

NANOSCIENCE COLLOQUIUM

Photopharmacology: Towards Light-Controlled Pharmacological Therapy

Prof. Dr. Wiktor Szymanski

Department of Medicinal Chemistry, Photopharmacology and Imaging, Groningen Research Institute of Pharmacy, University of Groningen

ABSTRACT: Molecular photomedicine holds the promise for precise treatments, which avoid systemic adverse effects and development of drug resistance. This promise is supported by current medical imaging modalities that are able to reveal the nature and location of malignancies, such as cancer and infections. At the same time, biomedical engineering has recently created methods to deliver light deep into human body. The photomedicine puzzle is currently missing its final piece – the way of translating light into a therapy. To address this challenge, drugs could be introduced whose activity could be reversibly or irreversibly turned on with light.

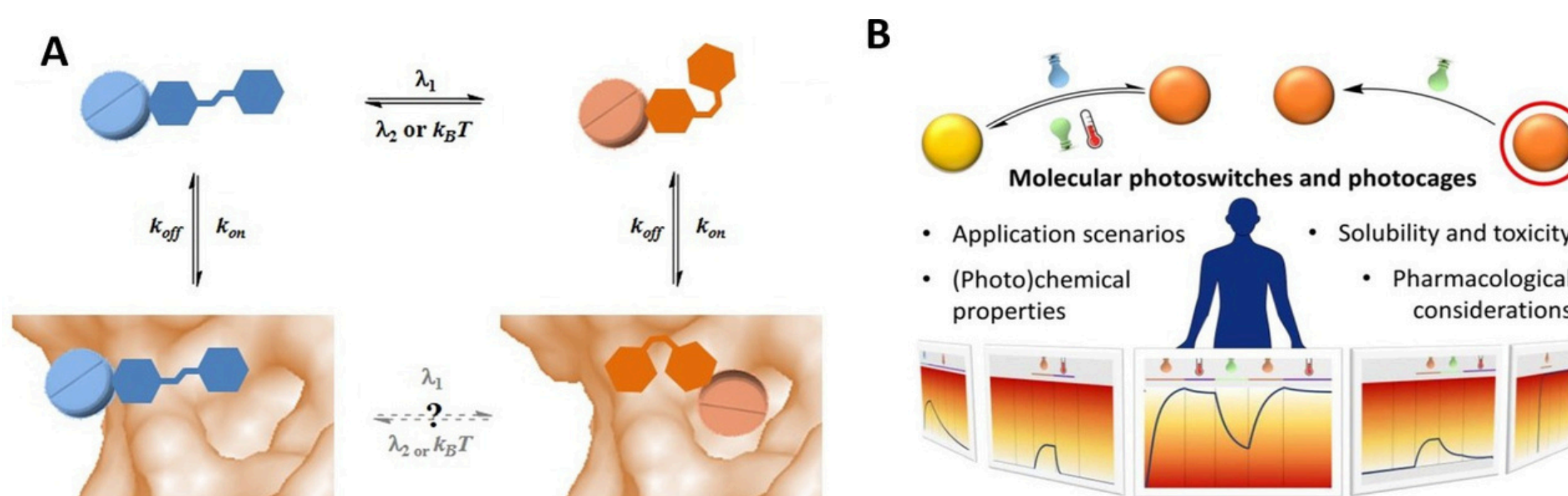


Figure. The principle of photopharmacology (A) and its key molecular tools (B)

The aim of this presentation is to describe the emerging concept of photopharmacology (Figure A),[1] which is currently being developed and applied to precisely control the activity of drugs using light. The presentation will focus on our efforts towards bridging light and medicine, focusing first on new light-operated tools[2] (molecular photoswitches[3,4,5] and photocages[6,7], Figure B). Next, I will highlight the synergies between medical imaging and therapy, offered by light, through photo-responsive optical[8] and magnetic resonance[9] imaging agents. The examples of light-controlled bioactive molecules presented will include small molecules[10,11] and proteins[12]. Finally, using those examples, I will highlight the structural aspects[13] of photopharmacology.

[1] Hoorens, M. W. H. et al. (2018) Trends. Biochem. Sci. 43, 567-575; [2] Welleman, I. M. et al. (2020) Chem. Sci. 11, 11672-11691; [3] Lameijer, L. N. et al. (2020) Angew. Chem. Int. Ed. 59, 21663-21670; [4] Hoorens, M. W. H. et al. (2019) Nature Comm. 10, 2390; [5] Medved, M et al. (2023) J. Am. Chem. Soc. 145, 19894–19902; [6] Schulte, A. M. et al. (2022) J. Am. Chem. Soc. 144, 12421-12430; [7] Alachouzos, G. A. et al. (2022) Angew. Chem. Int. Ed. 61, e202201308; [8] Reeßing, F. et al. (2020) ACS Omega 5, 22071-22080; [9] Welleman, I. et al. (2024) Smart Mol. 2, e20230029; [10] Hoorens, M. et al. (2019) Eur. J. Med. Chem. 179, 133-146; [11] Kolarski, D. et al. (2021) Nature Comm. 21, 3164; [12] Mutter, N. et al. (2019) J. Am. Chem. Soc. 141, 14356-14363; [13] Arkhipova, V. et al. (2021) J. Am. Chem. Soc. 143, 1513–1520.