

The Evolutionary Significance of Inflammation in Disease Defense

Inflammation, generally perceived through a pathological lens, has emerged as a crucial and highly efficient defense mechanism. A study from Shenzhen Institute of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS), delves into the evolutionary importance of inflammation, its dual role in preventing and curing diseases, and its prospects in immune-preventive and immunotherapeutic strategies.

The study was published in the journal *The Innovation Life* on September 15.

The study delves deep into the intricate aspects of inflammation within our immune defenses, redefining the traditional perception of inflammation as a harmful process. Led by a team of esteemed researchers, this innovative perspective provides compelling evidence that controlled inflammation can be a formidable ally in the fight against various diseases, including cancer and autoimmune disorders.

Contrary to the historical perception of inflammation as purely pathological, its principal role in humans is that of a defense mechanism. Inflammatory responses are instrumental in upholding physical and functional integrity, often operating without conspicuous symptoms. They are initiated when foreign agents breach the body's protective barriers, culminating in the identification, phagocytosis, and elimination of the invaders. Pathological inflammation only manifests when the initiating agent cannot be eradicated or when the immune system falters, as exemplified by autoimmune disorders, chronic inflammatory diseases, allergies, and severe cytokine storms.

Inflammation plays a pivotal role in augmenting the efficacy of vaccines. Adjuvants are substances that induce a controlled inflammatory response at the vaccination site, amplifying the protective immune reaction. Adjuvants like alum and oil-in-water emulsions activate macrophages, phagocytosis, and the inflammasome,

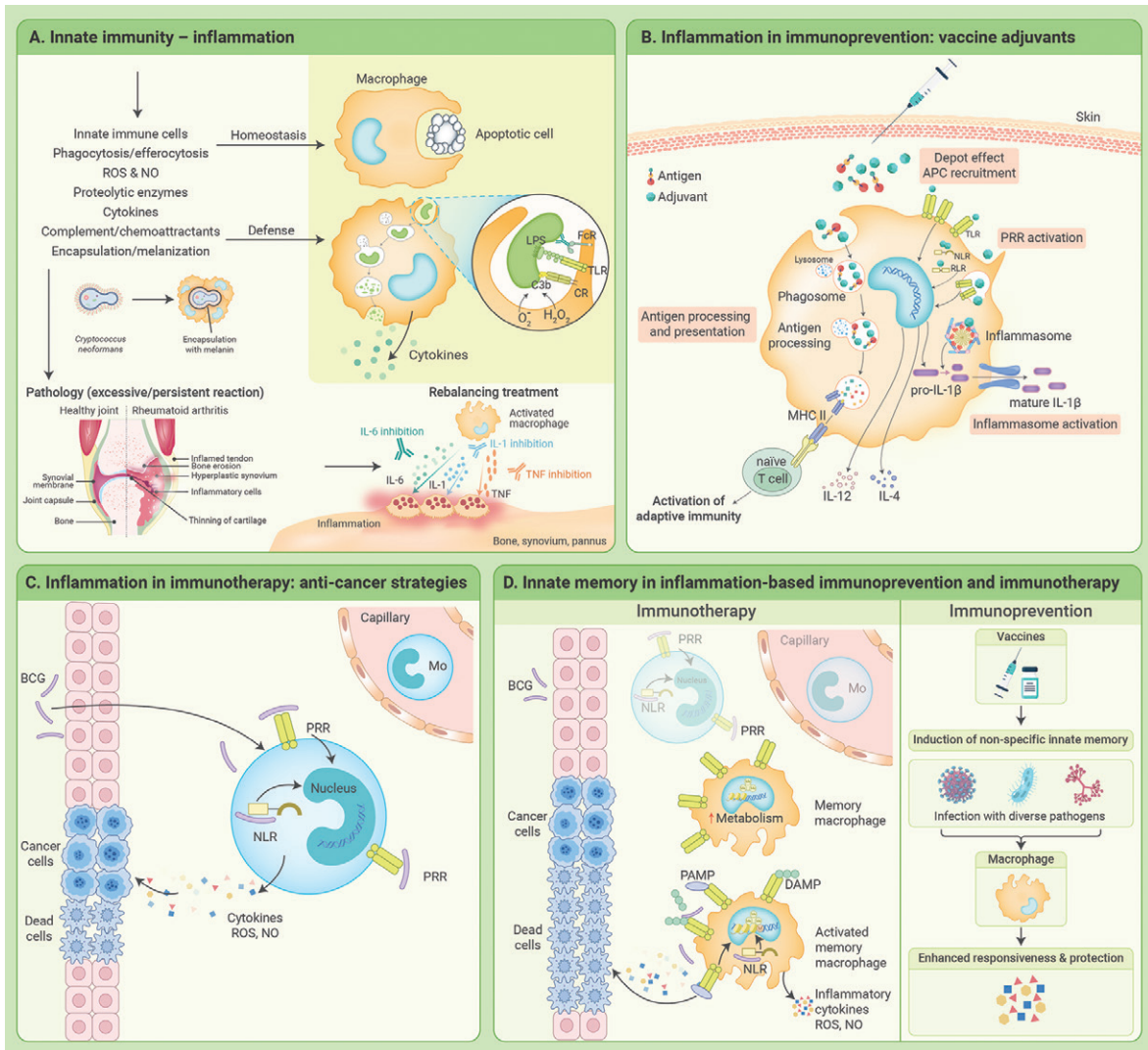
resulting in the production of inflammatory cytokines such as IL-1 β . IL-1 β serves as the bridge connecting inflammation to adaptive immunity, thereby bolstering the immune response and fostering enduring protection against vaccine antigens.

Within the context of tumor development, inflammation assumes a dual role. The tumor microenvironment (TME) can promote tumor growth by pushing tumor-associated macrophages (TAMs) to adopt a pro-healing phenotype. Therapeutic endeavors aim to modulate the TME, redirecting TAMs towards a cancer cell-killing role. In this regard, innate immune checkpoints and immunotherapeutic strategies targeting macrophage activation are currently under investigation.

The use of inflammation for treating cancer traces its roots back over 3,000 years. Ancient Egyptian and Roman physicians harnessed infections to combat tumors. This practice evolved into bacterial-based immunotherapy, exemplified by Coley's toxin, which continues to find applications in certain cancer treatments today. BCG, a tuberculosis vaccine made of live bacteria, activates macrophages for tumoricidal activities and can evoke innate memory, offering promising avenues for anti-cancer immunotherapy.

Inflammation retains its formidable status as a protective immune mechanism. Advances in comprehending its development and regulation empower us to harness its potential for effective immune-preventive and immunotherapeutic purposes, while mitigating adverse outcomes. The identification of innate immune checkpoints and strategies for inducing protective innate immune memory against infections and tumors beckon exciting prospects for the future of medical science.

"Inflammation, an ancient and highly efficient defense mechanism, continues to unveil its extraordinary potential in disease prevention and treatment," said



Exploiting inflammation for improving health. (Image by SIAT)

Prof. Aldo Tagliabue, who is the chief scientist of the Laboratory of Inflammation and Vaccines, SIAT, “propelling innovations in the realm of immunology and kindling optimism for enhanced healthcare outcomes.”

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Reference

Boraschi D. and Tagliabue A. (2023). Harnessing the power of inflammation in immunoprevention and immunotherapy. *The Innovation Life* 1(2), 100025. doi: 10.59717/j.xinn-life.2023.100025.