NEWS RELEASE

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NTU Singapore scientists develop cooling sunscreen from pollen

- Pollen sunscreen blocks UV rays and does not harm corals

Materials scientists from **Nanyang Technological University, Singapore (NTU Singapore)** have invented the world's first pollen-based sunscreen derived from Camellia flowers.

In experiments, the pollen-based sunscreen absorbed and blocked harmful ultraviolet (UV) rays as effectively as commercially available sunscreens, which commonly use minerals like titanium dioxide (TiO_2) and zinc oxide (ZnO).

In laboratory tests on corals, commercial sunscreen induced coral bleaching in just two days, leading to coral death by day six. Each year, an estimated 6,000[1] to 14,000[2] tonnes of commercial sunscreen make their way into the ocean, as people wash it off in the sea or it flows in from wastewater.

In contrast, the pollen-based sunscreen did not affect the corals, which remained healthy even up to 60 days.

In other tests, the pollen-based sunscreen also demonstrated its ability to reduce surface skin temperature, thereby helping to keep the skin cool in the presence of simulated sunlight.

The innovation has been published today in *Advanced Functional Materials*, a peer-reviewed, high-impact scientific journal.

Lead author of the study, **Professor Cho Nam-Joon, President's Chair in Materials Science and Engineering** at **NTU Singapore**, said that pollen is widely available and often consumed for its health benefits.

"We know that pollen is naturally UV-resistant, as its shell needs to protect its inner contents from harsh environmental conditions, including sunlight. Our research aimed to develop a way to process pollen grains into a gel-like form, so that they can be

[1] National Park Service. (n.d.). *Protect yourself, protect the reef*. U.S. Department of the Interior. https://www.nps.gov/subjects/oceans/sunscreen.htm

[2] Smithsonian Ocean. (n.d.). *Sunscreen and the environment*. Smithsonian Institution. https://ocean.si.edu/ecosystems/coral-reefs/sunscreen-environment

easily applied to human skin," explained Prof Cho, who is also **NTU's Director of Flagship Programmes** and the **Director of the Centre of Cross Economy at NTU**.

"We wanted to develop an affordable and effective natural sunscreen that is non-allergenic to humans and eco-friendly to the environment. This is where NTU leveraged our deep expertise in materials science and engineering to develop a sustainable real-world solution that has an impact on both humanity and the Earth."

The study is part of NTU's push for sustainability, one of the University's key research pillars aimed at developing real-world solutions with environmental impact.

NTU's School of Materials Science and Engineering, where the research was conducted, is currently **ranked #2 globally** after MIT and #1 in Asia in the QS World University Rankings by Subject 2025[3].

Benefits of sunscreen

Sunscreens are designed to absorb or reflect UV rays away from the skin, as prolonged UV exposure can lead to skin problems such as sunburn and skin cancer.

However, many commercial sunscreen chemicals are harmful to marine life, particularly corals[4] [5].

In contrast, pollen is coated in a substance called sporopollenin – one of the toughest natural biopolymers – which protects the genetic material during transit. It is so resilient that it has been found in fossils millions of years old.

Using a proprietary water-based process that does not involve harsh chemicals or high heat, Prof Cho's team processed both Camellia and Sunflower pollen by removing the inner contents of the pollen shell and converting it into a microgel formulation, similar to those used in skincare products.

When applied, the microgel layer is just microns thick – barely the width of a human hair – and transparent to the naked eye.

In animal experiments[6] conducted by collaborators at Seoul National University, it was shown that both Camellia and sunflower pollen microgels effectively blocked UV rays

[3] QS University Subject Rankings - Materials Sciences. https://www.topuniversities.com/university-subject-rankings/materials-sciences

[4] Rücker, J., Leonhardt, J., & Wild, C. (2025). Effects of three sunscreens on the ecophysiology of hard and soft corals from the Maldives. *Marine Pollution Bulletin*, *219*, 118316. https://doi.org/10.1016/j.marpolbul.2025.118316

[5] Stien D, Clergeaud F, Rodrigues AMS, Lebaron K, Pillot R, Romans P, Fagervold S, Lebaron P. Metabolomics Reveal That Octocrylene Accumulates in Pocillopora damicornis Tissues as Fatty Acid Conjugates and Triggers Coral Cell Mitochondrial Dysfunction. Anal Chem. 2019 Jan 2;91(1):990-995. doi: 10.1021/acs.analchem.8b04187. Epub 2018 Dec 18. PMID: 30516955.

[6] All animal experimental procedures in this study were conducted in accordance with the approval of the Institutional Animal Care and Use Committee (IACUC) of Seoul National University Bundang Hospital (Approval number: BA-2405-391-004-01).

and reduced skin cell damage and inflammation, with Camellia pollen performing better in their comparative tests.

When benchmarked against a commercial sunscreen containing chemical and mineral filters, both pollen-based microgels demonstrated comparable, if not superior, UV protection.

In tests simulating sunlight exposure, the Camellia pollen microgel was found to regulate skin temperature more effectively than commercial sunscreen, keeping the skin temperature 5 degrees Celsius cooler for 20 minutes.

This cooling effect is attributed to the pollen's natural properties, which absorb less energy in the visible to near-infrared spectrum – the wavelengths largely responsible for heat generation.

The pollen-derived sunscreen has been tested to have a Sun Protection Factor (SPF) of about 30, meaning it blocks approximately 97 per cent of the UV rays.

Also, not all types of pollen cause allergy and Camellia pollen is generally considered non-allergenic, as it is a self-pollinating flower.

Giving an independent comment, dermatological diseases expert **Associate Professor Andrew Tan Nguan Soon** from **NTU's Lee Kong Chian School of Medicine (LKCMedicine)**, noted: "Beyond its eco-friendly credentials and UV-blocking performance, the pollen-based sunscreen uniquely cools the skin, a benefit not typically found in commercial sunscreens."

"By naturally reducing skin temperature during sun exposure, this sunscreen promises enhanced comfort and healthier skin, making it especially compelling to explore further for stability under various storage conditions and scalability of sustainable pollen harvesting," added Prof Tan, who is the **Provost's Chair in Metabolic Disorders and Vice Dean (Innovation and Enterprise), LKCMedicine.**

Ocean biogeochemist **Associate Professor Patrick Martin**, from **NTU's Asian School of the Environment**, gave his independent view: "Many types of chemical pollutants, including sunscreens, enter the ocean each year, and marine life can be highly sensitive to them."

"Numerous lab studies have shown that certain sunscreen compounds can harm corals, although these are often conducted at concentrations higher than what is typically found in the environment. It's difficult to pinpoint how much harm each factor contributes in complex marine ecosystems, so any effort to reduce chemical pollution is welcome. This pollen-based sunscreen is a promising step towards protecting both human health and marine life."

The team is supported by the **NTU Innovation and Entrepreneurship** initiative and is looking into scaling up the technology.

A technology disclosure has been filed through **NTUitive**, the University's innovation and enterprise company, and the team hopes to work with industry partners to commercialise the technology.

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Notes to Editor:

*Paper titled: "**Nature's Guard: UV Filter from Pollen**", published in Advanced Functional Materials, 4 Sep 2025.*

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Media contact:

Lester Kok
Senior Assistant Director
Corporate Communications Office
Nanyang Technological University, Singapore
Tel: +65 6790 6804
Email: lesterkok@ntu.edu.sg

About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 35,000 undergraduate and postgraduate students in the Business, Computing & Data Science, Engineering, Humanities, Arts, & Social Sciences, Medicine, Science, and Graduate colleges.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Earth Observatory of Singapore, Nanyang Environment & Water Research Institute and Energy Research Institute @ NTU (ERI@N).

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources. Ranked amongst the world's top universities, the University's main campus is also frequently listed among the world's most beautiful. Known for its sustainability, NTU has achieved 100% Green Mark Platinum certification for all its eligible building

projects. Apart from its main campus, NTU also has a medical campus in Novena, Singapore's healthcare district.

For more information, visit www.ntu.edu.sg