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PRESS RELEASE (2026/02/06)

Understanding how cancer cells use water pressure to move through the body

Researchers unveil a previously unrecognized physical mechanism that governs cancer cell migration

Fukuoka, Japan—Cancer is one of the leading causes of death worldwide, marked by the uncontrolled growth of abnormal cells. What makes it more dangerous is the ability of cancer cells to move quickly through the body, allowing them to invade surrounding tissues. While this behavior is well known, the mechanism behind this rapid spread remains unclear. Researchers from Kyushu University set out to fill this gap and unveiled a new physical process that helps cancer cells move rapidly throughout the body.

This study was led by Professor Junichi Ikenouchi from Kyushu University's Faculty of Medical Sciences, along with his colleagues at Kyushu University, in collaboration with Yokohama City University. The findings of this study, published in *The EMBO Journal* on February 3, 2026, reveal how water pressure generated inside cells aids in cancer cell migration.

Healthy cells typically move by attaching to surfaces, which allows them to pull themselves forward. While existing therapies can target this adhesion-based movement, cancer cells evade this treatment approach by following a different strategy: amoeboid migration. In this mode, cells form temporary bulges called blebs, enabling them to squeeze through tight spaces without attaching to their surroundings.

For a long time, it was believed that bleb expansion was driven by internal pressure—until research by Ikenouchi in 2021 overturned that assumption. "In our previous research, we observed that expanding blebs show unique cytoplasmic properties such as high levels of calcium ions, suggesting that blebs are not just passive, pressure-driven protrusions but specialized cellular compartments," explains Ikenouchi.

Inspired by this, the researchers wanted to further explore the reasons behind these bleb expansions. Furthermore, they also noticed significantly higher levels of calcium/calmodulin-dependent protein kinase II (CaMKII) present in the cells, prompting a critical question: does CaMKII have a more direct physical role in shaping cells and their movements?

As the researchers probed deeper into bleb dynamics, they discovered that CaMKII does much more than act as a signaling protein. When a bleb begins to grow, there is an increase in the calcium levels inside the cells. In response to this surge, CaMKII present in the cell undergoes a structural change and assembles into a large protein supercomplex together with other molecules.

Once formed, this supercomplex behaves like an osmotic engine, creating a concentration gradient that draws water into the bleb through osmosis. The water pushes the cell membrane outwards, leading to rapid growth of the bleb. This newly discovered process was named "CODE" which stands for "CaMKII-based osmotically-driven deformation."

"Surprisingly, cells can generate force simply by changing how proteins are distributed inside them," says Ikenouchi. "CaMKII creates pressure by gathering in one place, and that pressure physically pushes the membrane outward."

These findings hold great significance in molecular biology, as most advanced cancer cells rely on amoeboid movement. In such cases, treatment becomes difficult; most current therapies only target cell proliferation or adhesion-dependent migration. Uncovering the CODE mechanism opens new avenues for therapies that specifically target amoeboid movement.

Apart from cancer, understanding how cells generate force through changes in their physical properties could also have implications for regenerative medicine, developmental biology, and tissue engineering. This research may inspire new therapeutic strategies that target cellular mechanics rather than classical signaling pathways, opening the door to more robust and effective treatments.

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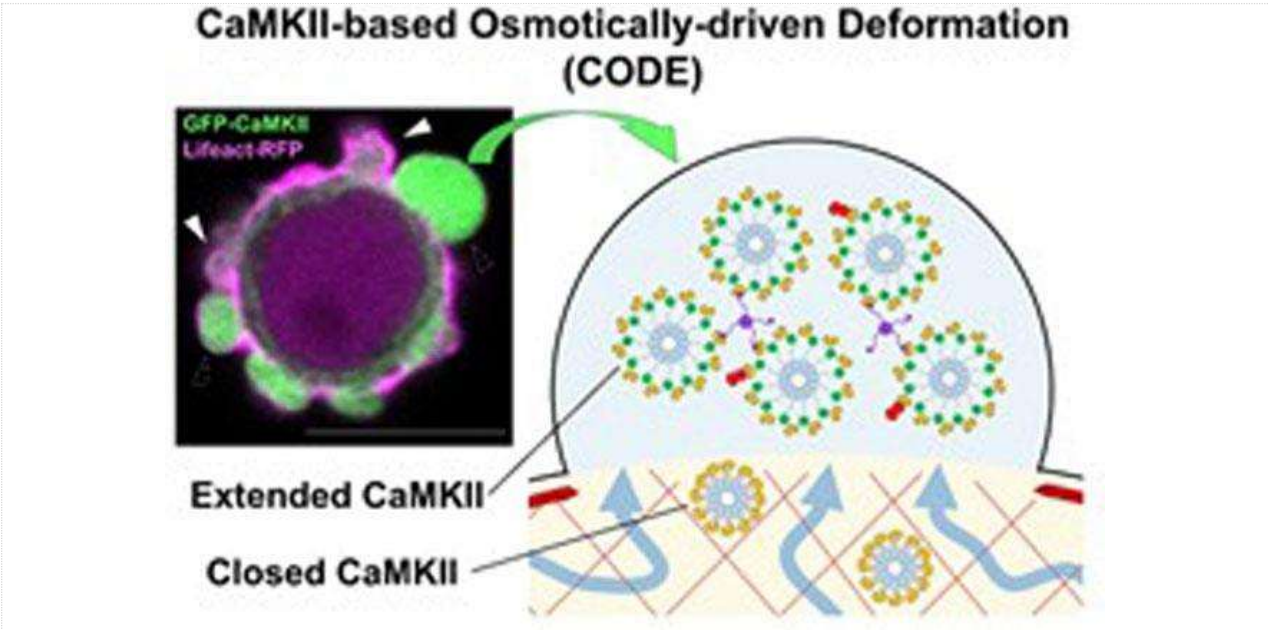
For more information about this research, see "CaMKII nucleates an osmotic protein supercomplex to induce cellular bleb expansion," Yuki Fujii, Yuji Sakai, Kenji Matsuzawa, and Junichi Ikenouchi, *The EMBO Journal*, https://doi.org/10.1038/s44318-026-00703-5

About Kyushu University

Founded in 1911, Kyushu University is one of Japan's leading research-oriented institutions of higher education, consistently ranking as one of the top ten Japanese universities in the Times Higher Education World University Rankings and the QS World Rankings. Located in Fukuoka, on the island of Kyushu—the most southwestern of Japan's four main islands—Kyushu U sits in a coastal metropolis frequently ranked among the world's most livable cities and historically known as Japan's gateway to Asia. Its multiple campuses are home to around 19,000 students and 8,000 faculty and staff. Through its VISION 2030, Kyushu U will "drive social change with integrative knowledge." By fusing the spectrum of knowledge, from the humanities and arts to engineering and medical sciences, Kyushu U will strengthen its research in the key areas of decarbonization, medicine and health, and environment and food, to tackle society's most pressing issues.



Calcium/calmodulin-dependent protein kinase II (CaMKII) gathers inside a growing membrane bleb, creating a local increase in water pressure. This pressure draws in water and pushes the cell membrane outward, helping the cell move by amoeboid migration.

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