


Researchers highlight advancements in biomedical research with enzyme-activated fluorescent probes

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Applications of Enzyme-activated Near-infrared (NIR) Fluorescent Probes in Biological Systems


Abnormal enzyme activity is strongly associated with occurrence of diseases, including cancer




Enzyme-activated NIR fluorescent probes are being increasingly used to track and visualize these changes for diagnosis and monitoring

Molecular design and principle


Fluorophore




Linker



Enzyme reaction





NIR fluorescence





Charge transfer, Förster resonance energy transfer, and photoinduced electron transfer blockade enable NIR fluorophore activation and emission


Probes developed for alkaline phosphatase, cholinesterases, and various other enzymes to monitor:



Cancer development and metastasis


Diabetes



Apoptosis



Metabolism



Inflammation



Liver disease

Advantages


 Minimized interference

 Enhanced sensitivity


 Real-time qualification

 Improved tissue penetration

Applications in biological systems



- *In vivo* imaging
- *In vitro* experiments and quantification
- Analyte tracking
- Therapeutic use
- Surgical guidance



Probes can be developed to distinguish complex disease signals in the future

Enzyme-activated NIR fluorescent probes offer precise visualization and tracking, holding great potential in disease monitoring, research, and therapy

Recent advances in enzyme-activated NIR fluorescent probes for biological applications
Jeong et al. (2023) | *Trends in Analytical Chemistry* | DOI: 10.1016/j.trac.2023.117335



Abnormal enzyme activity is a hallmark of several diseases including cancer, neurodegeneration, inflammation, and metabolic disorders. Enzyme-activated near-infrared fluorescent probes have emerged as highly sensitive and specific visualization tools for the real-time monitoring of enzyme activity. This review highlights recent advances in the development of enzyme-activated fluorescent probes, and their diverse applications in biomedical research, diagnostics and health care. Credit: The authors

Enzymes, essential for normal cellular and physiological functions, are implicated in various diseases like cancer and diabetes due to their abnormal activity. Therefore, tracking enzyme activity is a valuable strategy for the diagnosis and monitoring of diseases. Conventional imaging techniques are limited by the need for contrast agents, low sensitivity, and spatio-temporal resolution.

To overcome these limitations, researchers are increasingly investigating [fluorescent probes](#) for non-invasive and real-time visualization of enzyme dynamics and corresponding disease status.

In a new review article, researchers from Korea have summarized the latest advancements in the development of enzyme-activated near-infrared (NIR) fluorescent probes and their diverse applications in biomedical research and medicine. Providing further insight into their article, the lead authors,

Professor Jun-Seok Lee from Korea University College of Medicine and Professor Juyoung Yoon from Ewha Womans University in Korea, explained, "While conventional biomarker examination relies on the comparative expression level of a target enzyme, it does not reflect enzymatic activity. Enzyme-activated fluorescent probes can help monitor the dynamics of [enzyme activity](#) in vitro and in vivo."

The review article was published in *Trends in Analytical Chemistry*.

Enzyme-activated fluorescent probes primarily consist of three components: a fluorophore that emits fluorescence upon activation, a linker, and an enzyme recognition unit. When the [probe](#) encounters the target enzyme, the resulting charge or [energy transfer](#) activates the NIR-fluorophore, emitting detectable fluorescence.

The authors describe various design strategies for these adaptable

fluorescent probes, with versatile applications in studies targeting enzymes involved in metabolic processes, neurotransmission, [cell growth](#), [cell death](#), and other key processes.

NIR-fluorescent probes are widely used in biomedical imaging to visualize cells and tissues, and they provide highly sensitive and real-time measurements of enzyme activity in cells as well as animal disease models.

Their selectivity allows for the detection of aberrant enzymes specific to certain tumors or diseases, aiding early and differential diagnosis. Additionally, they are used to outline tumor margins or specific tissues, guide surgical resection, and hold promise in assessing therapeutic responses to enzyme-targeting therapies. Furthermore, their applications extend to environmental sensing, food safety, water, and air analysis.

Enzyme-activated fluorescent probes offer [high specificity](#) and sensitivity, excellent biocompatibility, ease of use, and tunable properties, making them valuable assets in [biomedical research](#) and health care. Further studies can help in the designing of multi-target fluorescent probes capable of distinguishing between different cell types and aiding in clinical research, diagnostics, disease monitoring, and treatments. Overall, these probes hold significant potential to revolutionize health care.

This review enhances our understanding of fluorescent probes and lays the foundation for future research that can expand their applications. The authors conclude by saying, "Abnormal enzyme activity is a hallmark of several diseases. NIR fluorescent probes can be used as molecular tools for visualization and quantification of such biomarkers. While significant advances have been made in their development, additional studies are needed to widen their bioapplications."

More information: Hyunsun Jeong et al, Recent advances in enzyme-activated NIR fluorescent probes for biological applications, *Trends in Analytical Chemistry* (2023). [DOI: 10.1016/j.trac.2023.117335](https://doi.org/10.1016/j.trac.2023.117335)

Provided by Korea University College of Medicine

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