PRESS RELEASE

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Safer, more effective vaccines with new mRNA vaccine technology

Singapore, 14 October 2025 – A team of researchers from Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine) and Tsinghua University has unveiled a new messenger ribonucleic acid (mRNA) vaccine technology that could make future vaccines safer, more effective, and less burdensome for patients.

Published in *Nature Materials*, the new approach uses albumin-recruiting lipid nanoparticles, called Evans Blue-modified lipid nanoparticles (EB-LNP), to deliver mRNA precisely to lymph nodes, which are immune system "command centres", while bypassing the liver, a common site of toxicity for current vaccines. In laboratory tests, the technique outperformed traditional delivery systems in both cancer treatment and viral infection protection, including against melanoma, HPV-related cancers, H1N1 influenza, and Omicron SARS-CoV-2 variants.

"Traditional lipid nanoparticle-based vaccines can accumulate in the liver after intramuscular injection, raising the risk of liver damage and dampening immune responses," explained Professor Shawn Chen Xiaoyuan, co-senior author of the paper, from the Department of Diagnostic Radiology, and Nanomedicine Translational Research Programme at NUS Medicine. "We aimed to design a smarter delivery system that avoids this problem and directs the vaccine exactly where it's needed."

While mRNA vaccines require efficient delivery to immune tissues, conventional polyethylene glycol-lipid nanoparticles (PEG-LNP) systems often get trapped in the liver. LNPs are made at extremely small scales in order to deliver medication or mRNA to our cells. However, repeated high doses, especially in cancer settings, can cause inflammation, anaphylaxis, and even liver damage. The solution was to use albumin—a natural transport protein in the body. The team engineered a delivery vehicle that hitchhikes on albumin to guide the vaccine payload through the lymphatic system directly to lymph nodes. There, the vaccine is efficiently absorbed and triggers a targeted and powerful immune response.

The team synthesised a special Evans Blue-modified lipid (EB-lipid) that binds tightly to albumin. When injected intramuscularly, EB-LNPs recruit albumin to their surface, which naturally guides them to lymph nodes instead of the liver. This design avoids systemic circulation, limiting liver exposure and potential toxicity. Even at lower doses, EB-LNP vaccines produced strong antitumor T-cell responses and high levels of neutralising antibodies. No liver inflammation or toxic responses were observed—even after repeated injections. Unlike traditional PEG-LNPs, EB-LNPs did not trigger strong anti-drug antibodies.

“This albumin-hitchhiking strategy represents a paradigm shift in mRNA vaccine delivery,” said Assistant Professor Guocan Yu, Key Laboratory of Bioorganic Phosphorus Chemistry & Chemical Biology, Department of Chemistry, Tsinghua University. “It has broad implications for cancer, infectious diseases, and potentially autoimmune disorders. For patients, that means fewer injections, reduced side effects, and longer-lasting protection.”

Going forward, the research team is preparing to advance to clinical trials to ensure human safety and efficacy, expand use cases to other diseases, such as autoimmune conditions and lymphatic cancers, and collaborate with the industry to scale manufacturing and accelerate vaccine development.

“Our hope is to transform how mRNA vaccines are designed—making them safer, more effective, and easier to administer,” said Pei Huang, co-lead author of the paper, and Research Fellow at the Department of Diagnostic Radiology, and Nanomedicine TRP at NUS Medicine.

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About National University of Singapore (NUS)

The National University of Singapore (NUS) is Singapore's flagship university, which offers a global approach to education, research, and entrepreneurship, with a focus on Asian perspectives and expertise. We have 15 colleges, faculties, and schools across three campuses in Singapore, with more than 40,000 students from 100 countries enriching our vibrant and diverse campus community. We have also established more than 20 NUS Overseas Colleges entrepreneurial hubs around the world.

Our multidisciplinary and real-world approach to education, research and entrepreneurship enables us to work closely with industry, governments, and academia to address crucial and complex issues relevant to Asia and the world. Researchers in our faculties, research centres of excellence, corporate labs and more than 30 university-level research institutes focus on themes that include energy; environmental and urban sustainability; treatment and prevention of diseases; active ageing; advanced materials; risk management and resilience of financial systems; Asian studies; and Smart Nation capabilities such as artificial intelligence, data science, operations research, and cybersecurity.

For more information on NUS, please visit http://www.nus.edu.sg/

About the NUS Yong Loo Lin School of Medicine (NUS Medicine)

The NUS Yong Loo Lin School of Medicine is Singapore's first and largest medical school. Our enduring mission centres on nurturing highly competent, values-driven, and inspired healthcare professionals to transform the practice of medicine and improve health around the world.

Through a dynamic and future-oriented five-year curriculum that is inter-disciplinary and inter-professional in nature, our students undergo a holistic learning experience that exposes them to multiple facets of healthcare and prepares them to become visionary leaders and compassionate doctors and nurses of tomorrow. Since the School's founding in 1905, more than 12,000 graduates have passed through our doors.

In our pursuit of health for all, our strategic research programmes focus on innovative, cutting-edge biomedical research with collaborators around the world to deliver high impact solutions to benefit human lives.

The School is the oldest institution of higher learning in the National University of Singapore and a founding institutional member of the National University Health System. It is one of the leading medical schools in Asia and ranks among the best in the world (Times Higher Education World University Rankings 2025 by subject and the Quacquarelli Symonds (QS) World University Rankings by subject 2025).

For more information about NUS Medicine, please visit https://medicine.nus.edu.sg/

About the National Medical Research Council (NMRC)

The NMRC was established in 1994 to oversee research funding from the Ministry of Health and support the development and advancement of biomedical research in Singapore, particularly in the public healthcare clusters and medical schools. NMRC engages in research strategy and planning, provides funding to support competitive research grants and core research enablers, and is responsible for the development of clinician scientists through awards and fellowships. The council's work is supported by the NMRC Office which is part of

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About the National Research Foundation (NRF)

The National Research Foundation, Singapore (NRF), set up on 1 January 2006, is a department within the Prime Minister's Office. The NRF sets the national direction for research and development (R&D) by developing policies, plans and strategies for research, innovation and enterprise. It also funds strategic initiatives and builds up R&D capabilities by nurturing research talent. Learn more about the NRF at www.nrf.gov.sg.