PRECISION X-RAY IRRADIATION

Application Note

Advancing Optical BioImaging: Bio, Chemi, and Fluorescence Technologies Combined with Irradiation Equipment.

Bioluminescence, chemiluminescence, and fluorescence are fascinating phenomena that involve the emission of light through biological processes, chemical reactions, or in response to excitation light, respectively (Figure 1).

Bioluminescence is the production and emission of light by living organisms, resulting from biochemical reactions between luciferins (light-emitting molecules) and luciferases (enzymes that catalyse the reaction). Chemiluminescence refers to light emission caused by a chemical reaction, occurring in both biological and non-biological contexts.

Fluorescence imaging involves the emission of light from excitable fluorophores, which absorb light at a shorter wavelength and re-emit it at a longer wavelength. This results in characteristic fluorescence, enabling the creation of detailed images of biological structures and processes.

Each method offers unique advantages, and their combination covers nearly the full range of optical imaging, providing powerful tools for studying molecular imaging in biological phenomena. Combining these with preclinical therapeutic irradiation opens up an exceptionally wide range of novel scientific experiments.

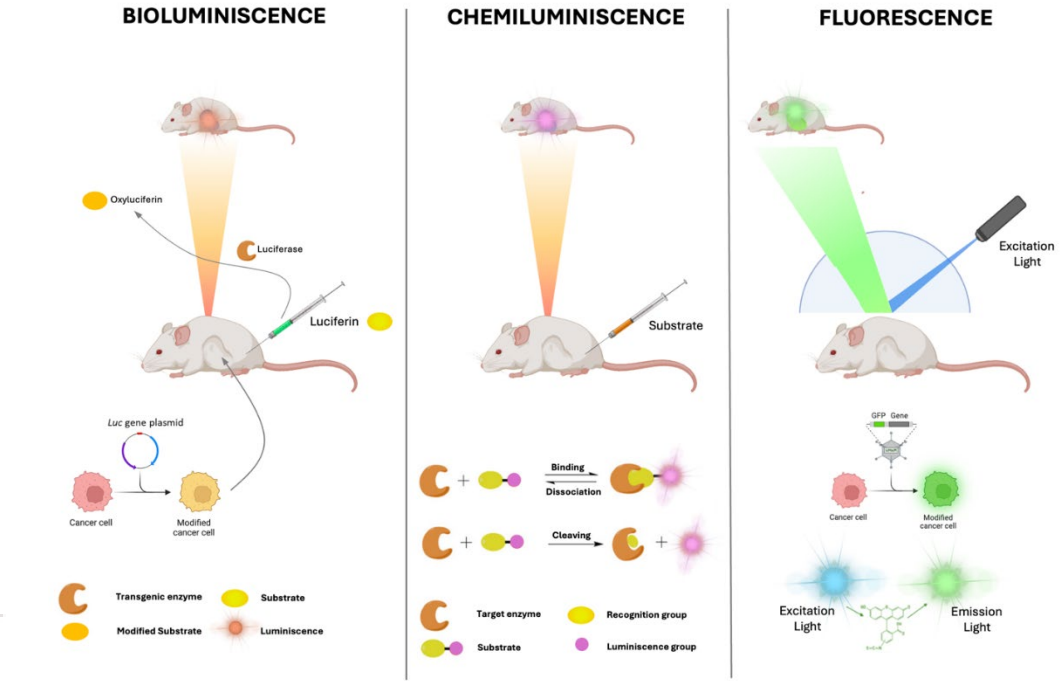

Figure 1. *Overview of bioluminescence (left), chemiluminescence (middle) and Fluorescence (right) processes. Created with BioRender.com*

Optical imaging capabilities in Precision X-Ray, Inc. systems: SmART+ (Small Animal Radiotherapy System) and X-Rad Irradiators.

The Precision X-Ray, Inc. SmART+ (small animal image-guided radiotherapy) system and X-Rad family of cabinet biological irradiators are state-of-the-art preclinical irradiators, which can be enhanced with advanced imaging capabilities through optional molecular imaging modules (OptiMAX and OptiFLEX), offering optimized tumor detection, an enhanced imaging workflow, and automated co-registration with anatomical imaging. The integration of Optical Imaging supports a wide range of applications, for example: Preclinical Imaging of Tumor Response to Radiation, Evaluating the Efficacy of Novel Drug Treatments, and Tumor Microenvironment and Therapeutic Responses[1-3].

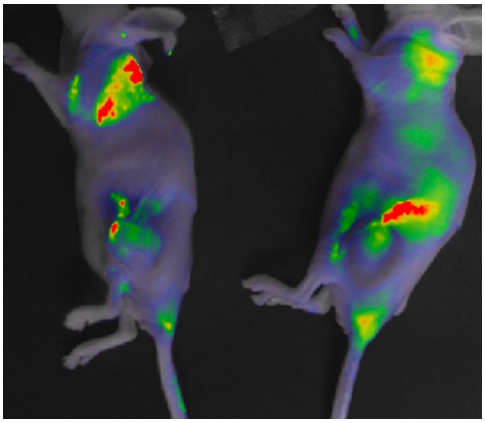

Figure 2. (left) *Examples of imaging-targeting in the SmART+ system using CT and BLI. The overlay of cellular activity measured by BLI on the CT scan is shown to optimize irradiation at the most active site of the subcutaneous (sc) tumors. (Right) FLI imaging with the prototype of the Integrated System in Precision X-Ray equipment, showing the fusion of white light and fluorescence images.*

Conclusion

The integration of these technologies (Bio, Chemi, and Fluorescence) covering the entire spectrum of optical imaging with the SmART+ and X-Rad systems (enhanced by OptiMAX and OptiFLEX), marks a significant improvement in the imaging capabilities of these systems. This integration facilitates targeted radiation delivery and allows for effective monitoring of processes and their efficiency. Additionally, these imaging capabilities can be employed independently of radiation for research purposes. This combination enhances sensitivity, resolution, and workflow efficiency, facilitating a broad spectrum of applications in preclinical research.

References

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2. *Douyère, M., Gong, C., Richard, M., Pellegrini-Moïse, N., Daouk, J., Pierson, J., ... & Boura, C. (2022). NRP1 inhibition modulates radiosensitivity of medulloblastoma by targeting cancer stem cells. Cancer Cell International, 22(1), 377.*

3. *Daouk, J., Jubréaux, J., Chateau, A., Schohn, H., & Pinel, S. (2020). Imaging performance of a multimodal module to enhance preclinical irradiator capabilities. Clinical Oncology and Research, 3(2).*