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New sensor molecules have potential for early cancer detection

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A research team lead by Academy Professor Kari Rissanen at the University of Jyväskylä has discovered a new water-soluble fluorescent detection system that is extremely sensitive to pyrophosphate (PPi).

Pyrophosphate has a key role in energy transduction, DNA replication and other metabolic processes that are dysregulated in cancer cells. The discovery might lead to the development of a method for early detection of cancer cells.

The team developed a simple metal complex which shows an intense orange fluorescent color in the presence of very low concentration of pyrophosphate (PPi) in water. The complex, also called a probe, had almost 1000 times higher level of response than earlier methods and an unprecedented sensitivity to detect PPi at a sub-nanomolar level (LOD ~ 0.8 nM). The discovery represents the first water-soluble fluorescent sensor that is capable of detecting pyrophosphate at this sensitivity level under physiological conditions.

The highly sensitive probes or sensors that are able to report the PPi level could lead to improved cancer diagnostics, since PPi plays a key role in energy transduction, DNA replication and other metabolic processes that are seriously misbehaving in cancer cells. All earlier PPi-selective sensor molecules or complexes have suffered from poor water solubility and low sensitivity in water. They can reach only micromolar levels and, thus, researchers have had to rely on protein-based probes that have their own limitations.

The researchers were able to show that the probe can image the pyrophosphate in the nuclei of living (HeLa) cells, making it an excellent probe for live cell pyrophosphahe imaging (Figure 1). The HeLa cells, originally from Henrietta Lack's cervix carcinoma, are the most long-lived human cancer cell line and are often used as a cancer cell model. In addition to their applicability in water, they can easily be formulated into a hydrogel and coated onto paper strips for low-cost pyrophosphate detection.

More information: S. Bhowmik, B. N. Ghosh, V. Marjomäki and K. Rissanen, "Nanomolar Pyrophosphate Detection in Water and in a Self-Assembled Hydrogel of a Simple Terpyridine-Zn2+ Complex," *J. Am. Chem. Soc.* 136 (2014), 5543– 5546.
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