Discovery of an amino acid that helps regenerate and rejuvenate the small intestine, opening a new direction for cancer treatment

MIT scientists have discovered that the amino acid cysteine ??can activate intestinal stem cells, helping to repair damage caused by radiation and chemotherapy. The research opens up a new approach in regenerative medicine.

This discovery could open up new approaches to repairing tissue damage caused by radiation or chemotherapy.

A new study from the Massachusetts Institute of Technology (MIT) shows that supplementing with foods rich in the amino acid cysteine ??can help repair and rejuvenate the small intestine. The team found that cysteine ?? activates an immune signaling pathway that allows stem cells to create new intestinal tissue.

This increased regenerative activity may help repair radiation damage, a common side effect of cancer treatment. While the study was conducted in mice, if similar results are seen in humans, increasing cysteine ??intake through diet or supplementation could be a way to help speed up tissue repair.

' *The study shows that if we give patients a diet rich in cysteine ??or a cysteine ??supplement, we can reduce some of the damage caused by chemotherapy or radiation,* ' says Professor Omer Yilmaz, director of the MIT Stem Cell Initiative. ' *What's unique here is that we're not using a synthetic molecule, but a natural compound found in food* .'

How does Cysteine ??help regenerate stem cells?

Previous studies have shown that certain diets, such as low-calorie diets, can help increase intestinal stem cell activity. However, this work is the first to identify a specific nutrient that can directly promote intestinal cell regeneration.

The study was published on October 1, 2025, in the journal Nature, with Professor Omer Yilmaz as the lead author and Dr. Fangtao Chi, a postdoctoral researcher at the Koch Institute (MIT), as the first author.

What we eat has a huge impact on our overall health, says Prof. Yilmaz. High-fat diets have been linked to obesity, diabetes and metabolic disorders, while calorie restriction has been shown to extend lifespan in many organisms. His lab has investigated how different eating patterns affect stem cell regeneration and found that both high-fat diets and short-term fasting can stimulate stem cell activity through different mechanisms.

' *We know that diets high in sugar, high in fat or low in calories all have clear effects on health. But at a more detailed level, we still know very little about how individual nutrients affect stem cell fate and tissue function* ,' – Professor Yilmaz explains.

The role of cysteine ??in immune activation

In the new study, the team fed mice diets rich in 20 different amino acids – the building blocks of protein – to see which had the strongest effect on the ability of intestinal stem cells to regenerate. The results showed that cysteine ??was the most effective, promoting the growth of stem cells and progenitor cells (precursors to mature intestinal cells).

Further experiments revealed that cysteine ??activates CD8 T cells, a special group of immune cells. When the intestine absorbs cysteine ??from food, intestinal mucosal cells convert cysteine ??into CoA, which is then released into the mucosal layer to stimulate CD8 T cells to produce the cytokine IL-22 – a key molecule that promotes intestinal stem cell regeneration.

It was previously unknown that CD8 T cells could produce IL-22 to aid in this process. When activated, these T cells can actively respond and repair damage in the intestinal mucosa.

' *Interestingly, when mice were fed a cysteine-rich diet, the number of IL-22-producing immune cells increased significantly, especially the CD8 T-cell group,* ' – shared Prof. Yilmaz.

The team also found that this process occurs mainly in the small intestine, where most dietary protein is absorbed, rather than in other parts of the digestive system.

Ability to repair intestinal damage

The results showed that a cysteine-rich diet increased the ability of the intestinal lining to regenerate after damage from radiation therapy. In unpublished experiments, the team also found that the diet helped repair damage caused by the chemotherapy drug 5-fluorouracil (5-FU), a common treatment for colon and pancreatic cancer, which often damages the intestinal lining.

Cysteine ??is abundant in meat, milk, beans and nuts, and the body can also synthesize cysteine ??from the amino acid methionine in the liver. However, cysteine ??produced in the liver is dispersed throughout the body,

not concentrated in the small intestine as when absorbed directly from food.

' *When consuming a diet rich in cysteine, the gut is the first place to come into contact with large amounts of this nutrient,* ' says Dr. Chi.

Additionally, cysteine ??also has antioxidant properties, helping to protect cells from damage. However, this is the first study to demonstrate the role of cysteine ??in stimulating stem cells to regenerate intestinal tissue.

The team is now expanding their research to determine whether cysteine ??can stimulate the regeneration of other types of stem cells, such as hair follicle stem cells. They will also look at other amino acids that may influence the process.

' *We believe we will uncover many new mechanisms of how amino acids control the regeneration and maintenance of the health of the small intestine and colon* ,' – said Professor Yilmaz.