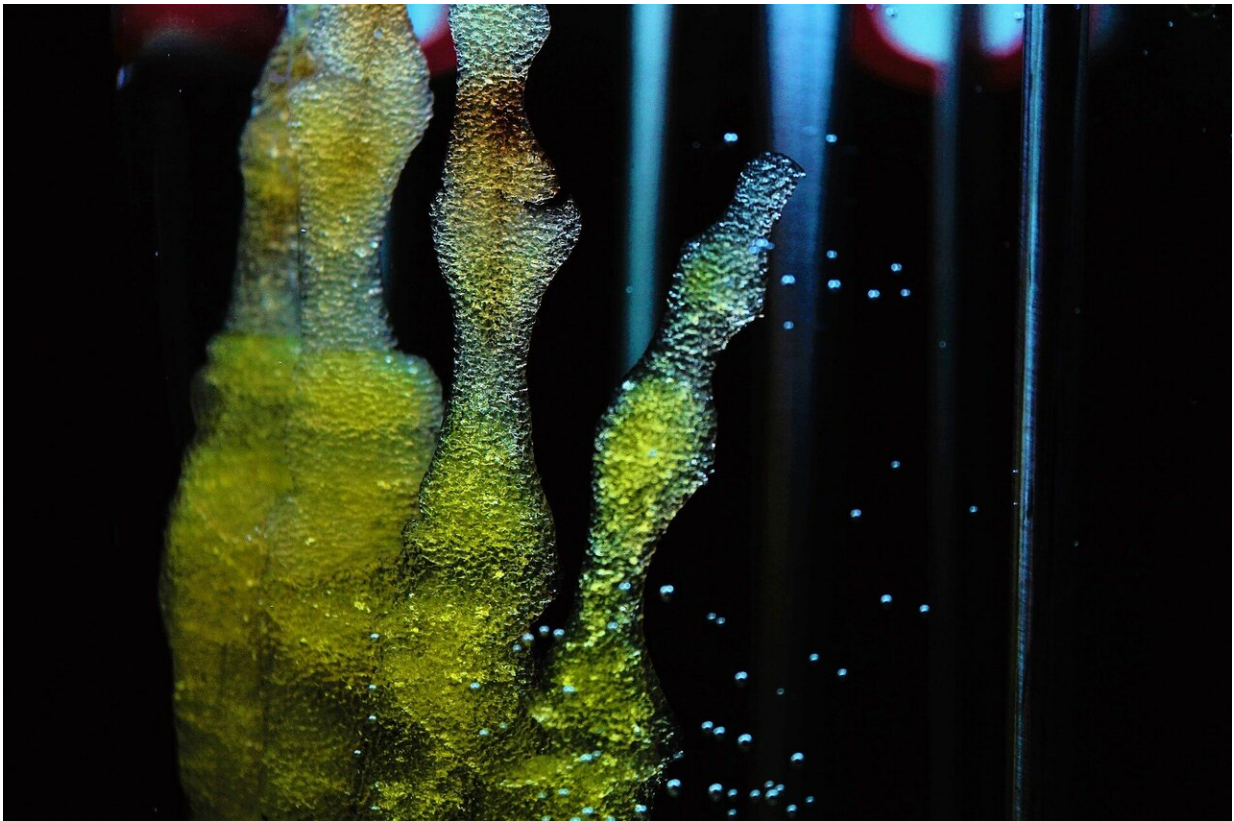


# Turning stem cells into bone with nanoclay-reinforced hydrogel

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Assistant Professor Alireza Dolatshahi-Pirouz and colleagues have developed a hydrogel that combines synthetic materials with living cells, and can turn stem cells into bone without adding external growth or

differentiation factors.

More than 50 percent of women and 20 percent of men over the age of 50 will experience a [bone fracture](#) during their lifetime. One way to prevent these fractures—particularly in the most sensitive parts of the skeleton—is delivery of [stem cells](#) by means of an injectable carrier, which safeguards the [cells](#) on the way into the body. Using a systematic combinatorial approach, the research team has tested 63 different nanoengineered hydrogels, and introduced an optimal biomaterial that not only protects the cells, but also facilitate the spontaneous differentiation of the stem cells into [bone](#) cells. Usually external growth factors and differentiation factors, which can be both toxic for the body and also quite expensive, are needed to turn stem cells into the desired type of cells.

## Relief to osteoporosis patients

Osteoporosis causes the bones to become brittle and fragile due to loss of density. Patients with this type of disease could in the future benefit from the nanoreinforced [hydrogel](#). Alireza Dolatshahi-Pirouz explains: "Bone is a dynamic tissue that is continually being built, broken down and rebuilt in a process called remodeling. This process is controlled by many interacting factors, and once this balance is disturbed, the problem arises. When we get older such an imbalance is often caused by hormonal changes, and is intensified by our cells becoming less effective and fewer in numbers. The idea behind this novel system is to bring a semi-synthetic scaffold into the body that attracts stem cells and provides the requirements to turn them into bone cells, and thereby, bring the balance back to the bone remodeling cycle."

## 63 combinations were tested

To form the hydrogel, the team has cross-linked [hyaluronic acid](#), which is a carbohydrate found in most human tissues and widely used in tissue engineering. This hydrogel by itself has some drawbacks, it is brittle, has poor load bearing qualities, and cannot withstand much external force or shock.

To create a stronger and more durable material, hyaluronic acid was combined with an alginate network and further reinforced with clay nanomaterials. Such a combination leads to a much tougher hydrogel with the proper stiffness, which is still porous enough to maintain the transport of nutrients through the hydrogel.

The most promising combinations were tested in terms of their capability to form new bone cells, and in-vitro studies showed that the hydrogels were capable of forming mineralized bone in a differentiation-factor-free environment. The results revealed that when these cell-laden hydrogels were deposited into an in-vitro model bone defect, new bone formation occurred that adhered tightly to the bone defect. "We believe that the specific nanoclay materials we use provide the required mineral composition, and give rise to the transformation of stem cells to bone tissue," Alireza Dolatshahi-Pirouz says.

## **The next step**

Clinical trials are ongoing with collaborators in Spain, where cell-free hydrogels are implanted into the body. The idea is that the hydrogels will attract stem cells in the body, and serve as small factories producing rejuvenated and more efficient stem cells. "It could also be really cool to incorporate electronics in the hydrogel to monitor what goes on in the body, for example in the bone defect, and if things are not progressing according to the plan, we could stimulate the hydrogel through the electronic interface to attract more stem cells or stimulate the cells more efficiently. As such, we would create a feed-back loop for monitoring

progress and stimulating the system depending on the feedback," Assistant Professor Alireza Dolatshahi-Pirouz added.

The results were published in *ACS Applied Materials and Interfaces* in a paper titled "Combinatorial Screening of Nanoclay-Reinforced Hydrogels: A Glimpse of the "Holy Grail" in Orthopedic Stem Cell Therapy?"

**More information:** Masoud Hasany et al. Combinatorial Screening of Nanoclay-Reinforced Hydrogels: A Glimpse of the "Holy Grail" in Orthopedic Stem Cell Therapy?, *ACS Applied Materials & Interfaces* (2018). [DOI: 10.1021/acsami.8b11436](https://doi.org/10.1021/acsami.8b11436)

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