

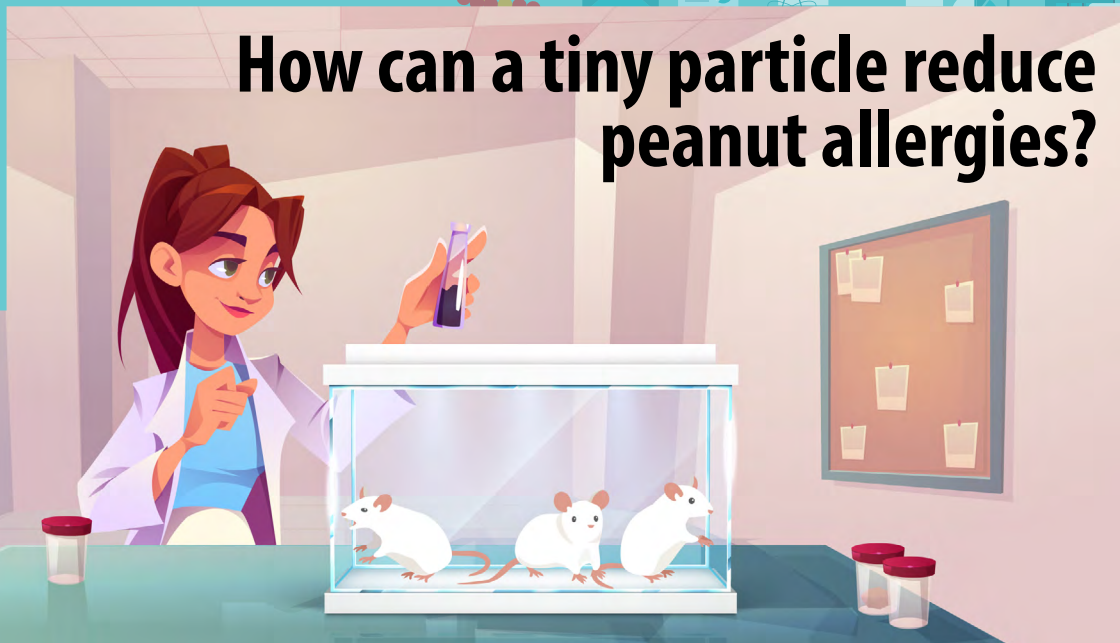
# How can a tiny particle reduce peanut allergies?

## Researchers:

Xiao Xu, Xiang Wang,  
Tian Xia, and Andre Nel

## Associate Editors:

Allison Gamzon and  
Alexandra Appleton



## Abstract

UPPER READING LEVEL

Did you know that food can be harmful to certain people? That's because they have food allergies. Food allergies can be dangerous if they cause anaphylaxis. This is the body's reaction to the food, which can be so severe that it may become difficult to breathe. It can also cause a person to faint. Scientists wanted to figure out if they could use a tiny piece of a peanut protein that is expressed by messenger RNA (mRNA) to reduce the harmful symptoms caused by

this food. They designed a very tiny particle to deliver this mRNA to the liver. They designed it to switch off allergic responses. The researchers then collected data to determine if there were fewer symptoms of anaphylaxis. Their tests showed that mRNA-carrying particles could reduce the impact of peanut allergies. That means that mRNA could be an effective solution to allergies in the future.

## Introduction

Many people worldwide have to be careful about what they eat because of food allergies. A **food allergy** is an **immune system** reaction that occurs after eating certain foods. Your immune system is the body system that protects you from infections. **When a person has a food allergy, it is because the immune system recognizes foreign proteins in the food substance.** It produces special **antibodies** known as **immunoglobulin E**, or IgE. The IgE goes to different cells in the body and signals them to produce chemicals. The release of these chemicals results in an allergic reaction. The most common food **allergens** include peanuts, tree nuts, milk, eggs, shellfish, fish, sesame seeds, soy, and wheat.

What kind of allergic responses can people have? Mild **symptoms** include a bit of pain in your belly or getting **hives** on your skin. **A severe reaction might include anaphylaxis.** Usually a person in anaphylaxis has trouble breathing because their airways narrow. Their blood pressure also decreases, so they may get dizzy or faint. Anaphylaxis is a life-threatening condition. It can occur seconds or minutes after interacting with a food allergen.

**Scientists wanted to know if they could use mRNA to enable the immune system to tolerate peanuts.** The particular mRNA they used acts as an instruction to make a protein.

It instructs the liver to make a small piece of peanut protein that doesn't act as an allergen and switches off the production of antibodies. The researchers hypothesized that they could send a specific mRNA molecule to the liver using a **nanoparticle**. The mRNA would then tell the cell to make protective **T-cells**. These T-cells then reduce the amount of IgE production and subsequent anaphylaxis.



Common food allergens include peanuts, shellfish, eggs, and milk.

## Methods

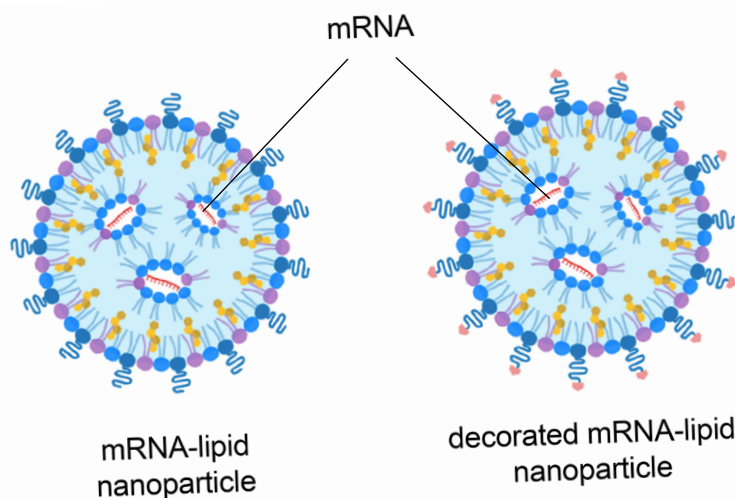
### Particle Development:

Scientists developed a nanoparticle to carry mRNA to the liver (Fig. 1). They made the nanoparticle from lipids, or fatty molecules. Lipids are chemicals that help your body with certain functions. One function includes making nanoparticles that can transport mRNA around the body to the immune system (as scientists discovered making COVID-19 vaccines). The researchers used four specific lipids to build the nanoparticle, entrapping the peanut mRNA. To ensure these nanoparticles travel to the liver, they also added a surface tag, or decoration, to the particles. This ensures that they zoom into the part of the liver that makes the protective T-cells. They also made a control particle that did not contain the surface decoration.

Finally, the scientists developed the mRNA that the particle would carry. They placed this mRNA in the center of the nanoparticle.

### Particle Testing:

The researchers made all the groups of mice sensitive to peanut protein by feeding them with peanut extract. Then they gave two groups treatment before they exposed them to peanuts. One group of mice had two injections of particles without the decorations. Another group received two injections of nanoparticles with decorations. The third group did not receive any treatment. The scientists then exposed all the mice to the peanut extract. They recorded their response to the exposure by monitoring their body temperature. (This drops when they develop anaphylaxis.) The researchers also assigned a body score to describe the level of anaphylaxis the mice experienced, such as breathing problems and fainting. The researchers observed how the amount of IgE, a peanut-specific IgE, and the protective T-cell levels changed. They then repeated the experiment with one difference. They gave the mice the nanoparticle treatment after feeding them with the peanut extract, not before.



**Figure 1:**

The nanoparticles developed to reduce anaphylaxis from peanuts.

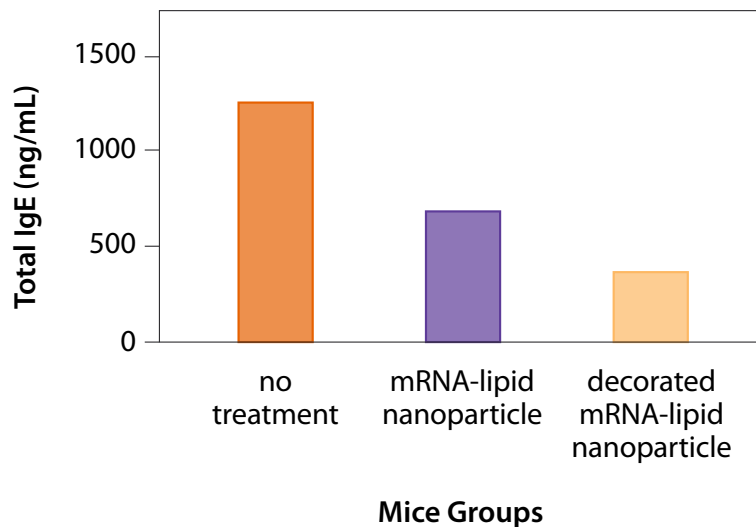
## Results

The mice that didn't receive a nanoparticle injection were not protected from anaphylaxis. They had more severe symptoms, including difficulty breathing and reduced movement. They showed a drop in body temperature and high anaphylactic scores.

The treated mice did not show a change in body temperature. They also had lower anaphylactic scores. The mice treated with the decorated nanoparticles had an even greater reduction in allergy symptoms.

The treated mice had lower levels of IgE. They also had higher levels of protective T-cells. The researchers saw similar results whether they injected the nanoparticles before or during the allergic reaction.

*Please see  
Figure 2 on page 3*



How did the mRNA-lipid nanoparticles affect IgE levels?

**Figure 2:**

The total IgE levels in mice made sensitive to peanut protein. One group received no treatment, one received the mRNA-lipid nanoparticle, and one received the decorated mRNA-lipid nanoparticle.

## Discussion

The nanoparticles did help reduce the mice's allergic reaction to peanuts! The treated mice experienced fewer symptoms of anaphylaxis than untreated mice. That is because the nanoparticles carried the mRNA to the liver. This mRNA instructed the formation of protective T-cells, which decreased the formation of the IgE. Because there was less IgE, there were fewer anaphylaxis symptoms. The researchers also learned that the decorated nanoparticles had a stronger effect than the non-decorated nanoparticles.

This research shows that nanoparticles carrying mRNA are a possible solution to allergies. They may be able to treat

many types of allergies, including cat and pollen. They may also make it possible to treat more than one allergy at once. This is important because many people have more than one food allergy.

But scientists need to do more research first. They need to determine how long the reduction of symptoms lasts. That information will help them figure out how often people need to receive the treatment. They also need to work out how much mRNA to place in each nanoparticle to reduce symptoms.

## Conclusion

While researchers continue to explore nanoparticles and mRNA treatment of allergies, you can help prevent anaphylaxis in people with food allergies.

- Be aware of the ingredients in the foods you bring into public spaces. After you eat, clean up your space so possible food allergens are not left behind.

- When providing food to friends at school, make sure you know if anyone has a food allergy. Label the ingredients in any foods you bring in so that students can easily check for anything that might trigger an allergy.

Many schools now have a no-nuts policy as this is a common allergy. This ensures that everyone can enjoy eating together while staying safe!

## Glossary of Key Terms

**Allergens** - a substance that causes an allergic reaction.

**Anaphylaxis** - a severe reaction to an allergen that affects multiple body systems.

**Antibodies** - a substance produced in response to a specific foreign substance.

**Food allergy** - a condition in which an immune system reaction occurs after eating a certain food.

**Hives** - round bumps that form on the skin that are very itchy.

**Immunoglobulin E (IgE)** - an antibody produced during an allergic reaction that triggers the release of chemicals throughout the body.

**Immune system** - the body system that protects the body from infections and other illnesses.

**Lipids** - fatty chemicals that help your body with certain functions, including moving materials from one part of the body to another.

**mRNA** - a particle that transfers genetic information to other parts of the body. This information is then used to make proteins that the body can use to produce protective immune responses.

**Nanoparticle** - a very tiny particle.

**Surface decorations** - extra substances placed on the outside of a nanoparticle.

**Symptoms** - a sign that a person may be experiencing a disease or condition. A runny nose is a symptom of a cold virus.

**T-cells** - a type of white blood cell that is part of the immune system. They protect the body against infection.

## REFERENCES

Xiao Xu, Xiang Wang, Yu-Pei Liao, Lijia Luo, Tian Xia, and Andre E. Nel (2022) *Use of a liver-targeting immune-tolerogenic mRNA lipid nanoparticle platform to treat peanut-induced anaphylaxis by single- and multiple-epitope nucleotide sequence delivery.* ACS Nano.

<https://pubs.acs.org/doi/10.1021/acsnano.2c12420>

FARE: Toolkit for food allergies in the classroom

<https://www.foodallergy.org/resources/food-allergies-classroom>

Nemours KidsHealth: Food allergies

<https://kidshealth.org/en/kids/food-allergies.html>

Nanooze: Exploring the world of nanotechnology

<https://www.nanooze.org/>

**Acknowledgment:** This article's adaptation was supported by the Moderna Charitable Foundation.



moderna

## Check your understanding

1 Why do some people experience anaphylaxis from eating food?

---

---

2 What was the function of the mRNA in the nanoparticle developed by the researchers?

---

---

3 Why did the researchers expose a group of untreated mice to peanut extract?

---

---

4 Brainstorm a list of other things (besides food) that can cause allergic reactions.

---

---

---

5 With a partner, design a meal that you might share with friends and family. Identify which foods in the meal might be a concern for a person with food allergies. Brainstorm alternative foods that you could serve to prevent an allergic reaction.

---

---

6 Many countries use food labels to tell people if a product contains an allergen or if it was produced in a place that contained an allergen. Do you think that food labels are an effective way to prevent anaphylaxis? Explain your answer.

---

---

---

---