfortunately, SR8278 also absorbs UVA wavelengths and induces phototoxicity in cultured keratinocytes in vitro. Using discarded human surgical skin as a model system, we also examined whether core circadian genes maintain rhythmic expression ex vivo and whether gene expression can be modulated by SR8278 and KS15. Interestingly, we observed a differential response in which the compounds generally increased gene expression in skin samples with low, basal levels of expression but decreased the expression in skin samples with high basal levels of expression. Together, these studies constitute some of the first to explore the use of circadian clock modulating compounds in the context of human skin.

Modeling micro-invasive disease progression and response to ALA-PDT in 3D Head and Neck Carcinoma cell cultures

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Significance: Oral cavity cancers are prevalent malignancies across the globe, with over 377,000 new cases and nearly 178,000 deaths in 2020. Lack of regular oral check-ups, timely biopsy, and late-stage diagnosis are typical in low-income middle-class (LIMCs) areas. About 70% of cases are diagnosed at Stage III-IV. Invasion is a critical step in the metastatic cascade that allows tumor cells to penetrate the surrounding tissue and eventually disseminate through the vascular system. Oral submucosal fibrosis (OSMF) premalignant condition increases the risk of malignant transformation and invasion, leading to a 5-year survival rate below 60%.

Aim: 3D-oral squamous carcinoma (OSCC) culture models with early invasion were developed to mimic physiological conditions in vivo. The model was treated with 5-aminolevulinic acid (ALA)-induced protoporphyrin IX (PpIX) photodynamic therapy (PDT) to assess differential response to treatment in primary nodules and ECM-infiltrating cell populations.

Approach: TR146 OSCC spheroids transplanted to extracellular matrix (ECM; Matrigel supplemented with type-I collagen). Imaging of spheroid and invasive TR146 was carried out before and after ALA treatment, as well as after the light delivery (a total of 100 J/cm^2 of 635 nm red laser light).

Results: Cell populations infiltrated by type-I collagen-rich ECM demonstrate a higher sensitivity towards photodynamic therapy (PDT).

Conclusion: PDT shows efficacy against OSCC in collagen stromal microenvironment and inhibits infiltration. PDT is a promising alternative to early oral cancer treatment and decreases the risk of premalignant to evasive malignant transformation.

Keywords: ALA-PDT, 3D model, Head and Neck Oral Cancer, Oral Submucosal Fibrosis (OSMF).

Near Infrared Photoimmunotherapy (NIR-PIT) of Cancer

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Three major cancer therapies; surgery, radiation and chemotherapy, have been mainstays in oncologic therapy in 100 years. Current immunotherapies don't directly destroy cancer cells, but rely exclusively on activating host immune system, therefore, have been effective to limited patients. Simultaneously destroying cancer cells and activating anti-cancer host immunity has never been successfully performed by a single cancer therapy. Here, we developed "near infrared photo-immunotherapy" (NIR-PIT) by employing a hydrophilic photo-absorbing silicon-phthalocyanine dye, IRdye700DX (IR700), which is covalently conjugated to antibodies (mAb) targeting cancer-specific cell-surface molecules. When exposed near infrared (NIR) light, the conjugates induce highly selective immunogenic cell death. An FDA-designated fast-track global phase 3 trial is on-going world-wide including US, EU and Asia. The first EGFR-targeting NIR-PIT drug (cet-IR700; Akalux™) and a NIR light emitting device (Bioblade™) for NIR-PIT have been approved for the clinical use against recurrent head and neck cancers in Japan in 2020. Since then, NIR-PIT for head and neck cancer was performed more than 400 times in 200+ patients in over 120 hospitals in Japan. As of summer in 2023, among all reported recurrent head and neck cancer patients, over all response rate (ORR) and disease control rate (DCR) of NIR-PIT was 63.5% and 84.5%, respectively. In conclusion, NIR-PIT successfully performed selective treatment of cancer with no apparent severe side effects as well as enhance anti-cancer host immunity, resulted in curing cancers, especially when combined with immune-suppressor cell targeting NIR-PIT that can further enhance host immunity against cancers and is under a clinical trial.

A Spheroid Model of Nitric Oxide's Pro-tumor Effects in Anti-tumor Photodynamic Therapy

Witold Korytowski

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Photodynamic therapy (PDT) is a unique oxidative stress-based anti-tumor modality that has

proven highly effective for various solid malignancies. Intrinsic and acquired resistance is a significant challenge for all cancer treatments, including PDT. We shoved previously that several human cancer cell lines can exploit nitric oxide (NO) from stress-upregulated inducible nitric oxide synthase (iNOS) to (i) resist photokilling sensitized by 5-aminolevulinic acid (ALA)-induced protoporphyrin IX, and (ii) promote growth and mobility aggressiveness of surviving tumor cells. ALA/light-targeted cells can also stimulate iNOS/NO-dependent aggressiveness in non-targeted bystander cells. We developed recently a mixed-spheroid model consisting of glioblastoma (LN229 or U87) cells and normal human (HMEC) epithelial cells. Using confocal microscopy, we analyzed the distribution of ALA-induced protoporphyrin IX within preformed spheroids. We showed that the rigidity of spheroids depends on the ratio of tumor/normal cells, and changes with ALA/light treatment. The survival of spheroid cells subjected to photodynamic action was determined. In general, higher doses of LED light were needed to achieve the same killing ratio for spheroids, as compared to 2D cultures. The effects of ALA/light treatment on the induction of iNOS, proliferative potential of surviving tumor cells, and the bystander effect of targeted outer layer (light penetrated) cells on centrally located (non-irradiated) cells will be also discussed.

Photodynamic Therapy-Induced Cell Death Based on Targeted Organelles

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The mechanism of cell death in photodynamic therapy (PDT) can vary significantly depending on the targeted organelle due to the specific interactions between the photosensitizer, light, and oxygen within that cellular location. Different cell death mechanism can indeed play a crucial role in overcoming drug resistance, a major challenge in cancer treatment. By utilizing PDT reagent to target specific organelles, it is possible to bypass some of these resistance mechanisms or induce synergistic effect when different target motions are engaged simultaneously. For this reason, my group has developed various PDT reagents targeting endoplasmic reticulum (ER), mitochondria, lysosome, and plasma membranes and investigate their cell death mechanisms depending on the targeted organelle. In this presentation, I will introduce molecular design strategy aimed at targeting organelles. Our developed photosensitizers will be presented for efficient reactive oxygen species (ROS) generation even in hypoxia conditions, detailing the cell death mechanism with proteomic analyses and phenomenological observations by ROS, and their in-vivo applications.[1,2,3]

1. Nam, J. S.; Kwon, T.-H. et al. *J. Am. Chem. Soc.* 2016, 138 (34), 10968-10977.
2. Lee, C.; Kwon, T.-H. et al. *Nat. Commun.* 2021, 12 (1), Article. DOI: 10.1038/s41467-020-20210-3 Scopus.
3. Lee, C.; Park, M.; Kwon, T.-H. *et al.* Oxidative photocatalysis on membranes triggers non-canonical pyroptosis. DOI: https://doi.org/10.21203/rs.3.rs-3126446/v1

Photosynthetic bacteria for environmentally safe biotechnological applications

Rossella Labarile

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Solar energy is the most abundant energy source on Earth and will be the key source of electricity in a low-carbon future. The development of solar power technologies is considered one of the best options to meet the increasing future energy demand. To maximize the potential of solar power, new materials are needed to harvest and convert solar energy alongside the current photovoltaic technologies. As new and optimized material, photosynthetic bacteria can pioneer the cutting-edge novel strategies for environmentally safe and cost-effective energy production.

One of the most investigated photosynthetic anoxygenic microorganisms [1] is the purple non-sulfur bacterium *Rhodobacter* (*R.*) *sphaeroides* recently reclassified as *Cereibacter sphaeroides* [2] belonging to the family Paracoccaceae in the class α-proteobacteria. Based on the promising evidences of their photo-metabolism, we explored the possibility of developing biohybrid photoelectrochemical systems exploiting adhesivity and conductive properties of polydopamine (PDA) [3]. First, biocompatibility of PDA and its monomer dopamine was tested by *in vivo* addition in the growth media of *R. sphaeroides* [4] in anoxygenic conditions. Then, PDA conductive coatings were used as biotic-abiotic interfaces in biohybrid photoelectrochemical devices through the encapsulation of entire bacterial cells (or single components – e.g. photosynthetic reaction center (RC) [5]) of *R. sphaeroides* [6] and *R. capsulatus* [7], ensuring electronic communication of the biological component with the electrodes' surfaces in photoelectrochemical cells. A measurable photocurrent at bio-hybrid interfaces was also recorded by using green coffee extracts, and more specifically chlorogenic acids, as sustaibable mediators for electron transfer in biohybrid systems.

[1] I. Kushkevych, J. Procházka, M. Gajdács, S.K.-M.R. Rittmann, M. Vítězová, *Int. J. Mol. Sci.* 22, 6398 (2021)

[2] A. Hördt, M.G. López, J.P. Meier-Kolthoff, M. Schleuning, L.M. Weinhold, B.J. Tindall, S. Gronow, N.C. Kyrpides,T. Woyke,M. Göker, *Frontiers in Microbiology*, 11 (2020)

[3] Y. Liu, K. Ai, L. Lu, *Chem. Rev.* 114, 5057–5115 (2014)

[4] R. Labarile, M. Varsalona, D. Vona, P. Stufano, M. Grattieri, G.M. Farinola, M. Trotta, *MRS Advances 8(8)*, 423–428 (2023)

[5] M. Lo Presti, M.M. Giangregorio, R. Ragni, L. Giotta, M.R. Guascito, R. Comparelli, E. Fanizza, R. Tangorra, A. Agostiano, M. Losurdo, G.M. Farinola, F. Milano, M. Trotta, *Adv. Electron. Mater.* 6, 2000140 (2020)

[6] R. Labarile, D. Vona, M. Varsalona, M. Grattieri, M. Reggente, R. Comparelli, G.M. Farinola, F. Fischer, A.A. Boghossian, M. Trotta, *Nano Research* (2023) https://doi.org/10.1007/s12274-023-6398-z

[7] G. Buscemi, D. Vona, P. Stufano, R. Labarile, P. Cosma, A. Agostiano, M. Trotta, G.M. Farinola, M. Grattieri, *ACS Applied Materials and Interfaces* 14(23), 26631–26641(2022)

Intact Photosynthetic Bacteria-Based Biosensors

Rossella Labarile

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Accomplishing the photoinduced extracellular electron transfer between intact, metabolically active, photosynthetic bacteria and electrodes allows converting solar energy into electrical energy without requiring long purification processes of the biocatalysts. [1] Our group recently developed a sustainable approach to obtain a redox-adhesive polydopamine matrix that simultaneously facilitates the photoinduced extracellular electron transfer, with a 5-fold enhanced photocurrent production, while maintaining the bacteria in close contact with electrode surfaces. [2] The use of these biohybrid photoelectrodes for the on-line, early monitoring of contaminants is herein presented, using nitrophenols as target compounds. Electrochemical and spectroscopic studies revealed a complex interaction between the bacterial cells and the nitrophenols, resulting in interesting photobioelectrocatalysis and the possible use of the system for both environmental monitoring and remediation. At this purpose, we are investigating bio-based, homemade electrodes to facilitate the application of these biosensors in the field.

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[1] L. D. M. Torquato, M. Grattieri, *Current Opinion in Electrochemistry* **2022**, 34, 101018

[2] G. Buscemi, D. Vona, P. Stufano, R. Labarile, P. Cosma, A. Agostiano, M. Trotta, G.M. Farinola, M. Grattieri, *ACS Applied Materials & Interfaces* **2022**, 14, 26631-26641

Lessons from ionizing radiation radiobiology with potential applicability to photobiology (Part I)

Christopher Lange

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Survival or failure of vital tissues and the consequential mortality of their organisms can be understood quantitatively in terms of the underlying survival of the stem cells that maintain those tissues [Lange and Gilbert [L&G] Model]. The L&G Model demonstrated that the planarian survival curve, a double negative exponential, is a sigmoid curve closely similar to a Gaussian sigmoid over the survival range 5 – 95%, that can be expressed as Probit (P_m) = (D-LD_{50})/K, where LD_{50} is the mean lethal dose and K is the probit width or reciprocal slope; this is analogous to $y(P_m) = D/D_0 - \ln(N\alpha E)$, yielding $K = 1.2\ D_0$ (i.e., D_0 causes 86% of the value of K), and $LD_{50} = D_0\ (\ln(1.9N\alpha E)$; i.e., LD_{50} is analogous to a cell survival quasi-threshold dose ($D_q = D_0\ \ln(E)$). The L&G model also explains irradiated mouse gut syndrome mortality [Hendry, Potten & Roberts]. In irradiated mice, the survival of crypts can be measured and the L&G model (assuming 100% repopulation probability) quantitatively relates crypt survival to stem cell survival. In a second step, mouse survival can be quantitatively related to crypt survival, again using the L&G model. This two-step procedure forms the basis of the Functional Subunits concept. This concept has been applied to explain normal tissue toxicity (i.e., towards understanding present day clinical dose-constraints for external beam radiation therapy). Application of the L&G model may also be applicable to epithelial phototoxicity and be used to optimize the safety parameters of nbUVB brachytherapy.

Lessons from ionizing radiation radiobiology with potential applicability to photobiology (Part II)

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Stem cell survival can be understood at the molecular level in terms of the kinetics of DNA DSB induction and rejoining, i.e., the Ostashevsky & Lange DSB Model. The DSB model explains cell survival curves as an initial slope (= $CG_{DSB}\ \exp(-t_{rep}/\tau_{dsb})$) with curvature away from it due to migration (loss) of DNA fragments thus made irreparable. "C" is the genomic DNA content, "G_{DSB}" is the radiation yield for DSBs, "t_{rep}" is the time available for repair (after which it is too late to affect survival) and "τ_{DSB}" is the time constant for DSB repair. This model correctly predicted t_{rep} for delayed plating experiments, while the LPL and RMR models did not. It also predicted cell survival curves from DSB repair kinetics data. Consistent with the DSB model, the survival of viruses (e.g., Bacteriophage T4) exposed to distinct radiation wavebands (e.g., ionizing, UV) can be understood in terms of radiation target theory and the kinetics of induction of genetic material damage and its repair. Hence, repair processes at a molecular level apply from virus genetic material to the human genome, and organismal survival can be understood at the cellular and molecular levels. Towards understanding the survival of virus to UVB irradiations, the Lytle and Sagripanti SNS factor is a measure of the repair capability for viral genetic materials. This is analogous to the 8 radiotaxa of Sparrow et al. They irradiated 79 species, from viruses to cells to multi-cell organisms, and measured D_{37} for survival or severe growth inhibition.

Role of Curvature in Acridone for Singlet Oxygen Oxidation of a Natural Product Homoallylic Alcohol

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Strategies for improving singlet oxygen oxidation paths to dihydrobenzofurans are needed. A density functional theory study provides evidence that acridone curvature and phenol O–H···π bonding facilitate singlet oxygen oxidation of a prenyl side-group to reach a dihydrobenzofuran. Mechanistic insight is provided for an *iso*-hydroperoxide intermediate [R(H)O$^+$–O$^-$] preceding the dihydrobenzofuran. The *iso*-hydroperoxide is analogous to the *iso* species CH_2I^+–I$^-$ and CHI_2^+–I$^-$ formed by UV photolysis of CH_2I_2 and CHI_3, and is also structurally reminiscent of carbonyl oxides ($R_2C{=}O^+{-}O^-$) formed in the reaction of carbenes and oxygen. Our DFT results point to intermolecular process, in which the *iso*-hydroperoxide's fate relates to O-transfer and H_2O dehydration reactions for new insight to the biosynthesis of dihydrobenzofuran natural products.

Oxidative photocatalysis on membranes triggers non-canonical pyroptosis

Chaiheon Lee

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Intracellular membranes composing organelles of eukaryotes include membrane proteins playing crucial roles in physiological functions. However, a comprehensive understanding of the cellular responses triggered by intracellular membrane-focused oxidative stress remains elusive. Herein, we developed an amphiphilic photocatalyst localised in intracellular membranes to damage membrane proteins oxidatively, resulting in non-canonical pyroptosis. Our developed photocatalysis generated hydroxyl radicals and hydrogen peroxides via water oxidation, which was accelerated under hypoxia. Single-molecule magnetic tweezers revealed that photocatalysis-induced oxidation markedly destabilised membrane protein folding. In cell environment, label-free quantification revealed that oxidative damage occurred primarily in membrane proteins related to protein quality control, thereby aggravating mitochondrial and endoplasmic reticulum stress and inducing lytic cell death. Notably, the photocatalysis activated non-canonical inflammasome caspases, resulting in gasdermin D cleavage to its pore-forming fragment and subsequent pyroptosis. These findings suggest that the oxidation of intracellular membrane proteins triggers non-canonical pyroptosis.

Merkel cell Polyomavirus in the Pathogenesis of Merkel cell carcinoma

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Merkel cell carcinoma (MCC) is a rare, but aggressive skin cancer. MCC is three times more lethal than melanoma, with a 46% disease-associated mortality rate, and 5-year disease-specific survival rates of 66% and 11%-30% for local and metastatic disease, respectively. There is compelling evidence to support a causal link between the Merkel Cell Polyomavirus (MCPyV or MCV), and MCC. MCPyV has been detected in several anatomical locations, most frequently in skin where MCC most commonly arises. Largely, MCCs contain clonally integrated MCPyV DNA, express viral T antigen transcripts and protein, and the viral large T and small t antigen oncoproteins. MCC has a propensity for local recurrence and regional nodal involvement. While not yet established, it is plausible that similar to recurrences seen in HPV-related cancers, MCC recurrences maybe be caused by residual oncogenic virus in treated skin. Therefore, nbUVB may prove to be an important adjuvant treatment to inactivate remaining MCPyV in tissues. Lytle and Sagripanti's SNS model predicted UVB sensitivity for Polyomaviridae, including MCPyV, is a D37 of 25-28 mJ/cm^2 and a D10 of 58-64 mJ/cm^2. Therefore, with a nbUVB surface dose of 300 mJ/cm^2, we calculated a 12 - 11 log MCPvY reduction at surface and a 5 log reduction at a depth of 50 um in tissue.

Topical retinoids as efficient singlet oxygen sensitizers

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Since their introduction in the 1980s, retinoids have been increasingly used for topical and systemic treatment of skin conditions such as acne-related dermatoses or psoriasis but also for therapy and/or chemoprevention of skin cancer and other neoplasia. Along the years, chemical modifications have led to more efficient and safer drugs. But, from a photobiological viewpoint, development of the 3rd generation of polyaromatic retinoids calls the attention on their potential photoactivity. In this context, adapalene along with tazarotene and tretinoin are currently the three topical retinoids approved so far by the Food and Drug Administration (FDA). Therefore, a detailed study of their photophysical and photobiological properties is critical to evaluate their photoreactivity toward biological components and their potential use as phototherapeutic agents. In a first stage, the photophysical properties of these drugs are investigated to get more insight into their excited states and their potential to trigger biomolecule damages. Then, retinoids phototoxicity is established *in vitro* using the standard Balb/c 3T3 NRU assay, that reveals a photoirritation factor (PIF) higher than the threshold of 5 set by the guidelines for phototoxic compounds. The Type II reactivity of these topical drugs is discussed together with their potential activity and use as phototherapeutic agents.

Imaging protoporphyrin IX photoproduct formation kinetics for monitoring of PDT response

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Photodynamic therapy (PDT) involving the use of 5-aminolevulinic acid (ALA) induced protoporphyrin IX (PpIX) has been shown to be clinically effective in the treatment of superficial lesions in the oral cavity. Clinical adoption however remains limited, due in part to a lack of robust enabling technology that includes techniques to simplify dosimetry and provide confidence that curative dose has been delivered. It is well known that the extent of photobleaching of the photosensitizer results correlates to some extent with total generation of reactive molecular species formed over the course of the treatment and has been shown by ourselves to correlate with tumor response. Here, to develop a more definitive optical signature of light dose deposited we explore combination of photobleaching measurements with imaging of PpIX photoproduct formation. It has previously been reported that a PpIX photoproduct identified as photoprotoporphyrin (Ppp) has a distinct fluorescence emission spectrum and peak absorption around 675nm. In this study through a combination of fluorescence spectroscopy and image analysis we establish PDT dose-dependent changes in the combined PpIX-Ppp fluorescence signal and demonstrate that this can be correlated to dose deposited tissue phantoms and outcomes in 3D cell culture models of oral squamous cell carcinoma (OSCC). Going forward, the potential to translate this into use as a real-time dosimetry surrogate in the clinic is enabled by combination with intraoral light-delivery hardware that incorporates optics for simultaneous multichannel fluorescence imaging.

UVB irradiation empowered neutrophils with transmigratory and proinflammatory abilities to mediate acute lupus flares with skin and kidney inflammation

Ming-Lin Liu

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UVB triggers acute lupus flares, but the underlying mechanisms are not well understood. We have reported that UVB exposure induces skin inflammation with neutrophil infiltration and neutrophil extracellular trap (NET) formation in wildtype mice. Here, UVB-irradiation induced acute lupus flares with skin and kidney inflammation and proteinuria in asymptomatic, young female lupus-prone mice. To understand this, we analyzed infiltrated neutrophils, NETs in skin and kidneys of UVB-irradiated MRL/lpr mice, and UVB-irradiated neutrophils in vitro. We found increased skin thickness, immune cell infiltration, neutrophil NETosis, and deposition of NET-associated IFNα, IFNγ, IL-17A, or C3 in skin and kidneys. Infiltrated cells in skin positively correlated with proteinuria ($r=0.57$, $p<0.05$), indicating a link between skin infiltrates and kidney injury. Neutrophils exposed in vitro to UVB or platelet-activating factor upregulated cytokines and C3, partially co-expressing CXCR4 and CX3CR1, chemokine receptors that may mediate neutrophil transmigration from skin to kidneys. Our preliminary study indicated that application of CXCR4 inhibitor IT1t significantly attenuated neutrophil infiltration, accumulation of NET-associated cytokines/C3, including IFNα (3.2% vs 0.43% area in UVB vs IT1t+UVB mice, $P<0.01$) in kidneys, decreased proteinuria in UVB-irradiated MRL/lpr mice. By directly targeting NETosis through a novel nuclear envelop regulation strategy, we found that controlling NETosis attenuated deposition of NET-associated cytokines and C3 in skin and kidneys of UVB-irradiated MRL/lpr·lmnb1^{Tg} mice with amin B overexpression. NET-associated IFNα ($r=0.49$, $p<0.01$) or C3 ($r=0.38$, $p<0.05$) in kidneys correlated with proteinuria. Thus, UVB irradiation led to neutrophil infiltration, transmigration, and NETosis, mediating skin and kidney inflammation in acute lupus flares.

Uncovering the molecular basis of the double bilin ligation reaction catalyzed by bilin lyases in the VUF family

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Marine *Synechococcus* are the second most abundant photosynthetic prokaryote in the open ocean. They harvest available ambient light using their complex antenna, also known as the phycobilisome (PBS). PBS contains rod structures consisting of phycocyanin and one or two types of phycoerythrin. Bilin lyases are enzymes that catalyze the bilin attachment to these proteins in a site-specific manner while ensuring appropriate stereochemistry. Some bilin lyases (called lyase-isomerases) not only catalyze the bilin ligation to specific Cys residues but also isomerize the bilin pigment to a different chemical form that absorbs light of a different color.

Recently, a group of novel bilin lyases, denoted VUF to highlight three representative members MpeV, MpeU, and CpeF, has been discovered and characterized. The VUF family has the unique capability of attaching a bilin chromophore at Cys50 and Cys61 in the β-subunits of phycoerythrin (CpeB or MpeB) via double ligation to rings A and D. Some members in this family are capable of isomerization of phycoerythrobilin to phycourobilin, but all members require the presence of the chaperone-like protein CpeZ. Based on protein structure modelling, we propose that MpeV and CpeZ form a large binding pocket to facilitate double ligation of phycourobilin to Cys-50/Cys-61 of CpeB. To address the technical challenges in obtaining stable enzyme/substrate complexes, we generated fusion constructs of MpeV and CpeZ to promote complex formation for structural studies. Here, we will demonstrate the production and functional assays of these fusion proteins, and we will characterize them for their suitability for crystallization and cryoEM studies.

Photosensitizing properties of a pterin containing adduct on DNA and related molecules

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Pterin (Ptr) is a heterocyclic compound present in nature with several and relevant physiological functions. Under UV-A radiation, Ptr presents fluorescence, photosensitizes the production of singlet oxygen ($^1O_2$) and participates in the degradation of several biomolecules.[1,2] Considering the main mechanism involved in the degradation of biomolecules, Ptr is a type I photosensitizer that acts through electron-transfer reactions where biomolecule radicals are formed.

Upon irradiation in the presence of O_2, DNA undergoes cleavage indicating the oxidation of the molecule most probably at the guanine residues.[3] In the absence of O_2, the electron transfer reaction occurs between Ptr and thymidine (T) nucleobases, giving rise to an adduct consisting in the pterinic moiety covalently attached to a T residue.[3] Interestingly, Ptr retains its photophysical properties so that the adduct is fluorescent, and it can be detected by its emission at 450 nm.[3]

In consequence, the formation of Ptr-T adducts in DNA molecules introduces a photosensitizer with the potential capacity to produce oxidative damage to the DNA itself and other biomolecules. Here, we present our findings on the capacity of these adducts to photoinduce damage to amino acids and nucleotides, and also their capacity to generate singlet oxygen.

References:

1 C. Lorente, A.H. Thomas, Acc. Chem. Res. 39 (2006) 395-402

2 C. Lorente, et al., J. Photochem. Photobiol. (2021) 100045

3 S. Estébanez, et al., Dyes and Pigments 160 (2019) 624–632

Prevention of Ptr Photosensitized Damage of Biomolecules by Vanillin

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Vanillin (4-hydroxy-3-methoxybenzaldehyde) is known as a flavoring agent and for its

antioxidant properties. However, not much is known about its antioxidant capacity in radiation mediated processes. For this reason, the main objective of this work is to evaluate whether vanillin can prevent photosensitized oxidation of biomolecules.

Biomolecules are oxidized by both direct and indirect absorption of electromagnetic radiation. UV-A radiation (310-400 nm) is about of 95 % of the total UV radiation of the sun reaching the earth surface, and its poorly absorbed by biomolecules. However, UV-A degrades biomolecules through photosensitized mechanisms. Pterins (Ptr) are natural compounds, present in all living systems, that can be accumulated in human skin during pathological conditions. It has been demonstrated that, under UV-A radiation, Ptr is able to oxidize biomolecules (B), mainly through a type I photosensitized mechanism. In this occasion, we report the efficiency of vanillin to reduce the degradation of 2´-deoxyguanosine 5´monophosphate and tryptophan during UV-A irradiation in the presence of Ptr. To carry out this study, aqueous solutions of a biomolecule and Ptr (pH 6, room temperature) were exposed to UV-A radiation (βexc=365 nm) during different times in presence and absence of vanillin. The photochemical reaction was studied by UV-Vis spectrophotometry, HPLC, fluorescence spectroscopy and LFP. Results indicate that vanillin prevents the degradation of the biomolecules, and a mechanistic study indicates that in our experimental conditions, although vanillin is capable to deactivate Ptr triplet excited states, the inhibition of the photosensitized process is due to the deactivation of nucleotide radicals.

Computational approaches to simulate excited state processes

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Computational approaches provide vital tools to understand mechanistic and spectroscopic experiments of excited states processes. However, methodologies for simulating excited states have their own challenges including the inability to describe important features such as conical intersections. We will present an approach to enhance the computational toolkit related to the study of excited state processes. Many fields, including photocatalysis, renewable energy technology, photobiology, and photochemistry, typically involve systems with complex correlation mechanisms that require going beyond response approaches. This computational approach will be inspired by the resonant Hartree-Fock (ResHF) wavefunction which naturally partitions correlation mechanisms and facilitates efficient models for capturing the remaining correlation. We will contextualize the need for new computational approaches to overcome these challenges within the framework of biological systems.

Photoreceptor proteins carry out various biological functions by efficiently converting harvested photon energy to chemical energy. They are used for various applications in life science and medicine. To improve their utilization, their absorption spectra should be shifted to the far-red, where the tissue is transparent. At least two different strategies exist to achieve the bathochromic shift. First, site specific mutagenesis can be applied to amino acid residues in the chromophore binding pocket. The second strategy is to modify the chromophore itself to achieve a more red-shifted spectrum. Here, we will present a recent example of the second strategy where we employed a hybrid quantum mechanics/molecular mechanics (QM/MM) method to study a dozen strongly red-shifted non-native chromophores which were incorporated into bacteriorhodopsin.

Mackintosh, M.J., Hoischen, D., Martin, H-D., Schapiro, I., and Gärtner, W. Merocyanines form bacteriorhodopsins with strongly bathochromic absorption maxima. *Photochem. Photobiol. Sci.* 2024, 23:31–53.

Rapid Synthesis and Structural Derivatization of Bioactive Bibenzyl Scaffolds via Metal-Free Organic Photocatalysis

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Bibenzyl widely exists in bioactive natural products that are being used as neuroprotective, anti-cancer, anti-bacterial, and anti-inflammatory agents. For example, hydrostilbene derivatives have been identified as relevant biologically active compounds, whereas batatasin shows anti-diabetic and anti-cancer activities. Furthermore, Gigantol exhibits anti-inflammatory activity and dihydro-resveratrol has an interesting antioxidant activity. Similarly, some of the bibenzyl derivatives are used as starting materials for the synthesis of other useful drug molecules. While the conventional methods for the synthesis of bibenzyls involve transition-metal catalyzed reductions of stilbene/phenylacetylene derivatives, these protocols are tedious, costly, and not environmentally benign. Alternatively, transition metal-free photochemical approaches for preparing these motifs are less explored. In this league, we developed all-in-one and recyclable photocatalysts that can be rapidly converted to various bibenzyl derivatives in a cost-effective manner. Herein, we are disclosing the photocatalytic synthesis of bibenzyl derivatives starting from heteroarylium sulfide salts. This novel approach was successful in the synthesis of several symmetrical and unsymmetrical bibenzyl derivatives *via* radical-enabled C(sp^3)-C(sp^3) coupling reactions. Significantly, the present approach was tailored to the synthesis of Brittonin A, imipramine, and honokiol analogs. My presentation will detail the novel photosynthetic method and highlight the key/elementary photochemical steps.

Residential ambient UVB and UVA and incidence of keratinocyte carcinoma in the nationwide US Radiologic Technologists cohort

Jim Mai

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Background: Few epidemiological studies have distinguished the effects of solar ultraviolet radiation (UVR) wavelength for UVB and UVA on risk of keratinocyte carcinomas (KC), including basal (BCC) and squamous cell carcinoma (SCC).

Methods: Using lifetime residential history and associated satellite-based noontime ambient UVR measures, incidence rate ratios (RRs) and 95% confidence intervals (CIs) were estimated for the association between UVB (305 nm), UVA (380 nm), and self-reported KC in non-Hispanic White participants in the nationwide prospective U.S. Radiologic Technologists study. UVB tends to be strongest for summer months while UVA maintains similar level of strength throughout the year. Independent associations of summer and annual UVA and UVB were examined in mutually adjusted models, additionally adjusted for demographic and sun sensitivity characteristics.

Results: There were 6,339 BCC and 1,253 SCC incident cases among 62,595 participants. Summer and annual UVB and UVA were associated with increased KC risk before mutual

adjustment. Summer UVB was associated with increased KC risk after adjusting for UVA (BCC quintile [Q]5 *versus* Q1 RR=1.42[95% CI:1.14, 1.78;*p*-trend=0.003] and SCC Q5 *versus* Q1 RR=1.69[95%CI:1.01,2.83;*p*-trend=0.047]), but not annual UVB. Annual UVA was associated with increased KC risk after adjusting for UVB (BCC Q5 *versus* Q1 RR=1.42[95% CI:1.13,1.77;*p*-trend=0.003], and SCC Q5 *versus* Q1 RR=1.81[95%CI:1.09,3.01;*p*-trend=0.024]), but not summer UVA.

Conclusions: KC risk was increased in participants living in locations with high summer UVB and high annual UVA. Our study was limited by lack of data on individual measures of personal UVR, and a population restricted to mostly female indoor non-Hispanic White workers.

Ultraviolet B irradiation alters the expression of S100-fused proteins in human skin.

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The fused-S100 protein family includes filaggrin (FLG), trichohyalin (THH), repetin (RPTN), cornulin (CRNN), filaggrin-2 (FLG2), hornerin (HRNR) and trichohyalin-like 1 (TCHHL1). Most of these proteins may be involved in terminal differentiation and barrier formation in the epidermis, although the exact function of these proteins remains unknown. Previous studies demonstrated that ultraviolet B (UVB) irradiation induces epidermal hyperproliferation and alters the expression of differentiation markers. In the present study, we immunohistochemically examined the effect of UVB irradiation on the expression of fused-S100 proteins using human skin xenotransplants. In sham-irradiated skin, CRNN, FLG, and FLG2 were observed in the granular layer, and TCHHL1 was observed in the basal layer of the epidermis. HRNR, RPTN, and THH are rarely detected in the epidermis. The expression of CRNN, FLG, FLG2, HRNE and RPTN markedly increased in the granular layer of UVB-exposed skin two days after UVB irradiation (500 mJ/cm^2), which is the minimal dose necessary to induce sun burn cells. The TCHHL1 signals were spread in both the basal and spinous layers of the irradiated skin on day 2 after UVB irradiation. The expression of THH was not induced on day 2 after UVB irradiation. The present study demonstrated that the expression of most fused-S100 proteins is enhanced by UVB irradiation, and that this expression might be associated with epidermal hyperproliferation. In addition, the expression pattern in UVB-irradiated skin differs among fused-S100 type protein family members, suggesting that the role in the barrier formation of the epidermis may differ among proteins.

Real-time path integral simulation of energy transfer in light harvesting complexes

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Fully quantum mechanical simulations of excitation energy transfer within the peripheral light harvesting complex (LH2) of Rhodopseudomonas molischianum at room temperature have been performed using the numerically exact small matrix decomposition of the path integral (SMatPI). The exciton-vibration Hamiltonian comprises the 16 singly excited bacteriochlorophyll (BChl) states of the B850 (inner) ring and the 8 excited states of the B800 (outer) ring with all available electronic couplings. The electronic states of each chromophore couple to 50 intramolecular vibrational modes with spectroscopically determined Huang-Rhys factors and to a weakly dissipative bath that models the biomolecular environment. The energy transfer process is investigated following photoexcitation of individual pigments or electronic eigenstates. The time constant obtained from the simulation results is in very good agreement with experimental values. We find that the flow of energy to the B850 states is enabled by molecular vibrations, and that nuclear quantum effects increase the amount of transferred energy. Further, the relaxation cascade from B800 eigenstates is characterized by two distinct time scales and is nonmonotonic, owing to significant energy shifts of vibrationally dressed states. Coherence maps clarify the intra- and inter-ring pathways of energy transfer and the role of quantum coherence.

Enhanced antibacterial effect of blue light in combination with an Amazonian tree sap (Croton lechleri)

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8.2 million patients in the U.S. suffer from non-healing wounds, many infected with antibiotic-resistant bacteria. Healthcare cost of infected wounds is $100B yearly. Blue light and Sangre de Drago (SD) (Croton lechleri) are natural agents that have potent antibacterial mechanisms of action via Reactive Oxygen Species (ROS) and anti-biofilm effect, respectively. We evaluate the enhanced antibacterial effect of this novel combination treatment. Dosimetry studies revealed the effective SD concentration (5%) and 415-nm blue light fluence (125.3 J/cm^2). E. coli K-12 (0.1-mL, 2x10^5 CFU/ml) was applied to 32 TSA plates, and distributed in four groups: (1) no treatment (Control), (2) SD-only, (3) blue light-only, and (4) combination SD + blue light. Plates were incubated for 12-hrs at 37 Celsius. Colony forming units (CFUs) were analyzed using Image J software. Average CFU count was highest in the control group (121), followed by SD-only (60), blue light-only (27) and combination treatment (0). Average CFU size was largest for control (0.47 mm^2), followed by blue light-only (0.3135 mm^2), and SD-only (0.17 mm^2). Blue light-only caused mainly a marked reduction in CFU count, indicating a bactericidal effect, while SD-only caused the largest decrease in CFU size, supporting an anti-biofilm effect. When combined, Sangre de Drago and blue light inhibited all bacterial growth. Treatment with 5% SD and 415-nm blue light works via complementary mechanisms, acting synergistically to enhance their antibacterial effect. As these mechanisms are not affected by common antibiotic resistance pathways, this novel combination treatment may be effective against antibiotic-resistant infections in non-healing wounds.

Genome-wide repair of UV damage in the chromatin of fission yeast

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Fission yeast (*Schizosaccharomyces pombe*) is an important model organism for DNA repair studies. Repair of UV damage in fission yeast is conducted through two parallel systems: nucleotide excision repair (NER) and the ultraviolet damage endonuclease (UVDE). However, how do the two pathways function together to remove UV damage is unclear. Additionally, the genomic DNA of fission yeast is packaged into chromatin and both euchromatin and heterochromatin are identified in the genome. It is also unknown how NER and UVDE function in distinct chromatin domains. In this study, we utilized an improved UV damage mapping method named cyclobutane pyrimidine dimer sequencing (CPD-seq 2.0) and characterized

genome-wide repair of UV damage in wild-type fission yeast as well as mutant strains with defects in NER or UVDE. Our data indicates that NER and UVDE cooperate to repair UV damage in both transcribed (TS) and non-transcribed strands (NTS), leading to comparable repair efficiency between the two strands. Moreover, global genomic NER (GG-NER) and UVDE are inhibited by nucleosomes near the dyad axis, while transcription-coupled NER (TC-NER) functions in a nucleosome-independent manner. Finally, we characterized functions of TC-NER initiation factors, Rhp26 (homolog of human CSB) and elongation factor ELOF1. Our data suggests that the two factors are involved in different transcribed regions in fission yeast.

Mechanisms of light perception and signal integration in a far-red-sensing photoreceptor

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Due to their compact size, domain modularity and deep tissue penetration of far-red light, studies on bilin-based far-red cyanobacterichromes (FR-CBCRs) are of great interest in optogenetics and biomedical applications. Our laboratory reported the first crystal structure of a representative single-domain far-red CBCR from *Anabena cylindrica*, which reveals an atypical all-*Z,syn bilin* conformation in the far-red absorbing (Pfr) state.[1] This far-red CBCR photoreceptor undergoes reversible photoconversion between the Pfr state and orange-absorbing Po state. To capture light-induced structural changes, we performed dynamic crystallography experiments on photoactive crystals of far-red CBCR using an automated serial *in situ* diffraction platform.[2-4] We have obtained light-induced signals suggesting concerted motions arising from transformation and/or relaxation of the bilin chromophore in a confined protein pocket. In cyanobacteria, far-red CBCR is often part of a much larger signaling protein that consists of multiple distinct sensor domains followed by a shared effector histidine kinase domain at the C-terminus. To examine the molecular mechanisms of light signaling and signal integration in the full-length context, we have recently cloned and characterized a multi-sensor photoreceptor protein Anacy4718 from *Anabena cylindrica* PCC 7122. Anacy4718 contains 10 modular domains including four CBCR domains. Collectively, these light-sensing domains enable light perception in a wide range of wavelengths from UV to far-red. Using spectroscopy, biochemistry and structural biology, we address how multiple sensor domains work together in the same protein to achieve "color vision" at the molecular level. In this conference, we will present our recent work tackling the signaling logic of Anacy4718.

References

(1) Bandara, S.; Rockwell, N. C.; Zeng, X.; Ren, Z.; Wang, C.; Shin, H.; Martin, S. S.; Moreno, M. V.; Lagarias, J. C.; Yang, X. Crystal Structure of a Far-Red–Sensing Cyanobacteriochrome Reveals an Atypical Bilin Conformation and Spectral Tuning Mechanism. Proc. Natl. Acad. Sci. 2021, 118 (12), e2025094118. https://doi.org/10.1073/pnas.2025094118.

(2) Biju, L. M.; Wang, C.; Kang, W.; Tom, I. P.; Kumarapperuma, I.; Yang, X.; Ren, Z. On-Chip Crystallization and Large-Scale Serial Diffraction at Room Temperature. J. Vis. Exp. 2022, No. 181, 63022. https://doi.org/10.3791/63022.

(3) Ren, Z.; Wang, C.; Shin, H.; Bandara, S.; Kumarapperuma, I.; Ren, M. Y.; Kang, W.; Yang, X. An Automated Platform for in Situ Serial Crystallography at Room Temperature. IUCrJ 2020, 7 (6). https://doi.org/10.1107/S2052252520011288.

(4) Ren, Z.; Ayhan, M.; Bandara, S.; Bowatte, K.; Kumarapperuma, I.; Gunawardana, S.; Shin, H.; Wang, C.; Zeng, X.; Yang, X. Crystal-on-Crystal Chips for in Situ Serial Diffraction at Room Temperature. Lab. Chip 2018, 18 (15), 2246–2256. https://doi.org/10.1039/C8LC00489G.

Clinical trial of photodynamic therapy for actinic keratoses using short-contact protocols to reduce pain yet maintain therapeutic efficacy

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Photodynamic therapy (PDT) using 5-aminovelunic acid (ALA) can be very effective for treating actinic keratoses (AK) of the face, but the downside of most PDT protocols is that long ALA incubation times can result in stinging pain during illumination. Recent studies with blue light PDT showed that shorter ALA incubations can reduce pain yet provide similar efficacy as conventional PDT. Here, we sought to develop a painless PDT regimen using red light. A randomized clinical trial was designed to compare three short-incubation regimens with 10% ALA nano-emulsion and red light (635 nm). Patients were randomized amongst three groups: Group A, 10 min ALA incubation and 20 min (75 J/cm^2) illumination; Group B, 20 min ALA incubation and 10 min (37 J/cm^2) illumination; and Group C, 1 hour incubation and 10 min (37 J /cm^2) light. At the initial visit, AK lesions were counted, and PDT administered. The same regimen (A, B, or C) was repeated at week 8. Final AK counts were done at 12 weeks. A total of 30 patients were enrolled. Pain levels appeared related to the length of incubation; Groups A and B had minimal pain (0-1), whereas Group C had higher pain levels (2-8, on an 11-point pain scale). Increased inflammation in lesions was documented in photographs at day 3 in all patient groups. Large reductions in AK lesion counts were observed; final results will be presented at the meeting. Shortening the ALA incubation time for red light PDT provides improved pain tolerability, while preserving efficacy.

Applications of the rare dual-release photochemistry of sulfoximines

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Generating two different reactive intermediates from a single chromophore is a rare occurrence in photochemistry. One of the few examples is the release of nitrenes and atomic oxygen from dibenzothiophene sulfoximines upon irradiation with light. The dual-release of two different reactive intermediates provides the potential to apply localized oxidative stress while nearly simultaneously labeling the nearby biomolecules. This is expected to provide a new means to probe oxidative stress in cells. To this end, the photochemistry of several *N*-aryl dibenzothiophene sulfoximines was investigated by conducting product studies, determining photophysical properties, and quantifying their quantum yields. Changing the electron demand of the substituents on *N*-aryl dibenzothiophene sulfoximines had a significant effect on quantum yield of the reaction. Adding an electron-withdrawing *N*-aryl substituent is shown to increase the quantum yield of dibenzothiophene *S*-oxide production, while adding an electron-donating *N*-aryl substituent is shown to decrease the quantum yield. These findings suggest that modification of the *N*-substituents can be used to influence the production of nitrene by dibenzothiophene sulfoximines.

Harnessing the Excited State Dynamics of Metal Complexes for Phototherapy

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Photodynamic therapy (PDT) is a special branch of photomedicine that employs a photosensitizer, light, and oxygen to destroy cancer cells with spatiotemporal selectivity. The photosensitizers used for PDT have historically been organic molecules, specifically porphyrins and other tetrapyrrole-related structures. Given the important role of metals in medicine, metallated analogs of these traditional systems (as well as metal complexes of markedly different architectures) have attracted considerable attention in recent years. TLD1433, a metal complex designed in our laboratory, is an example that is also the first ruthenium-based photosensitizer for PDT to advance to clinical trials. This presentation will discuss some of our current research efforts that were shaped by the design and development of TLD1433 as a bladder cancer PDT agent.

Keynote Lecture

Is PUVA (Psoralen+UVA) no longer necessary for refractory skin diseases?

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Biologics are becoming first-line therapies as systemic treatments for psoriasis. Although these treatments are highly effective, patients unable to take them for medical or financial reasons may be considered for photo (chemo) therapy. We have initiated photochemotherapy with bathwater delivery of psoralen plus UVA (bath-PUVA) since 1998 and collected the data of 229 patients (180 males and 49 females) treated with bath-PUVA. The efficacy, safety, and background characteristics were investigated. The psoriasis area and severity index (PASI) 75 achievement was in 80.4% of patients, PASI 90 in 43.7%, and PASI 100 in 2.6%. The absolute PASI score ≤1, ≤2, ≤3 was achieved in 16.2%, 41,9%, and 61.1% of patients. The PASI reduction rates were similar to those induced by treatment with biologics. BMI did not significantly affect PASI achievement. Smoking history did not significantly affect the PASI achievement. The absolute PASI score was significantly higher with psoriatic arthritis (PsA) ($p<0.001$). CRP rates α0.31 mg/dL before bath-PUVA had a significantly lower PASI achievement ($p=0.0422$). Based on this large-scale retrospective analysis, bath-PUVA is as effective as the current biologics, and the efficacy does not depend on BMI and smoking. The less effective group was found to have higher CRP levels at treatment initiation and PsA. Furthermore, bath-PUVA is a treatment that helps induce regulatory T cells (Treg) and restore their functions, as well as balance chemokines. This treatment is highly effective in maintaining long-term remission not only for psoriasis but also for other challenging skin conditions such as atopic dermatitis and cutaneous T-cell lymphoma.

Phthalocyanine near-infrared fluorescent probes for selective detection and assessment of kinase inhibitors in live cells

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We have developed a new generation of phthalocyanine near-infrared (NIR) turn-on fluorescent sensors with high recognition selectivity for specific biomacromolecular targets. In this presentation, we will discuss a new phthalocyanine fluorescent imaging platform for qualitative and quantitative assessment of inhibitor/receptor interactions *in vitro* and in live cells. As a proof-of-concept model, we focus on small molecule inhibitors for epidermal growth factor receptor (EGFR) tyrosine kinase as a ubiquitous important target for anticancer therapeutic development. The sensor consists of two domains: an anchor that specifically binds a target receptor (i.e. intracellular ATP binding pocket of EGFR kinase) and a NIR fluorescent phthalocyanine reporter. Competitive binding of a small molecule inhibitor causes changes in the aggregation/deaggregation state of the phthalocyanine domain yielding a selective turn-on fluorescent readout. We demonstrated that this simple single-fluorophore platform is capable of quantitative assessing biomolecular target interactions with either covalently or non-covalently binding unmodified ligands. As small molecule fluorophores, the phthalocyanine-based sensors do not require genetic modifications and, as such, can operate in unmodified cells, are less likely to alter structure and function of the target and off-target molecules, and can permeate through the cell membranes. All these characteristics are crucial for the assessment of ligand/receptor interactions in a range of formats including high throughput screening of native cells.

Increased conjugation of IRDye800CW potentiates photodynamic therapy with Cetuximab-IRDye800CW

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Fluorescence image guided surgery (IGS) with Cetuximab(Cet)-IRDye800CW and other antibody-IRDye800CW conjugates can aid in delineating tumor margins, but unresected residual tumor tissue can lead to local recurrence. Unresected residual tumor tissue following IGS can potentially be eliminated with photodynamic therapy (PDT), but PDT lacks molecular specificity to cancer cells. These issues can be solved with antibody-targeted PDT. In this study, we showed for the first time that modifying the existing IGS probe Cet-IRDye800CW by increasing the IRDye800CW conjugation per antibody from 2 to 11 potentiates its use as an antibody-targeted PDT agent. With 810 nm irradiation, 1:11 Cet-IRDye800CW produced singlet oxygen, hydroxyl radicals, and peroxynitrite. *In vitro* assays with FaDu head and neck cancer cells showed retention of EGFR binding specificity of 1:11 Cet-IRDye800CW and up to 90% phototoxicity in FaDu. Compared to indocyanine green, an approved chromophore that can be used as a photosensitizer, 1:11 Cet-IRDye800CW displayed higher phototoxicity while also remaining less toxic without light activation. We propose that 1:11 Cet-IRDye800CW is a potential agent for PDT following resection when activated with sustained illumination devices such as implantable surgical bed balloon applicators or fiber optic patches. High-payload IRDye800CW conjugation is potentially applicable to other resectable cancers through the use of other full-length antibodies.

ASP Lifetime Achievement Award Lecture

Light and Life: highlights of lifelong contributions to advancing photobiology

Santi Nonell

Santi Nonell

Institut Químic de Sarrià, Universitat Ramon Llull, Barcelona, Spain

I have been very fortunate to have been granted the opportunity to dedicate my research career to photobiology, focused on the fields of singlet oxygen, photodynamic therapy, and photoprotection.

A substantial portion of our research has been dedicated to understanding and controlling singlet oxygen production in biological systems.

We have developed instrumental techniques and fluorescent probes for detecting singlet oxygen and other reactive intermediates that have been pivotal in advancing our understanding of their production and reactivity. Also, we have developed a large number of novel photosensitizers and characterized an even larger number of photosensitizers synthesized by colleagues worldwide. Two molecules may serve to define my career: porphycenes, a class of porphyrinoid compounds with exceptional fluorescence and photosensitizing properties, and phenalenone, a universal singlet oxygen photosensitizer that roots back to Darwin.

In the realm of anticancer photodynamic therapy, we have explored various aspects affecting treatment outcomes. This includes the development of molecular, nanostructured, and genetically encoded targeted photosensitizers, as well as their combination with other treatments like chemotherapy and fluorescence-guided surgery. Additionally, we extended our research program to antimicrobial photodynamic therapy, actively combating antimicrobial resistance. Our latest endeavor, the Light4Lungs project (www.light4lungs.eu), exemplifies this commitment.

Cross-talk and collaboration with industry has allowed us to delve into the world of sunscreens and photoprotection, resulting in innovations like the adaptable progressive sunscreens.

The journey in photobiology continues, fueled by curiosity and a desire to make meaningful contributions to science and health.

CryoEM and mutagenesis studies of two bacteriophytochromes from *Rhodopseudomonas palustris*

Ellie Norouzi

Ellie N. Sardareh[1], Indika Kumarapperuma[1], Zhong Ren[1], Irin P. Tom[1], Weijia Kang[1], Chang Liu[2], Linta Biju[1], Minglei Zhao[2] and Xiaojing Yang[1]

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Two tandem bacteriophytochromes, RpBphP2 and RpBphP3 are responsible for perceiving low-intensity light conditions in photosynthetic bacterium *Rhodopseudomonas palustris*. Utilizing biliverdin as chromophore, these photoreceptors play important roles in sensing light intensity and quality, thereby regulating the gene expression of pucBAd LH4 that constitutes the light-harvesting and photosynthetic apparatus. Despite similar protein sequences and domain architectures, RpBphP2 and RpBphP3 exhibit different photoconversion behaviors. Upon red light illumination, RpBphP2 photoconverts to a far-red-light absorbing Pfr state, while RpBphP3 converts the near-red-absorbing Pnr state. Although the crystal structures of the photosensory core modules have been determined for both systems, their full-length structures remain uncharacterized. This knowledge gap has hindered our understanding of the molecular mechanisms of light signaling in these modular photoreceptors. In this study, we employ cryo-EM to elucidate the full-length structures of both RpBphP2 and RpBphP3 in their dark and light-illuminated states. We also use site-directed mutagenesis to test the critical mechanistic aspects of long-range signaling. Together, this research is expected to provide structural insights into light signaling and kinase activation in bacteriophytochromes and beyond.

Enhancing photodynamic immunotherapy with optimized drug combinations reprograming the immunosuppressive tumor microenvironment

Patrycja Nowak-Sliwinska

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Immunotherapies, notably immune checkpoint blockade (ICB), show promise in CRC, yet only a minority of patients benefit. These therapeutics challenges underscore the need for combined approaches. So called "cold" tumors impair the induction of immunogenic cell death (ICD) for photodynamic therapy (PDT), thus impeding its efficacy and the subsequent immunotherapy. In this study, using statistical and experimental approach, we optimized multidrug combinations (ODCs), for their efficacy and potential as agents enhancing the anti-tumor immune response.

Our study aimed to test already developed ODCs utilizing tyrosine kinase inhibitors (TKIs) and anti-angiogenic drugs to enhance the immune response against CRC. We evaluated four distinct ODCs in AKP ($APC^{-/-}$, $Kras^{G12D}$, $TP53^{-/-}$) CRC organoid model and in an innovative established 3D co-culture model (ccAKP) comprising AKP organoids, endothelial cells, and immune cells. ODCs efficacy and selectivity were assessed *in vitro* and *in vivo* through organoids viability, tumor growth control, tumor immunogenicity enhancement, and modulation of the tumor microenvironment.

One ODC emerged as particularly promising, significantly suppressing organoid growth compared to chemotherapy. It also increased T cell infiltration and activation within ccAKP, sensitizing them to anti-PD1 therapy. In a syngeneic mouse AKP CRC organoid graft model, this ODC exhibited a significantly reduced tumor growth and substantially increased T cell infiltration and activity. Moreover, ODCs were found to upregulate endothelial adhesion molecules, reduce neovascularization, and normalize vessel formation, crucial for facilitating T cell infiltration. These findings underscore the potential of ODCs to overcome limitations in current regimens and augment the efficacy of immunotherapy in CRC.

Natural anthraquinones with antimicrobial and antitumor potential in Photodynamic Therapy.

Susana Carolina Nuñez Montoya

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Within the secondary metabolites produced by plants, anthraquinones (AQs) constitute the most numerous group of quinones with a wide range of biological effects. Our group has been developing a research line studying the antimicrobial, antiviral, and antitumor effects of photosensitizing AQs from several bioactive plant species from South American.

After studying the photophysical and photochemical properties of each AQ, we evaluate their antiviral, antibacterial, antifungal, antiparasitic, and antitumor activity using photodynamic inactivation/inhibition protocols. Prior to this, cytotoxicity in mammalian cells is studied to establish the concentration range where the toxic effect is low or nil, thus estimating a therapeutic index for each compound to assess its potential as a drug. The research is completed by studying possible mechanisms of action, such as photosensitization, oxidative and nitrosative stress, apoptosis, necrosis, and the relationships among these.

The most significant results demonstrating that some of these AQs possess substantial

photo-induced effects "in vitro" on Candida spp., Leishmania spp., Herpes Simplex Virus type 1, and different tumor cell lines will be summarized.[1-4] The study of AQs with photosensitizing properties holds promising prospects. Their controlled utilization can produce targeted biological effects such as inactivation or inhibitory action on microorganisms (bacteria, fungi, and parasites), viruses, or tumor cells, with minimal or no effect on host cells. Thus, we initiate preclinical studies of natural AQs on pathologies currently lacking safe and effective treatments (infections and neoplastic diseases), aiming to provide substances that will be evaluated by experimental pharmacology as potential therapeutic alternatives.

1 Marioni et al. PlosOne (2017) doi: 10.1371/journal.pone.0181517

2 Comini et al. Photochem. Photobiol. Scs. (2017) doi: 10.1039/c6pp00334f

3 Dimmer et al. Phytomedicine (2019) doi: 10.1016/j.phymed.2019.152894

4 Cogno et al. Photodiag. Photodynamic Thpy. (2020) doi: 10.1016/j.pdpdt.2020.101852

Controlling intracellular receptor activation with a genetically encoded opto-ligand

Patrick O'Neill

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Cells use dynamic networks of signaling proteins and lipids to carry out functions ranging from migration to proliferation. In many cases the response of these networks to molecular cues is orchestrated by G protein couple receptors. To better understand how this works, there is a need for new experimental capabilities to activate or inhibit these receptors with rapid, reversible, subcellular control. Here we report the development of a genetically encoded "opto-ligand" that enables optical control over the activation of the bradykinin B2R receptor. B2R is present at both the plasma membrane and the nuclear membrane, but it has been difficult to study the function of the nuclear B2R receptors by conventional pharmacological methods. We show that our opto-ligand can selectively activate the nuclear and not plasma membrane localized B2R receptors when expressed inside cells. The successful opto-ligand design involves an unexpected twist on a widely used light sensing protein domain. This new tool can help dissect the role of nuclear B2R signaling in important processes such as cancer proliferation. Unlike photoswitchable drugs generated by chemical methods, our genetically encoded approach opens new avenues for targeting receptor signaling at specific organelles.

Reshaping the role of phototherapy in photodermatoses

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Treating photosensitivity diseases with UV-based therapies appears at first glance paradoxical, but clinical practice proves that such methods are still leading interventions in patients with difficult-to-manage UV sensitive conditions. The idiopathic photodermatoses are the primary targets of photo therapeutic management, including polymorphous light eruption (PMLE), chronic actinic dermatitis (CAD), actinic prurigo (AP), solar urticaria (SU), and hydroa vacciniforme. For patients that do not respond to usual strategies of photoprotection, phototherapy is likely the next best option by itself or in combination with other treatments. The choice of UVB, UVA1 or PUVA depends most often not on specific therapeutic considerations but rather on availability of the hardware. Recently, there have been encouraging developments in managing CAD and SU. JAK inhibitors, which have shown encouraging results in e.g. autoimmune disease and atopic dermatitis, have also been helpful in managing otherwise non-responsive CAD patients. Omalizumab targets IgE and has been used to manage patients with SU. These developments are encouraging and we look forward to additional agents coming to enlarge the range of options for these often desperate patients. Still, the main obstacle for new therapies may be the concern for side effects and for cost. Phototherapies if used correctly have a very favorable side effect profile and costs are not excessive.

Optimizing antibody-photosensitizer conjugate specificity and dosimetry in 3D cell culture tumor models

Nicholas Otero

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Photoimmunotherapy (PIT) has been shown to be a promising approach for targeted depletion of cancer cells and priming of other therapies. Despite its vast potential, it is challenging to optimize the dosimetry of a given antibody photosensitizer conjugate (PIC) and its coordination with other therapies due to the many mechanisms of interaction within the tumor microenvironment. Here we present a simple 3D model with fluorescent-labeled cells to study the characteristics of a verteporfin-cetuximab conjugate and determine an optimized protocol for its implementation in photoimmunotherapy.

Photochemical targeting of platinum resistance in ovarian cancer cells: The role of lipid peroxidation

Marta Overchuk

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Over 75% of ovarian cancer patients develop resistance to platinum-based chemotherapies, leading to a critical reduction in available treatments. Malignant ascites portends the poorest outcomes, and recent evidence suggests that associated fluid shear stress (FSS) may contribute to treatment resistance. Therefore,

strategies to overcome FSS-induced resistance are urgently needed. Photodynamic priming (PDP), a photochemistry-based technique utilizing subtumoricidal doses of light and a photosensitizer, has emerged as a promising approach to enhance tumor response to complementary therapies. This study explored the potential of benzoporphyrin derivative (BPD)-mediated PDP to overcome FSS-induced resistance to cisplatin in ovarian cancer cells. Consistent with previous findings, ovarian cancer cells cultured under FSS exhibited marked resistance to cisplatin. BPD-PDP effectively re-sensitized the OVCAR-3 cells to cisplatin, but not Caov-3 cells under FSS. While the precise mechanism of BPD-PDP-induced platinum sensitization remains under investigation, recent studies suggest BPD-enabled photodynamic therapy may induce ferroptosis-like cell death. Ferroptosis is a form of cell death mediated by lipid peroxidation, which is effective even in cells with impaired apoptosis signaling and platinum response. To investigate the potential role of lipid peroxidation in the observed platinum re-sensitization, this study compared lipid profiles and ferroptosis sensitivities between OVCAR-3 and Caov-3 cells. Interestingly, OVCAR-3 cells displayed greater susceptibility to ferroptosis and possessed a higher degree of phospholipid unsaturation, indicating increased vulnerability to lipid peroxidation compared to Caov-3 cells. These findings suggest that BPD-PDP holds promise to overcome FSS-induced platinum resistance, potentially by targeting chemoresistance-associated alterations in the lipidome.

Targeting the Unseen: Nanotechnology-enhanced photoimmunotherapy combined with fluorescence-guided intervention enhances survival in peritoneal carcinomatosis mouse models

Sumiao Pang

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Peritoneal metastasis arises from the direct shedding of tumor cells from ovarian, colorectal, and other cancers, resulting in tumor dissemination and proliferation on peritoneal surfaces and abdominal organs. Nearly 70% of ovarian cancer patients that undergo surgery and chemotherapy will experience relapse due to residual micrometastasis. Photoimmunotherapy (PIT) is an emerging modality that can enhance standard therapies, such as chemotherapy and surgery, by treating microscopic tumors before lethal recurrence. PIT involves the administration of photosensitizer-antibody conjugates (photoimmunoconjugates) followed by light activation to generate reactive oxygen species, which induce direct cell death and potent anti-tumor immunity. Addressing challenges associated with detecting and treating peritoneal metastasis will require (i) efforts to advance targeted co-delivery and monitoring of photoimmunoconjugates and chemotherapy, (ii) treatment personalization through drug delivery monitoring and light dosimetry optimization in real time, and (iii) a medical laser endoscopy system capable of simultaneously performing and monitoring intraoperative treatment in the peritoneal cavity. We have previously shown that combining fluorescence-guided intervention using a cloud-connected medical laser platform (ML7710) and targeted nanomedicine improves the acute treatment response and reliability of photoimmunotherapy therapy for the management of micrometastases. This presentation will focus on: (i) redesigned targeted light-activatable multi-agent nanoplatform enabling higher cytotoxic drug loading, (ii) image analysis of nanoparticle tumor penetration depth in organs, and (iii) improved survival outcomes in a peritoneal metastases mouse model. By refining the delivery, activation, and treatment protocols, our nanoplatform-enhanced photoimmunotherapy strategy can improve the overall efficacy of PIT in managing peritoneal metastases and potentially improving patient outcomes.

Mathematical modeling of antibody-photosensitizer conjugate tumor distribution for predicting photoimmunotherapy dosimetry and efficacy

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As targeted therapy in oncology continues to evolve, the use of antibody-drug conjugates (ADCs) is gaining attraction for their ability to selectively deliver cytotoxic agents to tumor cells. In particular, targeted and activatable photoimmunotherapy (taPIT) exploits photoimmunoconjugates (PICs) as a vehicle for photosensitizers such as benzoporphyrin derivatives (BPD). However, the efficacies of ADCs and PICs are multiparameter and difficult to optimize empirically, presenting us with many unanswered crucial questions about their behaviors within a tumor microenvironment. For example, the extent of bystander effect is dependent on conjugation chemistry and physical properties of the ADC or PIC. To address this, we developed a mathematical model that describes the distribution of ADCs within a tumor tissue. The model is a system of coupled ordinary and partial differential equations that depicts the movement of PIC and BPD within and to/from different compartments – blood, interstitial/extracellular space, cell surface, cytoplasm, and lysosome. The equations contain terms representing both the diffusion and reaction/binding kinetics of the molecules. Though simplified and idealized, the model attempts to capture biologically realistic features and implement physiologically plausible parameters found in literature. As an example, we simulated the distribution of PIC throughout a 1mm-diameter tumor spheroid. The structure of blood vessels formed by VEGF-mediated angiogenesis was generated via our custom invasion percolation algorithm. After evolving the system in time, we were able to identify locations with high and low drug concentrations and predict the killing upon illumination. In future, we aim to add more complexities to better approximate real systems.

Lysosomal oxidation by neutral Ir(III) complexes to overcome drug-resistant cancer by downregulating autophagy

Mingyu Park

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Autophagy, a critical cellular quality control process, involves the degradation of damaged cell components via lysosomal fusion with autophagosomes. However, heightened autophagy

can promote drug resistance in cancer cells by aiding their survival and adaptation. Targeting autophagy with oxidative stress is a promising clinical strategy to counteract this resistance, but the dual role of reactive oxygen species (ROS) in both promoting and inhibiting autophagy has been a significant barrier to leveraging ROS therapeutically for autophagy inhibition. In our study, we synthesized iridium(III) complexes, designed to precisely control ROS in lysosomes, thereby selectively inhibiting autophagy. Proteomic analysis demonstrated that the oxidation significantly oxidized proteins essential for autophagy, including those involved in lysosomal function and fusion processes. This oxidative impact led to lysosomal dysfunction, aligning with our proteomic findings. Further, the effectiveness of this strategy was confirmed in vivo with B4, a complex specifically tuned to absorb red light. Our research paves the way for the therapeutic application of ROS in treating cancers resistant due to autophagy.

Conical intersection accessibility dictates brightness in red fluorescent proteins

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Red fluorescent protein (RFP) variants are highly sought after for *in vivo* imaging since longer wavelengths improve depth and contrast in fluorescence imaging. However, the lower energy emission wavelength usually correlates with a lower fluorescent quantum yield than their green emitting counterparts. To guide the rational design of bright variants, we have theoretically assessed two variants (mScarlet and mRouge) which are reported to have very different brightness. Using an alpha-CASSCF QM/MM framework (chromophore and all protein residues within 6 Å of it in the QM region, for a total of more than 450 QM atoms), we identify key points on the ground and first excited state potential energy surfaces. The brighter variant mScarlet has a rigid scaffold, and the chromophore stays largely planar on the ground state. The dimmer variant mRouge shows more flexibility and can accommodate a pre-twisted chromophore conformation which provides easier access to conical intersections. The main difference between the variants lies in the intersection seam regions, which appear largely inaccessible in mScarlet but partially accessible in mRouge. This observation is mainly related with changes in the cavity charge distribution, the hydrogen-bonding network involving the chromophore and a key ARG/THR mutation (which changes both charge and steric hindrance).

Investigating how gain-modulated pulse amplification impacts femtosecond laser ablation efficiency in soft tissue

Liam Price

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The use of femtosecond laser pulses to remove material with nanoscale control is well documented. This precise laser-based ablation is particularly promising with respect to potential biomedical applications. However, there are several obstacles inherent to soft-tissue ablation that can affect the efficiency of the ablation process if the laser pulse parameters are not well tuned. Here, we explore tissue ablation using gain-modulated nonlinear pulse amplification (GMA), a new pulse amplification technology, for tissue ablation. is uniquely capable of producing high energy pulses (~100 nJ) with sub-50 femtosecond duration. We hypothesize that pulse duration and peak power are not only salient to tissue breakdown but also to the generation of disruptive nanocavitation bubbles. Both factors are fundamental to ablation efficiency and speed. Upon creation, nanocavitation bubbles heavily distort the optical properties of the ablation volume, significantly reducing the local ablation efficiency. Following their collapse, these bubbles then release a shockwave that causes off-target tissue damage. While the creation of these nanocavitation bubbles is largely unavoidable at the pulse energies required for nonlinear tissue ablation, we explore the fine tuning of laser pulse parameters to try to mitigate their optically disruptive and physically destructive properties for precision ablation.

Bioactives from marine macroalgae, a natural strategy to mitigate the prevalence of skin cancer associated with climate change

Miguel Puertas

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In recent decades, the concentration of greenhouse gases in the atmosphere has increased considerably, especially gases such as carbon dioxide, methane, and gases derived from industrial processes. The presence of these gases accelerates climate change, affecting the ozone layer, with a consequent increase in the planet's average temperature and the intensity of solar radiation which could seriously threaten human health. Ultraviolet radiation (UVR) from the sun affects and is affected by global climate change. The decrease in stratospheric ozone allows more harmful UVB rays to reach the Earth's surface and cause DNA damage to plants and animals. There is extensive literature on the relationship between increased exposure to ultraviolet radiation and an increase in skin cancer, as well as photoaging, sunburn, among others. One of the most widely used options to reduce the risk of damage induced by UVR from the sun has been the use of photoprotectors (sunscreens). For example, mycosporine-like amino acids (MAAs) are synthesized by algae and enable them to protect themselves from the harmful effects of UV radiation, making MAAs a potential source of additives for the development of highly effective skin care products. Our objective is to design an alternative therapeutic strategy in health, based on macroalgae bioactives, that contributes to reduce the incidence of skin cancer, especially in vulnerable populations exposed to excessive UV radiation, derived from the negative impacts of climate change on health, in accordance with SDG 3: Health and Well-being; strengthening resilience and the capacity to adapt to climate-related risks.

Light-triggered nanoliposomes to combat multi-drug resistance

Jose Quilez Alburquerque

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Hospital-acquired infections are one of the major driving forces of morbidity and mortality in the USA. The overuse and misuse of antibiotics have led to a distressing issue of multi-drug resistance (MDR), where these drugs are no longer effective. In this regard, photodynamic therapy and priming (PDT/PDP) appears to be an innovative therapeutic strategy to overcome MDR in bacteria. PDT works using three simple elements, light with a specific wavelength, a photosensitizer (PS), and oxygen, generating reactive molecular species (RMS), which leads to local and remote effects within the cells to mitigate some of the bacterial MDR mechanisms, such as drug permeability enhancement, efflux pump damage, and drug-modifying enzyme inactivation. However, to overcome MDR, antibiotics and PS must be delivered simultaneously with an optimized dosage ratio at the infection site. This task is extremely challenging when both drugs are administered independently due to their different pharmacokinetic properties. Fortunately, this issue can be solved by utilizing superior drug delivery systems such as photoactivatable multi-inhibitor liposomes (PMIL) that co-deliver two clinically approved agents, the photoactive molecule, benzoporphyrin derivative, and the antibiotic minocycline. Light activation of PMIL tunes minocycline release at the right time and location while simultaneously photodamages transmembrane efflux pumps involved in its resistance thus enhancing its accumulation and intrinsic efficacy. This combination treatment with non-overlapping targets works synergistically to overcome their respective drawbacks and overcome bacterial MDR.

Photoactivable liposomes in combination with minocycline cooperatively overcome resistance to irinotecan in pancreatic cancer

Jose Quilez Alburquerque

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Pancreatic ductal adenocarcinoma (PDAC) is the fourth leading cause of cancer deaths. The poor diagnosis, early metastasis, limited drug accumulation in the tumor microenvironment, and acquired resistance to salvage chemotherapeutic cocktails lead to poor clinical outcomes. Herein, we address chemoresistance by developing mechanism-based combination regimens that integrate drug-repurposing strategy with optically activated nanotechnology by employing three clinically approved agents with no overlapping toxicities. We introduce a dual priming approach to target different chemoresistance mechanistic pathways in cancer cells. (i) Minocycline antibiotic priming attenuates DNA repair enzyme activity tyrosyl-DNA phosphodiesterase 1 (Tdp1). This protein is over-expressed on pancreatic cancer cells and drives cancer cell proliferation. (ii) Photodynamic priming by an engineered nanoliposomal formulation, which contains benzoporphyrin derivative as a photoactive molecule, damages drug efflux transporters and triggers the release of subtherapeutic doses of the Top1 inhibitor, irinotecan (IRI). Individually these three treatments are ineffective, however, an appropriate sequential combination synergistically impacts the viability of heterotypic 3D cancer models that incorporate cancer cells and pancreatic cancer-associated fibroblasts. Preliminary data shows that the dual priming approach enhances the activity and the accumulation of the chemotherapeutic IRI in the tumor tissue, reduces normal, increases T-cell tumor infiltration toxicity, and improves the treatment outcome in immune-compromised mice.

Self-assembled verteporfin nanoaggregates for photodynamic therapy in glioblastoma multiforme

John Quinlan

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Photodynamic therapy (PDT) using verteporfin (VP) has been performed in the clinic for over twenty years using Visudyne, a lipid-based formulation of VP. Lipids can hinder cellular uptake of their drug cargo and may be recognized by the immune system, potentially leading to hastened drug clearance from systemic circulation. VP is hydrophobic and its tendency to aggregate in aqueous solution has been noted for decades. We have carefully controlled the aggregation of VP to produce NanoVP, a carrier-free nanodrug of VP. NanoVP is amorphous, roughly spherical, and ~100 nm in diameter. Importantly, NanoVP requires no carriers or excipients, permitting delivery of pure VP for the first time. NanoVP is stable in aqueous solution, and upon interaction with biomolecules, NanoVP dissociates to permit light activation of VP monomers. NanoVP is taken up by cells to a greater degree than liposomal VP, resulting in greater cell killing after light activation. Currently, 5-aminolevulinic acid (5-ALA) is under clinical investigation for PDT in glioblastoma (GBM). We investigated the efficacy of NanoVP PDT in an orthotopic patient-derived xenograft model of GBM using interstitial light delivery. We found that interstitial NanoVP PDT outperforms liposomal VP PDT in orthotopic glioblastoma and confers a slight survival benefit over 5-ALA PDT. In all, NanoVP offers a novel delivery system for VP and has promising potential as a photosensitizer for use in GBM.

Transcriptome Analysis in Mouse Skin After Exposure to Ultraviolet Radiation from a Canopy Sunbed

Sami Qutob

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Exposure to ultraviolet radiation (UV-R), from both natural and artificial tanning, heightens the risk of skin cancer by inducing molecular changes in cells and tissues. Despite established

transcriptional alterations at a molecular level due to UV-R exposure, uncertainties persist regarding UV radiation characterization and subsequent genomic changes. Our study aimed to mechanistically explore dose- and time-dependent gene expression changes, that may drive short-term (e.g., sunburn) and long-term actinic (e.g., skin cancer) consequences. Using C57BL/6N mouse skin, we analyzed transcriptomic expression following exposure to five erythemally-weighted UV-R doses (0, 5, 10, 20, 40 mJ/cm^2) emitted by a UV tanning device. At 96 hours post-exposure, 5 mJ/cm2 induced 116 statistically significant differentially expressed genes (DEGs) associated with structural changes from UV-R damage. The highest number of significant gene expression changes occurred at 6 and 48 hours post-exposure in the 20 and 40 mJ/cm2 dose groups. Notably, at 40 mJ/cm^2, 13 DEGs related to skin barrier homeostasis were consistently perturbed across all time points. UV-R exposure activated pathways involving oxidative stress, P53 signaling, inflammation, biotransformation, skin barrier maintenance, and innate immunity. This *in vivo* study's transcriptional data offers mechanistic insights into both short-term and potential non-threshold-dependent long-term health effects of UV-R tanning.

Optically Controllable Blue Opsin at the Endoplasmic Reticulum

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Recent evidence has illuminated the endomembrane G protein-coupled receptor (GPCR) regulatory signaling pathways involved in various physiological and pathological processes including heart failure and addiction. Engineering optogenetic tools to dissect endomembrane GPCR signaling is pivotal by rapidly switching on and off signaling pathways on different subcellular organelles in living cells. The blue cone opsin, a light-sensitive GPCR derived from the human blue cone photoreceptor has garnered attention due to its unique ability to activate G protein signaling pathways in response to blue light with a covalently linked 11-cis-retinal chromophore. Here, an endoplasmic reticulum (ER)-targeted blue opsin (Endo-BO-1) is developed by genetically engineering the protein's N- terminus and C- terminus of the GPCR while preserving its folding and functionality. The blue light triggered active conformation of Endo-BO-1 behaved differently from the wild type which was probed using the Venus-mini-Gsi protein affinity assay that recruited from the cytosol to the endomembrane sites. The temporal subcellular activation of Endo-BO-1 is achieved by exclusive illumination of a portion of the endomembrane receptor pool in a single cell. This optogenetic Endo-BO-1 construct will provide a unique ability to precisely control the timing and location of blue light exposure and modulate the activity of GPCR, enabling the investigation of intracellular G protein signaling in various physiological processes.

nbUVB Photo- and/or Brachy-therapy for the treatment of virus in tissue (Part I)

Marigdalia Ramirez-Fort

Marigdalia K. Ramirez-Fort[1] and Christopher S. Lange[2]

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Extrapolating from the Lange and Gilbert Model, the Ostashevsky and Lange DSB Model, and the Lytle and Sagripanti SNS Model, we've learned that understanding both viral and cellular repair kinetics are the cornerstones to identifying radiotherapeutic opportunity. Decades of clinical data are readily available for the use of narrowband ultraviolet-B (nbUVB) in the treatment of a variety of benign skin diseases. Narrowband UVB is largely administered with the therapeutic purpose of inducing cytotoxicity of diseased cells (e.g., psoriasis, atopic dermatitis), where the target is the cellular DNA. In this context, nbUVB causes direct DNA damage via the formation of cyclobutane pyrimidine dimers (CPD) and indirect DNA damage via production of reactive oxygen species (ROS) (predominantly the hydroxyl radical). The nbUVB D_{50} of human oral mucosa cells is ~402 mJ/cm^2; assuming a simple exponential dose response, yields a D_{37} of 580 mJ/cm^2 and a D_{10} of 1,334 mJ/cm^2. Therefore, if there is repair, the sensitivity of these cells is considerably overestimated and hence doses of this magnitude should be safe to use. Lytle and Sagripanti's SNS Model estimates the sensitivity of a variety of viruses to UVB; their calculated estimates agreed with the measured values. Specifically, the SNS predicted sensitivity for *Papillomaviridae* (e.g., HPV viruses) is a D_{37} of 30 - 38 mJ/cm^2 and a D_{10} of 69 - 87.4 mJ/cm^2. The SNS model predicted sensitivity for *Poxviridae (*e.g., molluscum contagiosum (MC)) is a D_{37} of 7 - 16 mJ/cm^2 and a D_{10} of 16 - 37 mJ/cm^2.

nbUVB Photo- and/or Brachy-therapy for the treatment of virus in tissue (Part II)

Marigdalia Ramirez-Fort

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From their SNS-based D_{37} values we estimated D_{10} values for comparison with our estimated oral mucosa D_{10} and obtained 16 [15.3 - 19.3] decades of HPV viral kill per decade of oral mucosa cell kill and similarly 50.3 [36 -83.4] decades of MC viral kill per decade of cell kill. Comparing decades of viral kill, to the overestimated sensitivity of oral mucosal cells, results in massive therapeutic gains for nbUVB photo- and/or brachy-therapy eradication of virus in tissue. Depth dose in tissue for UVB has not yet been defined to the extent that it has been for ionizing radiations. Preliminary UV percent depth dose measurements by Coohill et al., determined that about 40 - 65% of a UVB (300 nm) / UVA (350 nm) prescribed skin surface dose (mJ/cm^2) is transmitted to a depth of 50 µm in mammalian tissue. Interpolating (40% depth dose at 300 nm (UVB) and 65% depth dose at 350 nm (UVA) on a semilog fractional depth dose), we obtain 43.65% depth dose of nbUVB (310 nm) at 50 µm. With a surface dose of 300 mJ/cm^2 per fraction, we therefore estimate a 131 mJ/cm^2 dose at 50 µm in tissue. Therefore, we calculate a 99.9 to 99.99% (3-4 decade) reduction of HPV at surface per fraction and 90 - 99% (1-2 decade) reduction at 50 µm in tissue. Similarly, we calculate a 99.999999% (8-19 decade) reduction of MC at surface per fraction and 99.99 - 99.999999% (4-8 decade) reduction at 50 µm in tissue.

Organic-Quantum Dot Hybrid Assemblies as Novel Type II Photodynamic Therapy Agents: Spectroscopy Mapping of Triplet Exciton Migration within the Hybrid Photo-materials

Sarita Rawool

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Triplet energy transfer (TET) processes play a major role in light harvesting/modulation applications. Designing systems that undergo efficient TET processes is crucial for applications such as type II photodynamic therapy (PDT). In recent years, Quantum dots have been widely used to engineer light-harvesting systems due to their excellent photo- and thermal stability,

high extinction coefficients, and easily tunable bandgap. There has been extensive work done in the area of organic-quantum dot assemblies over the years. However, the photo-excited state dynamics and kinetics of energy flow in such assemblies have not been completely unfolded so far.

In our ongoing investigation of organic-inorganic hybrid assemblies, we performed the spectroscopic mapping of triplet exciton dynamics in a hybrid photosystem made of a triplet chromophore (naphthoquinodimethyl-*bis*-thioamide, QDM) and CdSe/ZnS core-shell type quantum dot. The interaction between QDM and CdSe/ZnS is mediated by carboxylate moieties on the organic chromophore and amine functions on the quantum dot. Steady-state emission and time-resolved transient absorption spectroscopy measurements revealed that QDM undergoes faster intersystem crossing populating its triplet state due to the heavy atom effect induced by the inorganic quantum dot. Furthermore, it was found that in the excited state of the complex, QDM triplet excitons could migrate to the quantum dot, extending the triplet lifetime of the hybrid photosystem compared to the triplet lifetime of the QDM alone. A longer triplet lifetime was found to improve the efficiency of TET to molecular oxygen to produce singlet oxygen ($^1O_2$) via the type II mechanism.

My presentation will highlight photophysical studies of the organic-quantum dot hybrid assembly as well as its potential use as a PDT agent.

Photochemical targeting of chemotherapy resistance and functional mitochondrial enhancements induced by perfluoroalkyl substances (PFAS) in ovarian cancer cells

Brittany Rickard

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In the context of ovarian cancer, mitochondrial health can determine response to chemotherapy. Increases in mitochondrial membrane potential (MMP), reactive oxygen species, and bioenergetics are associated with resistance to platinum-based chemotherapeutics, such as carboplatin. Importantly, environmental stressors like perfluoroalkyl substances (PFAS) may enhance mitochondrial health and impact chemotherapy response. Recently, we demonstrated that short-term (48-hour) PFAS exposure increases MMP and induces carboplatin resistance in ovarian cancer cells, particularly OVCAR-3. We also showed that mitochondria-associated photodynamic priming (PDP) using benzoporphyrin derivative (BPD) or 5-aminolevulinic acid-induced protoporphyrin IX (ALA-PpIX) overcomes carboplatin resistance following short-term PFAS exposure. Here, the effects of long-term (144-hours) or chronic (26-day) PFAS exposure were examined. Superoxide production significantly increased following long-term PFAS exposure in OVCAR-3 cells, compared to controls. Pyruvate kinase activity also significantly decreased compared to controls, indicating that PFAS exposure may induce bioenergetic flexibility. To evaluate the effects of chronic PFAS exposure on mitochondrial health, cells were grown in the continuous presence of 500 nM perfluoroheptanoic acid (PFHpA) for 26 days. Compared to short-term PFAS exposed cells, chronic PFAS-exposed OVCAR-3 cells were significantly more resistant to both carboplatin and doxorubicin. MMP was also significantly increased in chronically exposed cells, suggestive of functional mitochondrial enhancement. Altogether, these findings demonstrate that, compared to short-term exposure, long-term and chronic PFAS exposures increase the scope of chemotherapy resistance and enhance mitochondrial function in ovarian cancer cells. Future work will evaluate the use of mitochondria-targeted PDP in combination with carboplatin or doxorubicin in OVCAR-3 cells that are chronically exposed to PFAS.

Structural bases of the light sensing in the phytopathogen Xanthomonas campestris. Long-range signaling mechanism of a bacteriophytochrome

Jimena Rinaldi

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Phytochromes constitute a large family of photoreceptor proteins that sense red and far-red light through the binding of a bilin molecule. They alternate between two photostates: Pr, which absorbs red light, and Pfr, which absorbs far-red light. Phytochromes have a photosensor module (PSM) and a variable output module (OM). Light is sensed by the PSM and then the signal propagates to the OM domain, which undergoes an allosteric shift. Although important contribution to the understanding of light perception in the PSM have been made during the last decades, it is not known how signal propagation and allosteric change occur. *Xanthomonas* is a bacterial genus, which includes phytopathogens that cause many diseases of agronomic relevance. Our group identified light as a key environmental signal that negatively modulates the virulence of *Xanthomonas campestris pv. campestris* (*Xcc*) through its unique bacteriophytochrome (*Xcc*BphP), establishing that light and *Xcc*BphB play a key role in the infection process. *Xcc*BphP is composed of the PSM at the N-terminus and a PAS9-like OM domain at the C-terminus. In the laboratory, we have solved the crystallographic structure of full-length *Xcc*BphP first in the Pr state and then in the Pfr. It was observed from the comparison of both photostates that light triggers very large conformational changes at the level of the tertiary and quaternary structure that have not been previously described. In this talk, these light-driven conformational changes

we will exposed, together the validation through solution experiments.

New Approach Methodologies for Photoallergy: Preliminary Investigations with Reference Chemicals

Gretchen Ritacco

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Photoirritation evaluation of fragrance materials by the Research Institute for Fragrance Materials (RIFM) follows a stepwise process using *in chemico* and *in vitro* methods as described previously (Ritacco *et al.*, 2022). Currently the only non-animal guideline test method to address photoallergy, the reactive oxygen species assay (ROS), OECD 495. In collaboration with the IIVS, RIFM investigated modifications to the *in chemico* Direct Peptide Reactivity Assay (DPRA; OECD 442C) and *in vitro* Keratinosens (OECD 442D) assay to evaluate a set of reference photoallergens. The "photo-DPRA" included a standard DPRA and one with UVA exposure (5 J/cm^2) as described by Hayato, *et al*. The "photo-KeratinoSens" investigated the activation of keratinocytes in the presence and absence of 5 J/cm^2 of UVA/visible light irradiation, using the methods presented in Tsujita, *et al*. (2015). Reference materials were also tested in the ROS assay. A set of 7 reference photoallergens were chosen as the test materials covering a variety of chemical classes and use categories. In the ROS assay, four reference materials were found to be photoreactive; results from one material were inconclusive, another remains to be tested. All reference materials were found to be photoreactive in the photo-DPRA. In the photo-KeratinoSens assay, four materials were judged to be positive while 2 were negative; another material remains to be tested. While the assays mis-predicted a small number of reference materials, overall, the results indicate that there is promise in pursuing new approach methodologies based on accepted skin sensitization assays to predict photoallergy potential of fragrance materials.

Mutagenic bypass of atypical UV photoproducts

Steven Roberts

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UV light is a major contributor to skin cancers on sun exposed parts of the body. This irradiation primarily damages DNA through the production of cyclobutane pyrimidine dimers (CPDs), which cause a characteristic mutation signature in irradiated cells, consisting of C to T substitutions in dipyrimidines. While the mutation spectrum of most cutaneous skin cancers consists overwhelmingly of this signature, driver mutations in human melanoma frequently involve other types of mutations suggesting that UV light may initiate melanoma through non-CPD based mechanisms. By serially exposing yeast to either UVC or UVB light and sequencing independent genomes, we found that UV light induces other classes of mutations more consistent with those seen in melanoma driver genes. In particular, UV frequently produces AC to TT tandem substitutions that create *BRAF* V600K oncogenic mutations specifically in skin cancers. These mutations display transcriptional strand asymmetries consistent with repair by transcription-coupled nucleotide excision repair and indicating that they likely result from atypical UV photoproducts. Analysis of mutations in yeast indicate that specific lesion bypass mechanisms help the cell tolerate these lesions during DNA replication and that DNA pol eta contributes to AC to TT substitutions. Surprisingly, pol eta protects against another non-canonical CA to AA UV-induced mutation. The differential impact of lesion bypass across from different UV lesions likely plays an important role in dictating how skin cancers evolve by dictating which driver mutations are most likely to occur.

Melanopsin as an optogenetic switch for activating G-protein pathways

Phyllis Robinson

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Melanopsin is an R-type visual pigment expressed in vertebrates. In mammals it is expressed in a subset of light-sensitive retinal ganglion cells (ipRGCs). This visual pigment is bistable and has properties that make it a good candidate for a optogenetic tool. Its kinetics properties can be manipulated by genetically modifying phosphorylation sites on its carboxy tail and the addition of RGS proteins.

Mechanistic Studies of the Visible-Light Sensitized Photosulfoxidation of Toluidine Blue O

José Robinson-Duggon

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Experimental and theoretical strategies for deducing mechanistic paths of photobleaching are challenging. Progress has been made based with the self-sensitized photooxidation toluidine blue O (TBO), leading to TBO sulfoxide and other products. Here, the photo*sulfoxidation* process was studied by mass spectrometry (MS) and discussed in the context of photodemethylation processes which both contribute to TBO consumption over time. Analysis of solvent effects with D_2O, H_2O, and CH_3CN along with product yields and MS fragmentation patterns provided mechanistic insight to TBO sulfoxide's formation. This is a unique albeit minor self-sensitized photooxidation path, where the TBO sulfoxide arises is minor and detectable amounts up to 12%. The photosulfoxidation process is dependent on oxygen wherein instead of a type II (singlet oxygen, $^1O_2$) reaction, a type I reaction involving TBO to reach the TBO sulfoxide is consistent with the results. Density functional theory results point to the formation of the TBO sulfoxide by the oxidation of TBO via transiently formed peroxyl radical or

thiadioxirane intermediates. We discovered that the TBO photosulfoxidation arises competitively with TBO photodemethylation with the latter leading to formaldehyde formation.

Understanding Toluidine Blue Photochemistry for Applications in Photosensitized Oxidations

José Robinson-Duggon

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Toluidine blue (TBO^+) is a cationic organic dye from the phenothiazine family. It has been reported that upon irradiation it can eradicate various microbial agents *in vitro*,[1] it has the tendency to accumulate in tumor cells *in vivo* and it has been used in topical applications for over thirty years to aid in the detection of certain types of cancers of the oral cavity and upper gastrointestinal tract.[2] To develop applications in photodynamic therapy (PDT) it is important to consider the self-sensitizing photooxidative processes undertaken by TBO^+ previously reported by us, in which demethylation of TBO^+ and other photoproducts can be generated.[3,4] TBO^+ has advantages in terms of selectivity for neoplastic tissue, its amphiphilic character and dark toxicity,[5] but the different competing photochemical processes that arises upon irradiation with visible light limit its generation of singlet oxygen. Likewise, it could limit photochemical processes of electron transfer. The above mentioned could decrease the performance of TBO^+ as a photosensitizer in PDT.

For several years we had been studying the use of TBO^+ and different approaches to maximize its singlet oxygen generation such as the supramolecular encapsulation within macrocyclic containers cucurbiturils and derivatizations to increase the bioaccumulation to improve its performance in photosensitized oxidations.[6,7] Currently, we are focusing in the generation of TBO^+ photoproducts to shed some light into the impact that this may have in the overall performance of this photosensitizer in the photosensitized oxidations of proteins and antioxidant enzymes, such as, Superoxide Dismutase (SOD) and Catalase (CAT).

References

[1] Wilson, M. et al. J. Appl. Bacteriol., 78:569 (1995)

[2] Epstein, J. et al. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endo., 83:537 (1997)

[3] Robinson-Duggon, J. et al. J. Phys. Chem. A, 123:4863 (2019)

[4] Otero-González, J. et al. Photochem Photobiol., 00: 1-10. doi:10.1111/php.13882 (2023)

[5] Tremblay, J. et al. Photochem. Photobiol. Sci., 1:852 (2002)

[6] Robinson-Duggon, J. et al. J. Phys. Chem. C, 121:21782 (2017)

[7] Robinson-Duggon, J. et al. J. Photochem. Photobiol. B, Biol., 223:112284 (2021)

An additional lineage of two-Cys cyanobacteriochromes reveals plasticity of second linkage formation

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Cyanobacteriochromes (CBCRs) are cyanobacterial photoreceptors distantly related to phytochromes. Like phytochromes, CBCRs use 15,16–photoisomerization of linear tetrapyrrole (bilin) chromophores to toggle between two photostates with distinct spectral and biochemical properties. Both photoreceptor families bind the bilin in a conserved pocket in a GAF domain and form a covalent thioether linkage between the bilin A-ring and a conserved Cys residue. However, CBCRs exhibit a much broader range of responses than do phytochromes, with known examples spanning the visible spectrum and extending into the near-ultraviolet and to the edge of the infrared (peak wavelengths ca. 378-742 nm). Bilins intrinsically absorb light in the green to red region of the spectrum, but formation of a covalent linkage between a second Cys residue and the bilin C10 atom allows CBCRs to detect light at shorter wavelengths. This tuning mechanism has evolved multiple times during the course of CBCR evolution. In this work, we present an additional lineage of two-Cys CBCRs, the CHX CBCRs. We demonstrate that most such proteins have both Cys residues in a conserved CHC motif. However, we fortuitously observed that some members of this lineage use a different second Cys residue. We show that this alternative Cys residue can play a similar role in distantly related CBCRs in which it is found and that a "Cys-swap" experiment in one CHX CBCR restores the photocycle, but the second Cys residue controls photoproduct stereochemistry. These results illuminate the astonishing flexibility of CBCR tuning mechanisms and provide further insight into CBCR diversity.

Wireless Devices for Monitoring Sleep and Circadian Rhythms

John Rogers

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Over the last decade, a convergence of new concepts in materials science, mechanical engineering, electrical engineering and advanced manufacturing has led to the emergence of diverse, novel classes of 'biocompatible' electronic, microfluidic and microelectromechanical systems with skin-like physical properties. The results create vast opportunities in diagnostic, therapeutic and/or sensory devices with important, unique capabilities that range from fitness/wellness, to sports performance, clinical healthcare and virtual reality environments. This talk describes the key ideas and presents some of the most recent examples in monitoring of sleep and circadian rhythms.

Photooxidation of Arylphosphines in Metal Organic Frameworks: A Mechanistic Probe for Cage Effects

Nicole Salimbangon

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Aryl-phosphines are class of organophosphorus compounds widely used in catalysis, polymerization, and also as fuel-stabilizers for jet fuels. The bulkiness of these compounds can be modified with substituents on the ortho position of the aryl group. Many aryl-phosphines are inert -that is- they are unreactive with triplet oxygen. In contrast, they react readily with singlet oxygen leading to phosphine oxides and/or phosphinate esters. The ratio of these products is highly sensitive to steric effects: the intramolecular formation of the phosphinate ester is preferred in a sterically demanding environment. This research studied the change of reactivity of phosphine oxidation chemistry inside metal organic frameworks (MOFs). We

used the photooxidation of triphenylphosphine and tris(ortho-methoxyphenyl) phosphine as the substrates and MOFs with porphyrin linkers as the catalyst. If the se reactions occurred inside the MOF pores, rearrangement to phosphinate ester should be preferred since phosphine oxide formation requires intermolecular oxygen atom transfer from the phosphadioxirane intermediate. Other MOFs with varying pore sizes were also examined for their cage effects. We have found that there is no increase of the phosphinate ester product relative to homogeneous solution phase chemistry. This result implies that singlet oxygen diffuses out of the MOF cage, and the photooxidation with phosphines occurs outside the cage, in contrast to previous suggestions in the literature.

A heterogeneous PDT system for water purification; effect of reactor design on Singlet Oxygen generation and bacteria killing

Pabasara Samarawickrama

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The conventional methods used for water disinfection, such as chlorination, ozonation, and UV irradiation, are not suitable for aquaculture due to numerous drawbacks, including the production of harmful compounds, cytotoxicity, and issues with turbidity, respectively. Therefore, Photodynamic Therapy (PDT) holds great promise in this field. However, most PDT studies have focused on dispersing the photosentizer into the solution. In such cases, separating the dye after treatment is not practical. Employing polymer-supported photosensitizers solves this problem as the photosensitizer remains fixed to the solid support, releasing only gaseous singlet oxygen ($^1O_2$) into the water. Singlet oxygen is non-toxic to biological life because it's a short-lived, reactive species and travels only a few hundred nanometers in water before decaying back to the breathable ground state. However, effectively delivering the $^1O_2$ generated on the polymeric substrate into the water to kill bacteria remains a challenge. We designed an experimental system with a hydrophobic photosensitizer ($ZnC_{32}F_{16}N_8$)-coated on polymer rods, closely packed in a tubular reaction vessel, and illuminated with a 639 nm LED. Uric Acid is used as the chemical probe for $^1O_2$ and the solution is bubbled with oxygen during irradiation. In this system, the effect of surface roughness, gas bubbling, spacing between coated surfaces and rod surface area exposed to the solution on trapping $^1O_2$ has been tested. In our preliminary tests, ~3.12 mM h^{-1} of $^1O_2$ generation under an irradiance of 60 J/cm^2 and ~1 log killing of planktonic *E. coli* under an irradiance of 3000 J/ cm^2 was achieved.

DNA Damage and Repair Mechanism in Duckweed (Spirodela polyrhiza) Under Ultraviolet (UV-B) Radiation Stress

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In living organisms, genomic DNA is a critical macromolecule; its stability and integrity are vital for the normal functioning of cellular processes, such as DNA replication and DNA repair. Sunlight is a significant source of ultraviolet (UV) radiation. Excessive exposure to solar UV-B radiation can cause damage to DNA structure by introducing bulky DNA photoproducts. If unrepair, these photoproducts negatively affect the physiological processes of living organisms.

In this study, *Spirodela polyrhiza* plantlets were exposed to different UV-B exposure times. After UV-B exposure, plantlets were incubated under normal growth conditions for recovery and sampled at 0 h, 12 h, and 24 h for genomic DNA damage analysis. The genomic DNA was probed on a slot-blot experiment for antibodies against the (6-4) PPs or CPDs to detect the damaged DNA and nucleotide excision repair capacity.

Our results suggest that duckweed plantlets at 0 hours of recovery had the strongest DNA damage signals; thus, in these samples, the DNA repair system did not have enough time to repair the DNA damage caused by the UV-B radiation. Weaker signals were observed in the 12-hour and 24-hour recovery times post-UVB, showing that with more recovery time, the NER mechanism has time to repair most of the damaged DNA in the duckweed. DNA damage and the repair mechanism in duckweed are dose-dependent. Our work suggests that *S. polyrhiza* is ideal for studying UV-B-mediated DNA damage as an alternative to the mammalian system to understand the effect of climate change on plant and human health.

Application of selected diene probes to monitor excited triplet states of synthetic eumelanin and pheomelanin

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Although melanin pigments can photogenerate reactive oxygen species, the role of excited triplet states in these processes remains ambiguous. In spite of application of advanced time-resolved spectroscopic methods, attempts to detect melanin triplet states have been mostly unsuccessful. This could be due to unfavorable optical properties of melanin, which exhibit significant absorption in the entire UVC-vis region. On the other hand melanin can photogenerate singlet oxygen, indicating energy transfer from excited triplet state of melanin to dioxygen. In this study, potassium sorbate (PS) and sorbic alcohol (SA) were used to probe triplet states of synthetic dopa-melanin and 5-S-cysteinyldopa melanin. Photogeneration of singlet oxygen by the synthetic models of eumelanin and pheomelanin, before and after their controlled oxidative photodegradation, were measured in the absence and presence of increasing concentration of PS and SA by time resolved near-infrared phosphorescence. Both dienes probes, being efficient quenchers of triplet excited states, practically do not interact with singlet oxygen. Compared to PS, SA showed higher efficiency to reduce the intensity of the melanin generated singlet oxygen, particularly at low concentration of the quencher (< 1 mM), which can be explained by higher energy of the SA triplet. The quenching effect of SA was stronger for oxidatively modified melanins. However, even at the highest concentration of the dienes, intensity of the melanin generated singlet oxygen was only partially reduced, suggesting that photoexcitation of melanin is accompanied by formation of triplet excited states with different energies, of which a fraction remains unquenchable.

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The role of the protein environment in the photoisomerization of the retinal chromophore

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Rhodopsins are light-sensitive, membrane-embedded proteins that carry a retinal chromophore. Upon light absorption, they undergo ultrafast photoisomerization. This double bond selectivity varies among different types of rhodopsins. Microbial rhodopsins bind the all-trans isomer of retinal, which is isomerized to 13-cis, whereas animal rhodopsins bind exclusively 11-cis retinal, which is isomerized to all-trans. This classification was recently challenged by the discovery of fused bestrhophin rhodopsins. This new protein belongs to the microbial subfamily but shows all-trans to 11-cis isomerization. In this contribution, we elucidate this unusual mechanism using multiscale simulations. We use the hybrid quantum mechanics/molecular mechanics method together with non-adiabatic molecular dynamics simulations to study the photoisomerization mechanism. Our results explain how the protein controls and selects the double bond for photoisomerization.

The role of bilin lyases and lyase-isomerases in blue-green chromatic acclimation in marine Synechococcus.

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Phycobilisomes (PBS) are huge antenna complexes in cyanobacteria that are mainly composed of phycobiliproteins. Phycobiliprotein biogenesis involves the attachment of chemically distinct bilin pigments to these proteins via enzymatic reactions catalyzed by bilin lyases. Some members in this enzyme group, called bilin lyase-isomerases, can attach a green-absorbing phycoerythrobilin and isomerize it to a blue-absorbing phycourobilin. These enzymes play a key role in a widespread phenomenon, called Type IV Chromatic Acclimation (CA4), present in about half of all marine *Synechococcus* cells. CA4 causes these cells to change color as a result of the massive restructuring of their PBS, after switching between blue and green light. Three bilins change on the α-subunits of the phycoerythrin I (CpeA) and II (MpeA) proteins during CA4.

All CA4 capable strains possess one of two possible genomic islands, CA4-A and CA4-B. The genes include two master regulators, FciA and FciB, a gene with similarity to phycoerythrin lyases or lyase-isomerases, (either *mpeZ* or *mpeW*), and a gene of unknown function, *unk10*. Our analysis of an *unk10*⁻ knockout mutant strongly suggests Unk10 plays a critical role in enhancing phycourobilin attachment at CpeA Cys-139 and MpeA-Cys-140. *Synechococcus* sp. A15-62 contains a CA4-B island, which encodes the lyase gene *mpeW*. A15-62 also encodes the *mpeQ* gene, a lyase-isomerase gene, located immediately upstream of the phycoerythrin-II operon. MpeQ isomerizes phycoerythrobilin to phycourobilin and ligates this to Cys-83 on MpeA. MpeW is highly upregulated in green light and ligates PEB to Cys-83 on MpeA. The biochemistry of these enzymes will be discussed.

An Enzyme-Coupled Istotope Dilution Mass Spectrometry Assay for Non-adjacent DNA Photoproducts as Intrinsic Probes for G-quadruplexes *in vivo*

Savannah Scruggs

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G-quadruplexes are non-canonical nucleic acid structures formed by guanine-rich DNA or RNA sequences and have gained significant attention due to their potential roles in various cellular processes, including gene regulation, replication, and telomere maintenance. These intricate structures consist of three stacked guanine tetrads, stabilized by Hoogsteen hydrogen bonding. Given their biological significance, the development of reliable methods for the *in vivo* detection of G-quadruplexes is crucial to understand their functional relevance. We recently discovered that UVB irradiation of human telomeric DNA fragments in the presence of K^+ produces unique non-adjacent *anti* cyclobutane pyrimidine dimers (CPDs). In contrast, B-form DNA produces exclusively adjacent CPDs with a head-to-head or *syn* regiochemistry. We propose therefore that UV light could be used to irreversibly capture non-B DNA structures *in vivo* by *anti*-T=T CPD formation for later detection *in vitro*. The detection of *anti*-T=T CPDs in irradiated cells would then provide unambiguous evidence that a G quadruplex, or some other non-B DNA structure exists in cells. To detect the formation of *anti*-CPDs we have been developing an enzyme-coupled Isotopic Dilution Mass Spectrometry (IDMS) assay for *anti* CPDs which is based on the enzymatic degradation of UV irradiated cellular DNA to CPDs of thymidine. The *anti* T=T CPDs can then be detected by co-mixing with authentic deuterated *anti* T=T CPDs and analysis by LC-MS/MS mass spectrometry. The integration of UVB irradiation, enzymatic degradation and deuterated thymidine CPD standards presents a promising avenue for advancing our understanding of the roles played by G-quadruplexes in cellular biology. This work was funded by NSF Grant 2003688.

In vivo NAMPT in epidermis is essential for UVB irradiation-induced oxidative and genomic stress responses and epidermal homeostasis.

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NAD (nicotinamide adenine dinucleotide) is an essential molecule involved in many biological reactions such as energy production and DNA repair. Genomic stress induced, such as UVB irradiation, causes activation of poly ADP-ribose polymerase (PARP) and a decrease in its substrate, NAD+. Nicotinamide Phosphoribosyltransferase (NAMPT) is the rate-limiting enzyme in the salvage pathway of NAD+ synthesis and is considered essential for the maintenance of NAD+ homeostasis. In vitro, it has been reported that maintenance of NAD + levels by NAMPT is essential for the survival of UVB-exposed epidermal keratinocytes. However, the function of NAMPT in epidermal tissue in vivo is not well understood. In this study, we generated NAMPT flox/flox, Keratin 5-Cre/ERT2 mice (NAMPT cKO mice), in which NAMPT can be deficient by epidermis-specific tamoxifen induction, and investigated the role of NAD metabolism in skin homeostasis, and its relation to epidermal cellular stress during UV irradiation. Tamoxifen treatment induced Nampt deficiency in 8-week-old NAMPT cKO mice, which showed a significant reduction in epidermal NAD levels. These mice also showed spontaneous epidermal necrotic changes, inflammatory responses and reactive epidermal thickening. In this skin, a decrease in PARP activity was observed in association with a decrease in NAD, suggesting that the accumulation of genomic stress is involved in inflammation. Furthermore, moderate UVB irradiation (100mJ/cm^2, one time) of NAMPT cKO worsened the cKO phenotype. These results suggest that NAMPT in epidermis in vivo is essential for epidermal homeostasis, with an important role in the stress response.

Phosphorylation of yeast Elf1 regulates transcription-coupled nucleotide excision repair by promoting binding of TFIIH to Elf1 C-terminal domain

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Transcription coupled nucleotide excision repair (TC-NER) pathway removes ultraviolet (UV) radiation induced DNA lesions, including cyclobutane pyrimidine dimers (CPDs) that stall RNA polymerase II (RNAPII). Human ELOF1 and its yeast homolog Elf1 have recently been identified as regulators of TC-NER. Human ELOF1 plays an important role in recruiting UVSSA, which is required for TFIIH recruitment, by promoting RNA polymerase II ubiquitination. Since yeast lacks a UVSSA homolog, the function of Elf1 in TC-NER and mechanism of recruitment of TFIIH is not clear. Our initial studies using the single nucleotide-resolution CPD sequencing (CPD-seq) and *in vitro* pulldown assay indicate that the unique C-terminal domain (CTD) of yeast Elf1 plays an important role in TC-NER by recruiting TFIIH, suggesting the Elf1 CTD is a functional homolog of human UVSSA. However, as Elf1 is an elongation factor constitutively associated with RNAPII during transcription, the question remains of how the Elf1 CTD is prevented from recruiting TFIIH and initiating repair in the absence of DNA damage. Here, we show that phosphorylation of serine 117 (S117) in Elf1 CTD by casein kinase II regulates TC-NER. Additionally, we reveal that phosphorylation of S117 promotes the binding of Elf1 CTD to TFIIH. In conclusion, our results suggest that phosphorylation of the Elf1 CTD is important for it to bind and recruit TFIIH and promote TC-NER.

6-Azauridine Derivatives as Phototheranostic and Photodynamic Therapeutic Agents for Cancer Treatment

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6-Azauridine is a nucleoside analog of uridine that exhibits antineoplastic and antipsoriatic properties. Unlike uridine, 6-azauridine's near-unity triplet-state population makes this nucleoside a promising candidate for developing photosensitizers for photodynamic therapy. In this contribution, we present results for two 6-azauridine derivatives. The first one, 5-(5-phenylthiophen-2-yl)-6-azauridine (PTAU), absorbs near-visible radiation and exhibits a fluorescence quantum yield of 43 ± 1%, a singlet oxygen quantum yield (Φ_Δ) of 52 ± 2%, and a triplet decay lifetime (τ_T) of 2.4 ± 0.25 µs in MeCN. Upon application to murine melanoma cells, PTAU primarily localizes in mitochondria, while a small fraction localizes in the nucleus. In addition, PTAU exhibits no dark toxicity and great photodynamic therapy efficacy, with IC_{50} of 125 ± 5 µM after a small dosage of 5 J cm^{-2} of 370 nm light. Surprisingly, PTAU also inhibits cell proliferation in the dark on two tested skin cancer cell lines. Hence, PTAU can act as both a phototheranostic agent and an inhibitor of skin cancer cell proliferation. The second 6-azauridine derivative, 5-(5-(4-(dimethylamino)phenyl) thiophen-2-yl)-2',3',5'-tri-o-benzoyl-6-aza-2,4-dithiouridine, (DATU), is a thionated analog that absorbs up to ca. 650 nm. DATU exhibits τ_T of 1.7 ± 0.15 µs and Φ_Δ of 61 ± 4%. Upon application to breast cancer cell lines, DATU demonstrated an IC_{50} of 62 ± 3 µM in the dark and 4.8 ± 1 µM upon irradiation at 525 nm. Therefore, DATU holds potential as a visible light activable photodynamic therapeutic agent for deeper tissue cancer treatment.

Comparative analysis of a solid lipid nanoparticle formulation and a liposomal formulation of a verteporfin lipid conjugate

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Light-activatable nanosized drug delivery systems, known as photonanomedicines, facilitate photodynamic therapy (PDT). In this study, we developed a solid lipid nanoparticle (LNP) formulation of lipidated benzoporphyrin derivative (BPD-PC) and compared it with a previously established liposomal formulation of BPD-PC (Lipo BPD-PC). We demonstrated that the novel LNP BPD-PC formulation exhibits improved stability and enhanced induction of immunogenic cell death. Our results demonstrated that Lipo BPD-PC generated 1.17-fold more singlet oxygen than LNP BPD-PC, while LNP BPD-PC generated 1.76-fold more hydroxyl radicals and/or peroxynitrite anions. Within 7 days of incubation in serum at 37 °C, 28% of BPD-PC leaked out of the LNP BPD-PC formulation, while 100% of BPD-PC leaked out of the Lipo BPD-PC formulation. There was no significant difference in cellular uptake of BPD-PC over 24 h when treated with LNP BPD-PC or Lipo BPD-PC. LNP BPD-PC and Lipo BPD-PC demonstrated similar phototoxicity in CT1BA5 (murine pancreatic cancer cells) when activated using 690 nm light. With an IC_{25} PDT dose, LNP BPD-PC induced immunogenic cell death, while Lipo BPD-PC did not. *In vivo* results revealed that the tumor delivery of BPD-PC was 2.41-fold higher with Lipo BPD-PC than with LNP BPD-PC in mice bearing CT1BA5 tumors. Overall, these findings suggests that LNP BPD-PC is a more stable nanoplatform than Lipo BPD-PC for carrying verteporfin lipid conjugates such as BPD-PC, and this is of particular interest for future photodynamic immune priming studies.

Inhibitory role of Frizzled 1 in melanoma development and progression

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Melanoma is a highly aggressive cancer of melanin-producing melanocytes, and exposure to solar ultraviolet (UV) radiation is the major contributing factor. Despite recent groundbreaking progress in melanoma therapeutics, including BRAF and MEK inhibitors and monoclonal antibodies against immune checkpoints, the prognosis remains very poor in almost half of the patients due to the development of drug resistance, the rapid distant metastasis, and a variety of autoimmune side effects. A broader understanding of the biology of melanoma is needed for developing novel and effective treatments. The mammalian Frizzled gene family comprises ten 7-transmembrane G-protein coupled receptors (GPCRs) mediating canonical and non-canonical Wnt signaling. They are widely involved in multiple biological processes during normal development and disease, including cancer. Earlier, we showed a pro-metastasis role of Fzd6 in melanoma. Here,

we focus on Fzd1, a homolog of Fzd6, in melanoma. We found that Fzd1 is highly expressed in multiple melanoma cell lines. To determine the role of Fzd1 in melanoma, we knocked down Fzd1 using siRNA in multiple melanoma cell lines. In contrast to the reported pro-cancer role of Fzd1 in other cancers, we found that Fzd1 knockdown in A375 and SK-MEL28 melanoma cells significantly increases cell proliferation and cell invasion *in vitro*, suggesting an unexpected anti-cancer role of Fzd1 in melanoma. To determine whether Fzd1 plays a similar role in melanoma *in vivo*, we are generating Fzd1 knockout YUMM1.7 cell lines for future xenograft experiments. To determine the potential mechanism of Fzd1 in melanoma growth and invasion, we examined the expression levels of several canonical Wnt signaling pathway genes, EMT, and MMP genes in A375 cells and identified many significant changes upon Fzd1 knockdown. We will validate these changes in several other human melanoma cell lines and in the *in vivo* mouse xenograft models. Furthermore, genetic rescue experiments will be performed using gain- and loss-of-function approaches to determine the involvement of these downstream targets in the Fzd1-induced anti-melanoma phenotype. Our work suggests that Fzd1 plays an inhibitory role in melanoma and highlights the distinct roles of Frizzled family receptors in melanoma development and progression.

Pharmacological activation of autophagy restores cellular homeostasis in ultraviolet-(B) -induced skin photodamage

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Excessive exposure to ultraviolet (UV) radiation negatively affects the human skin, characterized by photo-damage (premature ageing) and acts as the primary etiological agent in photo carcinogenesis. Direct or indirect UV exposure to skin causes genotoxic stress and is the major factor challenging the skin homeostasis. Autophagy signaling allows the fundamental adaptation of cells to metabolic and oxidative stress responses. Cellular dysfunction has been observed in aged tissues and in toxic insults to cells undergoing stress. Conversely, promising anti-ageing strategies aimed at activating the autophagy signaling pathway have been found to significantly improve the ageing-related disorders. Autophagy signaling have also been found to positively enhance the DNA damage recognition in UV-induced genotoxic stress to skin cells. In current study, we investigated the geno-protective roles of autophagy in UV-B exposed primary Human Dermal Fibroblasts (HDFs) and elucidated the underlying molecular mechanisms. We found UV-B exposure to HDFs impairs the autophagy signaling response that led to enhanced DNA damage due to increase in oxidative and endoplasmic reticulum (ER) stress responses, whereas pharmacological activation of autophagy restores the cellular homeostasis in UV-B exposed HDFs by alleviating the oxidative and ER stress mediated DNA photo adduct formation. P62 knockdown in HDFs which is one of the core components of autophagy signaling enhance the DNA damage and disturbs the PTEN/p-AKT tumor suppressor signaling axis. These results suggest that interventional autophagy offers significant photo-protection against the UV-B -induced photo-damage and holds a great promise in targeting autophagy signaling as a suitable therapeutic strategy against the skin photo-damage disorders.

In silico evaluation of the effect of skin type on light dosimetry for photodynamic therapy

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Photodynamic therapy (PDT) is a photochemical technique that uses photosensitizers to destroy abnormal cells and can be used to treat skin diseases. The success of this therapy depends on the light delivery to the target area in the skin. The way light propagates in the skin tissue is varied with its optical properties. This variation in light distribution affects the irradiation dose to the tumor tissue and surrounding tissues, which is a factor that determines the efficacy and safety of PDT. In dark skin types such as Asian skin, there is a greater risk of epidermal damage due to optical absorption by higher melanin content than light skin types. Therefore, the effect of skin type on setting irradiation parameters needs to be considered. This study presents an *in silico* evaluation of the effect of skin type on light dosimetry for PDT by comparing optical penetration depth and energy deposition between skin types. A numerical model of the skin, comprising the epidermis, dermis, subcutaneous fat, blood vessels and tumor tissue, was constructed based on experimentally measured optical properties of human skin. A Monte Carlo light transport simulation was used to calculate light distribution in the skin tissue. The results show that the optical penetration depth was similar between skin types, while the difference in energy deposition in the epidermis was significant. These numerical results considering skin type will help develop evaluation methods for irradiation parameters in PDT for Asian skin.

Studies of Ocular Effects of Far-UV-C Wavelengths on the Human Cornea

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Photokeratitis and photoconjunctivitis have been studied in animal models by several investigators over the past 80 years, but only one study used human volunteers, and this was performed over four decades ago. A very recent effort to study effects on the cornea from "Far UV-C" (~200 nm to 240 nm) radiation has revealed some very interesting effects that may indicate a different photochemical interaction mechanism than at longer UV-C or UV-B wavelengths. These studies have a potential impact on revision of human exposure guidelines for ultraviolet radiation, which could increase applying UV-C germicidal applications. We studied the exposure from a 222-nm filtered KrCl excimer lamp at radiant exposure (doses) up to 100 mJ/cm^2 and did not produce any indications of photokeratitis in the human cornea. However, a curious effect not experienced at 254 nm occurred at 222-nm irradiances above ~10 μW/cm^2. These higher irradiances (unlikely to be encountered in occupied areas) produced a mild foreign-body sensation that did not adversely affect visual acuity at threshold and recovered within 15 minutes. The tears, produced by the lacrimal and meibomian glands form a dynamic film that covers the cornea and conjunctival surfaces. Blinking of the lids circulates the tears maintaining the tear layer. The thin (only 3-4 nm) phospholipid layer covers a much thicker aqueous layer and slows evaporation. Based upon these studies, one possible mechanism would be that incident, higher-energy (~ 5.6 eV), 222-nm photons may photochemically induce changes in the tear film

by photodecomposition, a process that fractures long-chain polymers like the tear-surface phospholipids allowing the underlying aqueous layer to more readily evaporate.

Concepts and technology development towards image-guided, multiplexed photoimmunotherapy

Bryan Spring

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This talk will introduce concepts of targeted photodynamic therapy with microscale fidelity using clinical antibody–photosensitizer (benzoporphyrin derivative monoacid A, verteporfin) conjugates. These initially quenched ("off") photoimmunoconjugates target tumor cell-surface biomarkers and become activated upon cell-internalization ("on"). Present efforts to further develop these concepts for precision treatment of heterogenous human ovarian cancer will be discussed.

Developing Ir(III) Bis(terpyridine) Complexes for in vitro Photodynamic Therapy of Melanoma Cells

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The bis(terpyridine) (tpy) coordinated Ir(III) complexes ($Ir(R\text{-}tpy)_2^{3+}$) have the advantages of high geometric symmetry and improved solubility in water compared to the well studied tris(bidentate) Ir(III) complexes. Depending on the substituents on the tpy ligand(s), these complexes could exhibit red-shifted absorption and long-lived triplet excited states, both of which are desirable features for photosensitizers for photodynamic therapy (PDT) applications. However, utilization of the $Ir(R\text{-}tpy)_2^{3+}$) complexes for PDT has been quite limited due to the harsh reaction conditions for synthesizing the complexes with absorption in the desired NIR regions. Our group has synthesized several series of mononuclear and dinuclear Ir(III) complexes bearing $Ir(R\text{-}tpy)_2$ units for PDT applications. The singlet and triplet excited-state properties of these complexes were systematically investigated via UV-vis absorption, emission, and transient absorption spectroscopy. When introducing -donating substituent to the terpyridine ligands or tethering the terpyridine ligands by dipyrrolopyrrole (DPP), the absorption spectra of the complexes were red-shifted to the NIR region, accompanied by long-lived triplet excited state. The in vitro PDT effects of these complexes toward a human skin melanoma cell line SKMEL28 were investigated. It was discovered that the longer the triplet lifeitme, the higher the singlet oxygen generation, and the stronger the PDT effects.

Nanopore sequencing of DNA photoproducts

John-Stephen Taylor

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There various methods for mapping DNA photoproducts in genomic DNA utilizing Next Gen sequencing which has revealed much information about site-specific photoproduct frequency and repair in vivo. These methods, however, rely on a series of sequential enzymatic steps that could introduce bias into the results and may not be suitable for telomeric DNA due to its repetitive sequence and single strand structure, or for photoproducts lacking a cognate enzyme or antibody. It would be therefore highly desirable if DNA photoproducts could be sequenced directly at the single molecule level which might also reveal the presence of compound lesions and unusual photoproducts. Ideal for this purpose would be nanopore sequencing which has been shown to be able to identify modified bases in single molecules of DNA. Herein we report on the direct sequencing of CPDs and (6-4) photoproducts in DNA fragments by nanopore sequencing. DNA sequences containing a single site-specific DNA photoproduct were constructed by template-directed ligation of 6-mer ODNs containing a single dipyrimidine photoproduct obtained by HPLC purification of an irradiated 6-mer containing a single dipyrimidine site. Ligation was carried out in the presence of barcoding ODNs and then ligated to the sequencing adapters. Nanopore sequencing was carried out on an Oxford Nanopore Minion device for a few hours. The raw data files were translated into sequences and binned according to the barcodes. The sequences were blasted against the native sequence, and the raw data files (squiggles) corresponding to sequence reads that appeared anomalous were then subjected to further examination revealing a substantial drop in current at the site of the DNA photoproduct. Other studies are currently underway to determine whether photoproducts can be directly detected by nanopore sequencing of globally irradiated DNA.

Type I photosensitized oxidations in proteins and the oxygen paradox

Andrés Thomas

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In type I mechanisms, an electron transfer (or hydrogen abstraction) from the substrate to the sensitizer in an excited state, typically a triplet excited state, takes place. Then, the corresponding formed radicals are involved in a complex set of competitive pathways to finally yield oxidized stable photoproducts [1]. Based on studies performed in model systems with pterins as photosensitizers, this talk explores the mechanisms involved in the type I photooxidations of proteins [2]. In particular, in type I reactions molecular oxygen (O_2) is not involved in the first bimolecular event, but almost always participates in subsequent steps giving rise to oxygenated products. An exception to this general behavior is the photosensitized dimerization of tyrosine (Tyr) and other substrates, where O_2 does not participate as a reactant in any step of the pathway yielding Tyr dimers (Tyr_2). However, in the pterin-photosensitized oxidation of Tyr, O_2 is necessary for the dimerization, phenomenon that we have named as the oxygen paradox. Pterins are able to photosensitize the formation of Tyr_2 in proteins [3], which leads to products of higher molecular weight and affects their solubility and elastic properties. Here, we propose a mechanistic model to explain the contradictory role of O_2 in this photochemical reaction system [4].

[1] M. S. Baptista *et al., Photochem. Photobiol.* **97**, 1456 (2021).

[2] C. Lorente *et al., J. Photochem. Photobiol.* **7**,100045 (2021).

[3] L. O. Reid *et al., Biochemistry* **55**, 4777 (2016).

[4] M. L. Dántola *et al., Photochem. Photobiol.* **98**, 687 (2022).

Functionalization of polyallylamine with 6-carboxypterin: A promising and novel biocompatible polymer with photosensitizing properties

Andrés Thomas

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Carboxypterin (Cap) is a photosensitizer under ultraviolet radiation. Cap can participate in photosensitization reactions including type I and type II photooxidation mechanisms.[1] These reactions can be used for the development of biomedical applications or for the treatment of environmental pollutants by photoxidation through the generation of reactive oxygen species (ROS) or radical species. To increase the stability of photosensitizer and the availability of ROS, the design of supramolecular structures that allow modulation of their photochemical properties is proposed.[1] Within this context, cationic synthetic polyelectrolytes such as polyallylamine hydrochloride (PAH) were covalently modified to attach Cap units to the polymeric structure. The aim of this research is to study the photophysical and photosensitizing properties of PAH functionalized with Cap and the photosensitization properties over biological molecules such as 2´deoxyguanosine (dG).[2] The polymeric photosensitizer (PAH-Cap) was obtained with an overall reaction yield of 67%, featuring a Cap substitution degree of 1% and advantageous spectroscopic properties compared to free Cap. Photosensitizing properties of PAH-Cap on dG were observed to occur via both type I and II at physiological pH. PAH-Cap can generate singlet molecular oxygen and initiate an electron transfer reaction at pH 7 in air-saturated solution upon UVA irradiation. Moreover, PAH-Cap can be employed in supramolecular assemblies and its potential application in photodynamic therapy (PDT) and disinfection technologies.

References

[1] Serrano, M. P., *et al. RSC Adv.* **9**, 19226–19235 (2019).

[2] Petroselli, G., *et al. J. Am. Chem. Soc.* **130**, 3001–3011 (2008).

Optical Control of Cell-Surface and Endomembrane-Exclusive β-Adrenergic Receptor Signaling

Waruna Thotamune

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Beta (β)-adrenergic G-protein-coupled receptors (GPCRs) are primarily responsible for signaling in the sympathetic nervous system and control numerous body functions, including increased heart rate, pupil dilation, glycogen metabolism, and adrenaline secretion. Dysregulation of bAR pathways underlies severe pathological conditions. Emerging evidence indicates pathological molecular signatures in deeper endomembrane bARs signaling, likely contributing to conditions such as cardiomyocyte hypertrophy and apoptosis. Using its ligand, isoproterenol, bound β1-AR structure (PDB ID: 7JJO), we synthesized a blue light (405 nm) sensitive, novel inactive isoproterenol derivative (OptoIso) with optically deprotectable groups. The goal was to control β1-AR signaling using light. Our results show that OptoIso efficiently activates β1AR signaling, as indicated by the miniGs protein and nanobody80 (Nb-80) recruitment to the activated receptor, Gβγ translocation, and cAMP production only upon exposure of cells to a few pulses of blue light. Due to its enhanced cell permeability, OptoIso efficiently entered cells, and blue light exposure after washing cells induced endomembrane-exclusive β1-AR activation at user-defined subcellular endomembrane regions. Given the disease relevance of β1-AR in general, and deep-organelle β1-AR in particular, OptoIso will be a valuable experimental tool to elicit spatial and temporal control of bAR signaling in user-defined endomembrane or plasma membrane regions in unmodified cells with native fidelity.

Identification of biomarkers for photoimmunotherapy of patient-derived primary ovarian cancer cell models

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High-grade serous ovarian cancer (HGSOC) is the most aggressive subtype of ovarian cancer that is usually diagnosed at an advanced stage. The standard treatment strategy for advanced ovarian cancer consists of tumor debulking surgery followed by adjuvant chemotherapy using platinum and taxane agents. Although the majority of advanced-stage ovarian cancers are sensitive to first-line chemotherapy, the development of resistance is frequent, leading to gross recurrence. The residual disease cannot be detected in more than half of the patients using currently available diagnostic regimens in the clinic, and the recurrence is generally asymptomatic at first. The relapsed disease is often refractory to the standard treatments. Hence, there is a need to develop novel theranostic strategies to potentiate the treatment of recurrent ovarian tumors. Tumor-targeted, activatable photoimmunotherapy (taPIT) – a form of targeted photodynamic therapy (PDT) – is a novel therapeutic modality that uses photoimmunoconjugates (PICs) directed against cell surface proteins overexpressed by cancer cells to selectively deplete the tumor cells while minimizing toxicity to surrounding healthy tissues. In addition to therapeutic application, PICs can be used for activatable fluorescence imaging of tumor cells. Photodynamic agents are effective against chemo-resistant tumor cells, and they can also re-sensitize chemo-resistant cells to chemotherapy. The current form of taPIT uses EGFR-targeted PIC, however, EGFR is not overexpressed by all ovarian cancers. Here, using mRNA sequencing, plasma membrane proteomics and flow cytometry, we have identified potential cell surface targets for photoimmunotherapy of patient-derived primary HGSOC cell models that have extremely low expression of EGFR.

Mechanisms of Light Signaling and Allosteric Regulation in Dual-sensor Photoreceptor PPHK

Irin Pottanani Tom

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PPHK (phosphorylation-responsive photosensitive histidine kinase) from cyanobacterium *Leptolyngbya*sp. JSC-1 is a dual sensor histidine kinase that operates a molecular logic OR in response to an upstream phosphorylation signal and a red-light signal. As a photoreceptor, PPHK belongs to the phytochrome superfamily, and performs light signaling via reversible photoconversion between the green light-absorbing (Pg) and the red light-absorbing (Pr) states. Full-length PPHK adopts a modular architecture with a dimeric scaffold, which is typical for sensory histidine kinases. Therefore, PPHK offers an excellent model system for structural and mechanistic dissection of the allosteric action and signal integration in modular signaling proteins including transmembrane chemoreceptors and mechanoreceptors. I will present our latest structural studies on full-length PPHK using cryo-electron microscopy. Specifically, we have determined the cryoEM structures of PPHK in different light signaling states at (near)-atomic resolution. These results have shed light on the long-sought-after structural basis of allosteric activation in modular photoreceptors and other signaling proteins.

ESP Presidential Lecture

Photosynthetic Odyssey: A Quest for Sustainable Solutions

Massimo Trotta

Massimo Trotta

Istituto per i Processi Chimico Fisici – Consiglio Nazionale delle Ricerche and Dipartimento di Chimica – Università di Bari

The universe is a pretty big place. If it's just us, it seems like an awful waste of space. And if we are not alone, what would be the common trait among inhabited planets? Most likely, it would be the natural energy sources available, such as the energy generated by thermonuclear reactions occurring in stars, and consequently, the natural energy conversion systems they possess. On our planet, photosynthetic organisms are the primary energy converters that sustain life on Earth for at least three billion years. The chances that this paramount process is general across the universe are very high.

How invaluable and universally relevant would it be to unlock and leverage the capabilities of photosynthetic organisms to set forth a positive and virtuous path? In this presentation, we will embark on a brief journey exploring the profound impacts that technologies based on photosynthesis, including artificial and semi-artificial methods, have already brought or are poised to bring to our planet. Given our urgent need for sustainable and circular processes, these advancements hold great promise for future development.

Photoactive Soft Materials based on Photosynthetic Enzymes

Massimo Trotta

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The complexity of the natural photosynthetic systems is difficult to reproduce *in vitro*; however, complexity is inherently associated to the efficiency of the living multienzyme character of photosynthesis, and any biomimetic attempts must cope with this stringent requirement. In this regard, we have designed and assembled efficient organic-biological hybrid systems formed by small to medium size organics molecules responsible of a given specific role and the photoenzyme responsible for energy transduction in photosynthetic organisms. Applications of photoresponsive enzymes as soft photoconverting material in different environment will be presented to show drawbacks, limitations, and potentials of such hybrid systems, along with some future interesting developments.

1. *Supramolecular Biohybrid Construct for Photoconversion Based on a Bacterial Reaction Center Covalently Bound to Cytochrome c by an Organic Light Harvesting Bridge Bioconjugate Chem.* 2023, 34, 4, 629–637.
2. *Enhancing light harvesting capability of the photosynthetic reaction centre by a tailored molecular fluorophore.* 2012 ***Angewandte Chemie Int. Ed***. 51, 11019.
3. *Synthetic Antenna Functioning As Light Harvester in the Whole Visible Region for Enhanced Hybrid Photosynthetic Reaction Centers* 2016 ***Bioconj. Chemistry 27***, 1614.
4. *Highly oriented photosynthetic reaction centers generate a proton gradient in synthetic protocells* 2017 **PNAS** 114, 3837.
5. *Functional Enzymes in Nonaqueous Environment: the Case of Photosynthetic reaction centers in Deep Eutectic Solvents*, 2017 **ACS Sustainable Chem. Eng.**, 5, 7768.

Subcellular optogenetic inhibition of PLCβ-GαqGTP interaction sheds light on the molecular regulation of Gαq-governed directional cell migration

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Though light-sensitive G protein-coupled receptors (GPCRs), such as opsins, can activate some of the G protein signaling pathways with subcellular spatial control, the lack of approaches to control signaling of selected heterotrimeric G proteins downstream of GPCRs with a user-defined spatial and temporal control has been a limitation in understanding how such signaling regulates cell physiology and behavior. Gαq-family G proteins primarily activate phospholipase C β (PLC β) and hydrolyze inner membrane phosphatidylinositol 4, 5-bisphosphate (PIP2), generating inositol 1, 4, 5-triphosphate (IP3) and diacylglycerol (DAG), which mobilizes $Ca2^{+}$ and activates protein kinase C (PKC), respectively. PKC and $Ca2^{+}$ control various physiological functions, including cytoskeletal remodeling, muscle contraction, opioid-induced pain sensitivity, membrane dynamics, cell proliferation, and survival. Therefore, PLC β signaling involves many diseases, such as impaired platelet activation, heart diseases, cancers, and diabetes. However, the molecular basis of intricate PIP2 hydrolysis regulation is poorly understood. Since activated PLCβ induces several abrupt cellular changes, including cell morphology, examining how the other pathways downstream of Gq-GPCRs contribute to the overall signaling has also been difficult. Employing the minimum essential domain of the Gαq-interacting helix-turn-helix (HTH) of PLC β as the template, we have engineered a series of optogenetic inhibitors to disrupt Gαq-PLC β signaling with varying efficacies and near-zero noise. Using subcellular spatial and millisecond temporal control of Gαq- PLC β signaling, we have gained insights into Gαq-pathway-governed directional cell migration.

The effect of UV-induced mutations on the binding of ETS transcription factors to the *Cdkn2a/p16* promoter

Takuma Uo

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Skin cancer is strongly associated with ultraviolet (UV) radiation that generates many mutations. There is thus a need to investigate what mutations drive skin cancer. Silencing of the *CDKN2A* gene, which encodes the p16 tumor suppressor protein, plays a key role in cancer progression. Our previous mouse study showed that chronic UV irradiation to skin induced mutations at the *Cdkn2a/p16* promoter. However, the impact of these promoter mutations on cancer progression remained unclear. We hypothesized that these mutations may inhibit the binding of critical transcription factors, thereby reducing the expression of the p16 tumor suppressor. The mutations at the *Cdkn2a/p16* promoter were found in the DNA sequence that was similar to the ETS transcription factor-binding element (EBE). To determine the functionality of this element (p16-EBE), we cloned this putative EBE into the reporter construct in which the binding of transcription factors to p16-EBE drives luciferase expression. ETS1 and ETS2 represent the ETS transcription factor family, with the latter expressed dominantly in skin. We found that overexpression of either mouse ETS1 or ETS2 resulted in higher luciferase activities than no overexpression control, indicating that ETS proteins bind to p16-EBE. We also tested mutated p16-EBE that carries the UV-induced mutation. With overexpression of mouse ETS1 or ETS2, the mutated p16-EBE showed markedly lower luciferase activities than wild-type counterpart, implying that the UV-induced mutation in p16-EBE inhibits the binding of ETS proteins to the *Cdkn2a/p16* promoter. This study highlights the importance of loss-of-function mutations in promoters that may contribute to cancer progression.

Keynote Lecture

Watching DNA repair at the single molecule level in chromatin: seeing is believing.

Bennett Van Houten

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We use a chemopotogenetic approach to create DNA damage and interrogate recruitment of DNA repair proteins to sites of damage. After briefly describing a novel method for placing 8-oxoG lesions in telomeres, work detailing the cooperation between nucleotide excision and base excision repair proteins in the removal of 8-oxoG will be presented. Poly[ADP-ribose] polymerase 1 (PARP1/ARDT1) acts as a damage sensor for multiple types of DNA lesions and is an important target for cancer chemotherapy. To better understand how PARP1 senses DNA damage, we utilized a new single-molecule approach that uses YFP- or Halo-tagged PARP1 in human cell nuclear extract. PARP1 binding kinetics to single-strand breaks was measured on long DNA substrates tethered to beads immobilized in optical traps. Real-time measurements provided on and off rates yielding an equilibrium dissociation constant, K_D, of 0.9 nM for PARP1 binding to nicks. In contrast, catalytically-dead PARP1 exhibited a 25-fold increase in lifetime and a K_D of 0.4 nM. The PARP1 inhibitors Olaparib and EB-47 had contrasting effects on PARP1 binding lifetimes; the former had no impact on binding lifetimes, whereas EB-47 increased lifetimes ~21-fold, in support of a reverse-allostery mechanism. ZNF1 & ZNF2 are sufficient for nick recognition, and F44 in ZNF1 helps facilitate nick recognition. PARP1 bound to non-damaged nucleosomes embedded in long DNA substrates without ends, with a K_D 12.8 nM, and to single-strand breaks embedded in the nucleosome some 3-10 fold tighter depending on the nick position and DNA tension. Real-time analysis of PARylation will also be presented.

Applications of Photoprotective Agents in Clinical Dermatology

Katie Varman

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Photoprotective agents such as polyphenols, carotenoids, and plant extracts are underutilized in the field of dermatology. Dermatologists readily recommend sunscreen and photoprotective clothing but are largely unaware of the significant protective effects of natural agents and even dietary interventions. Photoprotective agents can be used synergistically to intervene at multiple points in the photo-carcinogenesis pathway. Points of interception include acting as chromophores and antioxidants. They can also dampen inflammatory and anti-apoptotic pathways such as EFGR, NFkB, and Wnt/β-catenin, reduce local UV-induced immunosuppression, and preserve energy production to enable successful genetic repair. In this manner, photoprotection extends far beyond sunscreens and sun avoidance. Examples of agents with in vivo evidence of photoprotection include polyphenols such as isoflavones, carotenoids such as lycopene, long-chain omega-3 fatty acids, niacinamide and plant extracts such as from polypodium leucotomos and maritime pine bark. These compounds can be used for high-risk skin cancer patients to mitigate the risk of ongoing photo-carcinogenesis, and they can be used to support tolerance of UV phototherapy and improve UV phototherapy outcomes. Lastly, moderate sun exposure has many health benefits such as reduction in cardiovascular disease, autoimmune and inflammatory disease and even dangerous cancer like breast and colorectal cancer. Another application of these photoprotective agents is for low-risk people who wish to reduce skin photo-damage but still gain the benefit of moderate sun exposure for overall health and wellness. This lecture will review a variety of photoprotective compounds and give examples of their clinical applications.

The N^6-methyladenosine RNA methylation-binding protein YTHDC2 regulates the repair of UVB-induced DNA damage and histone modification

Michelle Verghese

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Exposure to ultraviolet B (UVB) radiation produces DNA lesions such as cyclobutane

pyrimidine dimers (CPDs), which can be repaired by a process called nucleotide excision repair (NER). If critical repair mechanisms are dysregulated, UVB-induced DNA damage can persist and contribute to the development of skin cancer. However, the molecular mechanisms underlying UVB-induced DNA damage and repair remain incompletely understood. Recent advances have shown that m^{6}A RNA methylation and its regulatory enzymes can serve to promote or prevent UVB-induced damage, thus implicating m^{6}A as an important mediator of skin carcinogenesis. YTHDC2 is an m^{6}A reader protein with unknown roles in UVB damage or skin cancer. Here, we discovered that YTHDC2 knockdown could enhance CPD repair, suggesting that YTHDC2 promotes UVB-induced damage. Interestingly, YTHDC2 knockdown did not affect protein expression of canonical NER regulators. Mechanistic studies revealed that knockdown of YTHDC2 could modulate histone modifications, including PRC2 component SUZ12 and histone modification H3K27me3. We also explored other m^{6}A regulators and found that knockdown of the m^{6}A eraser FTO mimicked the effect of YTHDC2 knockdown, suggesting a role for FTO and m^{6}A in the underlying mechanism. Finally, we found that YTHDC2 expression was increased in human cutaneous squamous cell carcinomas (cSCC). Taken together, our results suggest that YTHDC2 regulates UVB damage repair and epigenetics and may function as a tumor-promoting factor in cSCC. Future work should further explore the mechanism of YTHDC2 in DNA damage repair and elucidate its function in epigenetic regulation.

ABC efflux transporter-mediated translocation of photosensitizers

Shruti Vig

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Resistance to cancer treatment due to multidrug resistance mediated by ATP-binding cassette (ABC) transmembrane transporters is a significant hurdle in clinical oncology. These transporters utilize ATP hydrolysis to expel anticancer agents and pro-tumorigenic molecules from cells, compromising treatment efficacy. Photodynamic therapy (PDT) has emerged as a promising approach against chemotherapy and radiation-resistant tumors, leveraging factors such as photosensitizer (PS) accumulation, subcellular localization, light exposure, and generation of reactive molecular species to induce cytotoxicity. However, ABC transporters can also expel many PSs, driving research into agents less susceptible to transporter-mediated efflux. Previous studies have demonstrated that ABC transporter expression impedes intracellular retention of various PSs like protoporphyrin IX and pheophorbide-a. This study aims to evaluate the substrate status of a panel of clinically used photosensitizers using cancer cell lines overexpressing ABCG2, P-gp, and MRP1 transporters, quantifying intracellular PS accumulation through extraction and flow cytometry. The presentation will discuss the involvement of ABC transporters in cellular resistance to clinically approved PSs, underscoring the imperative for further investigation to devise more effective treatment modalities.

Synergetic effect of chlorophyllin (Chi) and curcumin (Cur) in aPDT of A. niger spores.

Cristian Villa

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A. niger is one of the most common causes of food spoilage around the world, leading to heavy economical losses. Several treatments have been developed in order to reduce fungal contamination, such as high pressure and thermal treatments; however, there is an increasing need for less invasive procedures such as aPDI. In this work, we evaluated the effect of the combination of two natural photosensitizers, curcumin (Cur) and chlorophyllin (Chi) on the aPDI of *A. niger* spores, using blue LED light (450 nm). Results showed that while separated each photosensitizer, reached up to 60% of fungal inhibition, the combination of both molecules lead to inhibition values up to 90%. Fluorescence and electronic microscopy studies revealed that by using both molecules, membrane damages on the *A. niger* spores increased considerably.

Development of chlorophyllin – gold nanoparticles (Chi-Au Nps) systems for dual photothermal and photoinactivation of bacteria.

Cristian Villa

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Over the last decade, development of dual treatments of infections based on antimicrobial photodynamic therapy (aPDT) and photothermal therapy (PTT) has generated great interest, as they can be an alternative to common antibiotic-based treatments. Most of the times, photosensitizers, such as chlorophyllin (Chi) can only be used in aPDT treatments, while nanomaterials such as gold nanoparticles (Au Nps) are commonly used only for PTT. In this work a chi – Au Nps system was developed and used for aPDT (LED = 440 nm) and PTT (Laser = 940 nm) against *S. Aureus* and *E. Coli*. Results showed that combined therapies could lead to significant reduction of bacteria, especially when visible light is a applied firstly than NIR radiation.

Regulation of microalgae metabolism using nanocarrier and light inducible systems

Flavia Vischi Winck

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The current critical challenges such as energy crises and climate changes impose the need for more sustainable, environmentally friendly applications. Microalgae biotechnology and the generation of microalgae high value bioproducts may be soon playing a pivotal role. Recently, the controlled gene silencing using functionalized nanoparticles carrying DNA antisense oligonucleotides enable remote control of gene expression by degrading DNA/RNA complexes through RNAse H1 in microalgae. Furthermore, the Light Emitted Diodes (LED) can be applied to the control of gene silencing. Therefore, we applied gene silencing technology using gold

nanoparticles as carrier system of antisense DNA to the investigation of the functional role of the N-acetylglutamate synthase/acetylglutamate kinase (NAGS) enzyme, previously suggested to be involved in lipid synthesis regulation. Gold nanoparticles functionalized with oligonucleotides demonstrated no toxicity in microalgae. The induction of antisense release was performed using green LED light, providing a successful 80% reduction in the target gene expression within 4 hours. Functional biochemical and molecular studies and fluorescence confocal microscopy of silenced cells indicated increased lipid production in *C. reinhardtii* cells without compromising cell viability. Future research aims to extend silencing technology to other genes, deepening our understanding of microalgae cell growth regulation and lipid body formation. The success in NAGS gene silencing aligns with prior findings on the importance of the Arginine metabolism pathway in controlling this metabolic response in microalgae and opens the possibility of biotechnological production of neutral lipids in microalgae without negative impacts on cell growth performance.

Excited state simulations of fluorescent and photoactive proteins for rational design

Alice Walker

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Fluorescent proteins are ubiquitous and powerful tools in chemical biology, imaging and sensing. Despite this, the underlying relationships between the electronic structure of the chromophore, the atomic-level details of the protein structure, and the final fluorescence output remain largely unclear. Computational chemistry can provide atomic and electronic details that connect populations of structures to experimentally observed photophysical effects, allowing for a deeper understanding of the relationship between protein structure and chromophore behavior. In this work, we apply dynamics calculations at various levels of theory, including classical molecular dynamics and combinations of multireference quantum mechanical methods, to investigate the underlying electronic-structure-function relationships of the chromophore to the protein environment. We describe our approach for developing new anion detectors formulated from mNeonGreen and cgreGFP in collaboration with experimental groups and the effect of targeted mutations on the fluorescence quantum yield on FusionRed. These new insights can be used for the development of new fluorescent protein sensors and improved rational design.

Protein-based sensors and tools for studying neuromodulatory systems

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One major challenge in neuroscience is capturing and manipulating neuronal signaling and modulation with high spatiotemporal resolution and across a large brain volume. To address this gap, my research group takes a chemical biology approach to design novel classes of protein-based sensors and tools. For example, we have designed new classes of fluorescence-integrators which generate permanent marks upon detection of specific neuromodulators. These fluorescence-integrators will enable whole-brain mapping of opioids, epinephrine, dopamine, and other neuromodulators with high spatial resolution. We have also designed light- and chemical-activated protein switches for controlling the activity of peptide agonists for G protein-coupled receptors (GPCRs), which will enable the activation of GPCRs in selective neuronal circuits to study their causal-effect on various physiological processes and behaviors. These protein-based sensors and tools will significantly facilitate the study of brain signaling and neuromodulation.

Recent progress in exploring the antimicrobial efficacy and potential health hazards of far-UVC

David Welch

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Far-UVC radiation is a promising antimicrobial technology which is growing in popularity. The main advantage of using far-UVC for inactivation of microbes stems from the opportunity to safely deploy this technology in occupied areas since exposure to these wavelengths is minimally hazardous to human health. Our group at Columbia University has been at the forefront of research into far-UVC for the past decade with studies exploring numerous aspects of this technology. This presentation will highlight studies on both the efficacy and safety of the far-UVC.

Research into far-UVC at Columbia has centered on verification of safety, since the primary benefit of using far-UVC is the prospect of directly irradiating occupied areas. Far-UVC exposure to the skin and eyes is being explored for endpoints related to safety using a variety of in vitro, ex vivo, and in vivo models. Our efficacy studies have tested the inactivation of viruses, bacteria, and fungi on surfaces and aerosolized. These efficacy studies are applicable to situations ranging from preventing the airborne transmission of diseases, to disinfection of cornea transplants, to planetary protection applications within NASA spacecraft assembly facilities. New data from these and other applications will be presented. An additional aspect to be discussed is film dosimetry which has been used for monitoring exposures of occupants to help determine realistic exposure doses within far-UVC installations.

Unveiling an m^{6}A RNA methylation-independent role of METTL14 in response to UV damage

Emma Wilkinson

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In response to UV radiation, DNA damage response pathways are rapidly deployed to prevent mutagenesis. These pathways are highly dynamic and involve changes in both epitranscriptomic and epigenetic regulation.

Here, we report a new role for METTL14 in response to UV damage. Our previous work has demonstrated that METTL14, a subunit of the N6-methyadenosine (m^{6}A) RNA methylation writer complex, is a critical factor in regulating global-genome nucleotide excision repair (GG-NER) of UV-induced DNA damage lesions in an m^{6}A-dependent manner. We now have uncovered a distinct role for METTL14 in response UV exposure in an m^{6}A-independent manner.

Using mass spectrometry, we found that METTL14 binding proteins overwhelmingly include chromatin modifying enzymes and

epigenetic regulators, which suggested a role for METTL14 in epigenetic regulation. We next sought to determine (i) whether METTL14 could bind to DNA, (ii) where METTL14 could bind, and (iii) whether METTL14 binding to DNA is disrupted upon UV exposure. In keratinocytes treated with or without UV radiation, using Cut&Run with antibodies against METTL3, the catalytic subunit of the m^{6}A writer complex, and METTL14, we found that METTL14 binds preferentially to promoter regions in DNA, while METTL3 binds non-specifically. In addition, we found that METTL14 binding to DNA was decreased upon UV exposure. Furthermore, we also found that METTL14 binding sites overlap with both ETS1 binding sites and hot spots for cyclobutene pyrimidine dimers, the major UV-induced DNA damage lesions. Together, our data suggests a new m^{6}A RNA methylation-independent role for METTL14 in response to UV-induced DNA damage.

A Blueprint for the use of far-UVC to improve indoor air quality and prevent future pandemics

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SUMMARY: Blueprint Biosecurity is a 501(c)(3) non-profit that rigorously assesses and evaluates interventions for pandemic prevention, and accelerates the development of the most promising ideas through funding and facilitation. Far-UVC is a promising, novel technology for inactivating airborne pathogens; however there remain significant interrelated uncertainties and challenges across multiple technical fields and disciplines - including photobiology. Blueprint Biosecurity is producing a technically detailed evaluation of far-UVC's potential as a pandemic countermeasure, alongside an actionable roadmap to direct funding and focus towards the most important research priorities. In this presentation, we will outline the further research that we believe needs to be conducted in the field of photobiology in order to evaluate the safety of far-UVC, and how photobiological considerations interact with other aspects of far-UVC technology such as disinfection efficacy, emitter design and photochemistry.

METHODS: To inform our work, we undertook comprehensive literature reviews across multiple fields including disinfection efficacy, photobiological safety, materials interactions, and atmospheric chemistry, and semi-structured interviews with over 100 industry and academic experts to form the knowledge base for our conclusions. The semi-structured interviews include both open-ended questions, as well as specific, targeted questions previously identified from the literature review and other interviews.

Harnessing topical small molecule interventions impacting innate and adaptive responses for pharmacological protection of skin against solar UV damage

Georg Wondrak

Georg T. Wondrak[1,2], Jana Jandova[1,2], Hsiao-Hui (Sherry) Chow[1,2], Shaan Bhullar[2], Chengcheng Hu[1,2], Denise Roe[1,2], Clara Curiel-Lewandrowski[1,2], Sally E. Dickinson[1,2]

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Solar ultraviolet (UV) exposure is a causative factor in skin photodamage, aging and cancer, involving disruption of normal cutaneous immune function. Therefore, our current research focuses on exploring both innate and adaptive immune regulatory pathways for preventive and therapeutic intervention. Building on our published data that demonstrate keratinocytic UV responsiveness of both TLR4 (Toll-Like Receptor-4) sand PD-L1 (Programmed-Death Ligand-1) in mouse and human skin, here we present data that suggest photoimmunopreventive efficacy of topical small molecule intervention targeting UV-induced keratinocytic immune signaling through either innate (TLR4)- or adaptive (PD-L1)-directed pharmacological modulation. NanoString nCounter™ transcriptomic analysis demonstrated that topical TLR4 antagonism (resatorvid) blocks solar UV-induced inflammation in acutely exposed SKH-1 mouse skin, substantiated in epidermis-specific (K14-Cre) TLR4 knockout skin under the same conditions. Using the small molecule PD-L1 antagonist BMS-202, analogous transcriptomic analysis demonstrates that topical keratinocytic PD-L1 inhibition blocks UV-induced inflammatory responses, while reversing UV effects on 'immune response' pathway gene expression. These data suggest that topical pharmacological interventions targeting TLR4 and PD-L1 show promise for skin protection against photodamage. In addition to pharmacological modulation of innate (TLR4) and adaptive (PD-L1) targets, we also tested feasibility of harnessing topical application of the small molecule innate immune mediator hypochlorous acid (HOCl). A topical HOCl formulation displayed photochemopreventive activity, and NanoString nCounter™ transcriptomic analysis substantiates the HOCl-induced suppression of angiogenesis and inflammation. It is hypothesized that simultaneous modulation of cutaneous targets involving both innate and adaptive pathways might provide additive benefit with the potential to enhance immune-directed topical photochemoprevention strategies.

UVA-photosensitization impacts miRNA expression in reconstructed human epidermis

Georg Wondrak

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In human skin, various chromophores may act as endogenous photosensitizers, potentiating photodamage induced by exposure to solar ultraviolet (UV) and visible radiation. A number of endogenous chromophores displaying activity as UV-sensitizers has been identified including protoporphyrin IX, urocanic acid, vitamins [e.g. riboflavin (B_2), B_6-vitamers, pterin-derivatives], melanin precursors, collagen-crosslinks, advanced-glycation and lipid-peroxidation endproducts, tryptophan-derived photoproducts, and glycolytic byproducts, all of which are associated with photon-driven excited state chemistry with formation of reactive oxygen species as key mediators of cutaneous photooxidative stress. MicroRNAs (miRNA) are small non-translated RNAs with important regulatory functions in skin but the role of solar UV exposure in miRNA regulation remains poorly defined. Here we have comprehensively profiled miRNA expression in human reconstructed epidermis exposed to UVA in the absence or presence of the standard endogenous photosensitizer riboflavin. Using the NanoString™ nCounter platform for miRNA-directed transcriptomic analysis (human v3 miRNA; 827 human miRNAs including 25 internal reference controls) we identified a subset of miRNAs exclusively responsive to combination treatment (UVA with riboflavin) but not altered by single agent exposure. Epidermal keratinocytic miRNAs responsive to photosensitization include established regulators of proliferation (e.g. miR-365b-5p), migration/invasion (e.g. miR-873-3p), metastasis (e.g. miR-197-5p), and chronological aging (e.g. miR-137). Extent of miRNA modulation in response to photosensitization surpassed the response elicited by exposure to an equivalent dose of isolated UVA or solar simulated full spectrum UV. Given the established role of miRNAs in skin structure and function these data suggest a heretofore undescribed role of photosensitization in miRNA-control of skin photodamage and photocarcinogenesis.

ASP Presidential Lecture

Illuminating Horizons: The Diverse Future of Photomedicines

Shiyong Wu

Shiyong Wu

Edison Biotechnology and Department of Chemistry and Biochemistry, Ohio University, Athens, OH

In the rapidly evolving landscape of Photomedicines, the future holds a spectrum of diverse and transformative applications. This presentation embarks on a journey through the transformative power of photochemistry and photobiology, with a keen focus on their impact in medicine and technology. We explore into novel photomedicine therapies, from targeted cancer treatments to wound healing, all orchestrated by the photons. Diagnostic breakthroughs using optical imaging and fluorescence probes illuminate our path toward precision medicine. The presentation will also highlight the interdisciplinary nature of Photomedicines, underscoring the importance of collaboration across fields to harness the full potential of light-based medicinal technologies. These diverse applications exemplify the immense potential of Photomedicines to illuminate a future brimming with innovation and possibility.

Photosynthesis: From Natural Marvel to Modern Solutions: Powering a Sustainable Future

Shiyong Wu

Shiyong Wu

Edison Biotechnology and Department of Chemistry and Biochemistry, Ohio University, Athens, OH

Photosynthesis, the natural process by which plants capture sunlight and convert it into energy, is the cornerstone of life. Yet, this ancient phenomenon holds immense potential as a catalyst for innovation. This talk explores how researchers are harnessing photosynthesis to develop cutting-edge technologies with transformative potential for a sustainable future and across diverse market segments. Examining advances in biomimetic energy solutions, photosynthetic biofuel production, and light-activated bioremediation, the presentation delves into their market applications. Highlighting the remarkable potential of bridging nature and technology, the talk outlines the challenges, opportunities, and the path towards a future where photosynthesis drives sustainability and unlocks significant business value.

Kendric C. Smith Symposia Lecture

Protein binding sites as cellular laboratories of DNA photochemistry

John Wyrick

Kathiresan Selvam[1], Kaitlynne Bohm[1], Smitha Sivapragasam[1], Marian Laughery, Bastian Stark[1], Shiva P. Adhikari[2], Patrick Hrdlicka[2], Tomohiko Sugiyama[3], Steven Roberts[4], Gregory Poon[5], and John Wyrick[1]

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We and others have previously shown that DNA binding by proteins such as transcription factors and histones significantly affects UV-induced DNA damage. For example, DNA binding by human ETS transcription factors induces the formation of cyclobutane pyrimidine dimers (CPDs) at specific locations in their binding sites, both *in vitro* and in human cells. Here, we use a new damage mapping method called CPD-capture-seq to characterize UV damage levels at individual ETS binding sites. These data indicate that elevated UV damage formation at ETS binding sites can explain many recurrent mutations in skin cancers such as melanoma. We have also discovered that ETS binding can suppress photoreversal of CPD lesions in binding sites, and identified a potential mechanism responsible for this effect. Analysis of rare and atypical UV photoproducts using our newly developed UVDE-seq method indicate that DNA binding by TATA-binding protein (TBP) stimulates the formation of 6-4 pyrimidine-pyrimidone photoproducts (6-4PPs), resulting in elevated UV-induced mutations at TATA sites. Our data also indicate that DNA binding by a yeast transcription factor induces a novel purine-pyrimidine photoproduct that is likely responsible for UV-induced AC>TT tandem mutations. Taken together, these findings suggest that protein-binding associated changes in the DNA structure significantly alter UV photochemistry and mutagenesis in human cancers.

Genome-wide map of repair by CPD photolyase

John Wyrick

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UV light induces cyclobutane pyrimidine dimers (CPDs) and other DNA lesions, which must be efficiently repaired to avoid cell death or mutagenesis. Many species, including bacteria, yeast, and other eukaryotes, primarily utilize photolyase enzymes to repair UV damage. Here, we use our CPD-seq method to map repair of CPD lesions by yeast photolyase across the genome. Our data indicate that yeast photolyase rapidly repairs UV damage, but is significantly inhibited when damage is located in certain classes of transcription factor binding sites or in nucleosomes. Repair of damage in nucleosomes is particularly inhibited when CPDs are located at the 3′ side of the nucleosomal DNA or at minor-in rotational settings. While photolyase efficiently repairs the non-transcribed strand (NTS) of yeast genes, repair of the transcribed strand (TS) is inhibited. Genome-wide analysis of UV-induced mutations in NER-deficient, photoreactivated yeast revealed a striking enrichment of mutations along the TS of yeast genes. Taken together, these data indicate that inhibition of photolyase repair along the TS, likely due to occlusion of CPDs by RNA polymerase II stalling, promotes UV mutagenesis.

B16F10 cells under influence of different lighting and stimulus

Eric Xavier

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In B16F10 murine melanoma cells, various wavelengths of visible light can cause an increase in cell proliferation speed; however, high doses and exposure time can also cause damage to cellular structures and damage to genetic material. We also know that visible light and ultraviolet light can increase the melanin pigmentation and increase the DNA repair enzymes. However, cells behave in opposite ways at different wavelengths at the same dosage. The use of specific wavelengths (650nm and 410nm) at a dose of 8j/cm2 (equivalent to one hour of Scandinavian

sunshine) has opposite effects. For example, the red light 650nm can cause an increase in cellular activity demonstrated by migration, invasion and clonogenic experiments, but the same dose, of blue light has an opposite effect on B16F10 cells. Data also suggest that the broad spectrum of the visible light band (VLB) and ultraviolet light also interferes in the rate of cell division. Therefore, the effect of visible light and even ultraviolet light is still a controversial field, which will depend on the doses, exposure time and type of cells or tissue analyzed.

Light Signaling and Allostery Mechanisms of Bacteriophytochromes

Xiaojing Yang

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Phytochromes are a superfamily of bilin-based photoreceptors that mediate a wide range of light responses in plants, fungi and bacteria. In photosynthetic bacteria, they regulate gene expression of key photosynthetic components and pigment-processing enzymes. Canonical bacteriophytochromes (BphPs) are multi-domain sensor histidine kinases that undergo light-dependent auto-phosphorylation in a two-component system where the phosphoryl group is relayed to an Asp residue in a cognate response regulator, thereby triggering downstream transcriptional actions. Despite the extensive studies on bacteriophytochromes, the molecular mechanisms of light signaling and allostery remain elusive in the absence of full-length structures representing distinct signaling states. To address this challenge, we tackle a few representative BphPs using an integrated approach of biochemistry, spectroscopy, mutagenesis and structural biology. Specifically, we harness dynamic crystallography and single particle cryo-electron microscopy to provoke, probe and resolve the functional relevant structural dynamics in the truncated photosensory domains and full-length proteins. Findings are expected to elucidate the long-range signaling mechanisms in dimeric receptor kinases beyond photosynthesis and photoreceptors, which also promise to offer optogenetic solutions for biomedicine and renewable energy research. In this conference, I will present our recent cryoEM studies of BphPs that undergo large structural changes in response to light.

In vivo skin tolerance to 233 nm far UV-C irradiation in healthy humans: implications for effective and safe disinfection strategies

Daniela F. Zamudio Díaz

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Far UV-C radiation, with wavelengths ranging from 200 to 235 nm, has gained attention as an effective disinfection strategy, notably in combatting nosocomial infections and the COVID-19 pandemic. Specifically, a newly developed 233 nm LED source has shown comparable germicidal efficacy towards conventional UV-C radiation at 254 nm, with minimal penetration depth and negligible damage to epidermal cells and mucous membranes.

This study aimed at assessing the skin safety of 233 nm far UV-C irradiation for potential applications in in vivo skin antisepsis and public area decontamination. This research incorporates the first in vivo irradiation study on healthy volunteers, considering various skin types and age groups, while also assessing the impact of multiple exposures.

Exposure to a biocidal dose of 233 nm, at 60 mJ/cm^2, resulted in reduced and superficial DNA damage in the skin compared to damage from ¼ of the minimum erythema dose of UV-B – a dose deemed safe for human exposure. Notably, older and dark-skinned participants exhibited more skin damage than their younger and light-skinned counterparts analyzed 24h after irradiation. However, all responses remained within acceptable limits. Additionally, repeated exposure up to a cumulative dose of 240 mJ/cm^2 led to the accumulation of DNA damage, indicating a challenge to repair mechanisms within a 24-hour timeframe. This underscores the importance of considering cumulative far UV-C exposure, particularly in scenarios involving repeated applications. These results provide the necessity for the effective and responsible implementation of far UV-C radiation in disinfection practices, contributing to enhanced public health measures during infectious disease outbreaks.

Fiber-scanning video multiphoton microendoscope towards real-time guidance of photo-immuno therapy

Kai Zhang

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We present a resonant fiber-scanning microendoscope with probe diameter of 2.5 mm and rigid length of 30 mm. The endoscope can capture microscopic images at a frame rate of 20 Hz, with sub-cellular (1.2 µm lateral) resolution and a field-of-view (FOV) of around 130 µm in diameter. Compared with the conventional fiber scanners, the presented fiber scanner provides a higher scanning frequency while keeping a comparable FOV. The computer-aided finite-element analysis showed that within the same stress limit for the fiber cantilever, the presented fiber scanner can provide a FOV 30 times larger than conventional fiber scanner with the same resonance frequency at 4 kHz. The endoscope also features 3D-printed mounts to replace the conventional ceramic parts, significantly lowering the manufacturing cost while keeping a similar mechanical performance. Coupled with the custom ultrafast fiber laser, the endoscope is capable of performing both two-photon fluorescence and second-harmonic generation microscopy to various biological samples. In the future, we aim to construct a video-rate multiplexed hyperspectral microendoscope that identifies multiple biomarkers *in vivo* and guide photo-immuno therapy of heterogeneous cancers.

Open-source high-power light-emitting diode array platform for cell-culture photodynamic therapy

Kai Zhang

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We present an illumination platform for cell culture photodynamic therapy using high-power light-emitting diode (LED) array. The platform automatically provides illumination to a cell culture well plate with pre-determined light doses to each well. A water-cooled LED array on an aluminum printed circuit board provides illumination power of up to 300 mW/cm^2 to an area equivalent to 4 wells in a 24-well plate or 16 wells in a 96-well plate uniformly (< 5%). For in vitro operations, LED array has a lower cost and higher throughput compared with laser sources. With the featured water cooling loop and pulse-width modulation power control, the LED array is stable and flexible with even open-loop control system. The platform also features a set of robot arms to automatically move and align the well plate to the center of the array with sub-mm-level precision. The cost of the setup is less than $1500 (excluding the computer) with an additional $400 for each new wavelength. We present the setup open-source, hoping to make custom illumination more accessible and practical for the photomedicine research community.

Energy transfer from phycobilisomes to photosystems in cyanobacteria

Jindong Zhao

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Phycobilisomes are the major light harvesting complexes in photosynthesis. Two types of phycobilisomes exist: the large PBS consisting of a core and rods (herein PBS) and the rod-only CpcL-PBS, which contains a membrane-attaching linker CpcL. PBS that are mainly associated with PSII and CpcL-PBS are mainly associated with PSI. We here report (1) the Cryo-EM structure of PBS from *Synechococcus* sp. PCC 7942, which contains a two-cylinder core and six rods. The attachment of the top two rods to the core in this PBS is different from that in other PBS which contain 3-cylinder or 5-cylinder cores. We show that the direct involvement of ApcE in the interaction between the core and the top two rods in PBS with 2-cylinder core. (2) We determined the bundle-shaped PBS structure of Gloeobacter 7421 with Cryo-Em combined with mutagenesis analysis. We show that the linker 1262 is the major rod-core linker protein, responsible for the attachment of the bundled rods formation on top of the core. (3) The attachment of PBS to PSII is studied and we show here that a small protein (small protein for PBS-PSII Association, SppA) is required for such an attachment in the cyanobacterium *Synechococcus* PCC 7002. In the absence of the gene encoding SppA, *Synechococcus* 7002 grew much more slowly under a green light illumination. Oxygen evolution rate in the sppA mutant illuminated with a 590-nm light was greatly reduced. We demonstrate that SppA interacts with both CP47 of PSII and ApcE of PBS.

New perspectives on the BLUF photoreceptors

Dongping Zhong

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The photoreceptor BLUF has been studied extensively but the detailed dynamics in the triad Y-Q-FMN have not been elucidated on the fundamental level. Here, we report our recent progress on the elucidation of the key dynamics and proton-coupled electron transfer (PCET) mechanism by design of various mutants. We revealed the six elementary reactions, two electron transfer and four proton transfer steps, and reported all timescales and their isotope effects. These results show a beautiful example of PCET operating in a biological system.

Innovating Precision Delivery Systems for NOTCH Activation in Cutaneous Squamous Cell Carcinoma

Yuxi Zhou

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Cutaneous squamous cell carcinoma (cuSCC), the second most common skin cancer, notably features NOTCH mutations in approximately 75% of cases, where NOTCH acts as a tumor suppressor. Developing NOTCH activators for cuSCC has been limited due to the pathway's requirement for force-induced activation. In our study, we proposed novel strategies to induce apoptosis in cuSCC by reactivating NOTCH signaling using bioconjugated microgel. Our findings indicate that NOTCH activation triggers apoptosis in cuSCC and UV-damaged cells using a synthetic NOTCH activator, DeltaMAX (dMAX). NOTCH activation on normal keratinocytes in 2D cultures showed increased cell differentiation but not cell death. Our results suggest that NOTCH reactivation using dMAX is selectively apoptotic for NOTCH-mutant cuSCC cells and is non-toxic to normal cells.

The first aim of this research involves utilizing dMAX bioconjugated microgel technology to create a three-dimensional cuSCC spheroid. Combining with patient-derived microtumor models, it allows for an in-depth investigation into the effects of NOTCH reactivation on cancer cell apoptosis and an understanding of the signaling pathways. The second aim focuses on deploying an advanced microgel-based local delivery system for *in vivo* applications, designed to optimize NOTCH-mediated apoptosis by preventing endocytosis and enhancing necessary ligand-receptor interactions. Furthermore, this proposal includes examining the dual role of NOTCH signaling in T-cell-mediated anti-tumor immunity.

Overall, this research aims to validate the efficacy of targeted NOTCH activation in treating cuSCC, potentially pioneering a new method for managing this aggressive cancer type and addressing the urgent need for more effective therapies.

NOTES