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Commentary

Applications of Meso-CF3-Fluorophore Boron-Dipyrromethene (BODIPY) for the Detection of Lysosomes

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DESCRIPTION

Trifluoropyrrolylethanol and pyrazolyl-pyrrole were combined to create a bright, far-red emitting, unsymmetrical meso-CF3-BODIPY fluorescent dye. The created dipyrromethane was then subjected to further oxidation and complexation. The optical properties of this Boron-Dipyrromethene (BODIPY) dye include optical absorption at at $\lambda ab \approx 610–620$ nm and emission at $\lambda em \approx 640–650$ nm. On Ehrlich cancer cells, the BODIPY was investigated as a lysosome-specific fluorescent dye that enables intravital staining of cell structures and subsequent real-time monitoring of cellular changes. Additionally, it was demonstrated that the concentration of the dye in the culture media affects the rate of dye uptake by cells, intracellular transport into lysosomes, and cell saturation with the dye. The optimal BODIPY concentration for fluorescent staining of living cell lysosomes was determined to be 5 M, but Ehrlich carcinoma cells were shown to be hazardous to 100 M.

Due to their special characteristics, Boradiazaindacene (BODIPY) dyes are presently becoming more and more common in applied sciences among a large family of useful fluorescent dyes. BODIPY-based materials can be used in dye-sensitized solar cells, OLEDs and dye lasers, photo-catalytic hydrogen generation, nonlinear optics, naked-eye metal detection, and sensors of biological targets due to their photophysical properties.

In biotechnological and biochemical research, BODIPY-based fluorescent probes are essential because they enable visualisation and tracking of biologically significant molecules, drugs, and macrostructures. As a result, they are an effective tool for studying intercellular and intracellular biochemical processes, such as assessing a substance's medical efficacy and cytotoxic effects during the preclinical development of biologically active compounds. An activity-based probe with a BODIPY motif was able to identify the active SARS-CoV-2 major protease within the nasopharyngeal epithelial cells of patients with active COVID-19 infection, highlighting the importance of BODIPY-based probes for diagnostic research.

Near-Infrared (NIR) absorption and emission are preferred among known probes with absorption/emission peaks in the 300–800 nm range because they better penetrate living tissue and cause less interference and photodamage. The healthcare industry and related fields are actively utilizing this efficient and adaptable technique for non-invasive *in vivo* and *in vitro* biochemical real-time research, and BODIPY-based probes meet this requirement and have demonstrated their efficacy among commercially available substances for fluorescent imaging.

Since lysosomes are involved in numerous physiological and pathological processes that take place in living cells, including macromolecule degradation, plasma membrane repair, cellular homeostasis maintenance, apoptosis, and destruction product removal. Lysosomes have a role in signal transmission, which helps them regulate anabolic and catabolic processes, promote cell growth, and influence the activity of other cellular compartments as well as the immunological response of the cell. In this context, genetic or acquired lysosome dysfunctions play a crucial role in the onset and progression of a number of diseases connected to metabolic problems, including cancer. The significance of real-time lysosome imaging at the subcellular level has thus been established by studies of pathological processes linked to lysosome function damage, including carcinogenesis, metastasis, and drug resistance of tumour cells. These studies included carcinogenesis, drug resistance of tumour cells, and metastasis.

Unfortunately, these dyes have several drawbacks: application is restricted to short-term visualisation, and storage requires low temperature and light protection. Additionally, it was noted that LysoTracker could function as a P-glycoprotein transport substrate and was susceptible to reversible photoconversion to green after illumination by a light source fitted with a 560/40 excitation filter. In this perspective, it is still important to look for fluorescent dyes that can stain lysosomes with specificity, are safe to use in living cell cultures, are easily soluble in aqueous media, and are stable inside cells under experimental circumstances and during storage.

For the purpose of fluorescence visualisation of lysosomes, a

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newly unsymmetrical meso-CF3-BODIPY fluorescent dye was presented. It emits at λem ≈ 640-650 nm with good quantum yields (0.7–0.9). According to its concentration in the culture media, this BODIPY 1 can accumulate in cell lysosomes, with the pace of its absorption by the cell, intracellular transport, and rate of saturation of the cell with the substance all varying. A high BODIPY concentration's stressful effects on cells may be responsible for the reported absorption limit of the chemical by cells at a concentration of BODIPY 1 in the culture medium.

After analysing the data, it was determined that 5 μM was the most practical concentration of the substance under test for fluorescent staining of lysosomes because it resulted in intense fluorescent staining that gradually increased throughout the day and had no toxic effects on cells, unlike when BODIPY 1 was used at high concentrations. Accordingly, it can be inferred that the synthesised BODIPY is simple to use, stable in the form of an aqueous solution, doesn't need particular storage conditions, and is appropriate for staining intracellular structures.