CCMB Scientists Decode ‘Sticky’ Molecular Traps Used by Plants to Arrest Viral Infections

Hyderabad, 13th May, 2026: Researchers at the CSIR-Centre for Cellular and Molecular Biology (CCMB) have revealed a key plant defense system in plants. Plants are known to use liquid-like, sticky protein droplets to trap and disable invading viruses. Their study, led by Dr. Mandar V. Deshmukh and published in the *Journal of the American Chemical Society* (JACS), provides a molecular-level mechanism for this process.

Many viruses contain double-stranded RNA as their genetic material. Plants make certain proteins more when they are infected by viruses, which can identify the viral RNAs. They are called RNA-binding proteins. And, some of them can bind to the virus’s genetic machinery at positions called the Viral Replication Complexes, and stall the genetic machinery from dividing. Unable to divide its genetic material, a virus fails to replicate itself in infected cells. However, the details of the proteins binding to the RNA remained a mystery.

Traditionally, RNA-binding proteins have been assumed to latch onto double-stranded RNA, simply like a key fits into a lock. However, using advanced techniques such as Nuclear Magnetic Resonance (NMR) spectroscopy, fluorescence microscopy, and molecular dynamics simulations, the CCMB group found more to these lock and key structures. They discovered a unique fold in double-stranded RNA-binding proteins. In this fold, electric charges are distributed on the surface of the proteins such that they create sticky patches. Positive electric charges attract negative charges. These charges are distributed across the proteins, attracting and binding them to one another. This interconnected mesh of proteins forms dense, gel-like droplets.

Team involved in the study led by Dr. Mandar Deshmukh (at the rightmost)

“These proteins act like a molecular glue”, says Dr. Jaydeep Paul, first author of the study. “By forming these dense, gel-like droplets, the plant cells effectively trap the viral RNA, preventing it from interacting with the machinery needed for replication.”

These droplets, also known as biomolecular condensates, represent a shift in how scientists understand a living cell. “Rather than a collection of static membrane-bound compartments like the nucleus and mitochondria, the cell is now seen as a dynamic environment in which membraneless organelles form like oil droplets in water. Understanding these states has significant implications for both basic science as well as translations in agricultural and medical biotechnology,” said Dr. Deshmukh.

For agriculture, this discovery opens new avenues for developing crop varieties with enhanced natural immunity. By mimicking or strengthening these protein-based traps, scientists can design plants that are more resilient to devastating viral outbreaks that cause billions of dollars in crop losses globally. In human cells, the study opens up the possibility for scientists to manipulate these sticky protein patches, to dissolve neurotoxic clumps associated with dementia or dismantle liquid barriers that protect growing tumors. Moreover, a thorough understanding of these molecular mechanisms would allow scientists to design drugs that precisely manipulate the sticky protein patches.