

# 3D Printed Bones: Hydroxyapatite

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## Abstract

3D printing is being applied in a variety of fields, medicine being one of many. For centuries, hydroxyapatite – a naturally occurring calcium mineral found in bones – has been used in implants, but it has not been entirely successful. Scientists have recently found a form in which this calcium can be used to create acceptable bone implants by constructing a mixture with a biocompatible, biodegradable, and elastic polymer. The focus of this project is to inform people of the capabilities of 3D printing in the medical field, with specific reference to new materials for bone implants.

## Research Question

How can 3D printing help produce bone implants that won't be rejected by the human body?

## Precedents and Prior Research

Ramille N. Shah, Ph.D. – professor at Northwestern University's Medical School – and her team has created a hyperelastic material from hydroxyapatite and a polymer. Prior implants have been created with hydroxyapatite including bone grafts and teeth. Bone grafts often come with health risks as they are hard, brittle, and prone to infection. Shah and her team found that by adding an elastic polymer to the calcium mineral – in a ratio of ten percent (polymer) to 90 percent (hydroxyapatite) - the body can accept the structure and regenerate bone. The mixture is also flexible and adjustable because of its elastic properties. Experiments are already being done on animals; human trials will begin within five years.

## Process

Research of bone structure was conducted to comprehend the purpose of hydroxyapatite in the bones. This mineral makes up 70 percent of the bone. The importance of a porous structure surfaced during this stage as well; it allows for regeneration of bone cells that infiltrate the structure.

Blender – an open source 3D content-creation program – was used to modify the model of a right humerus found on thingiverse. Professor Dan Collins assisted with adjusting the model to be ready for the printer.

## Results

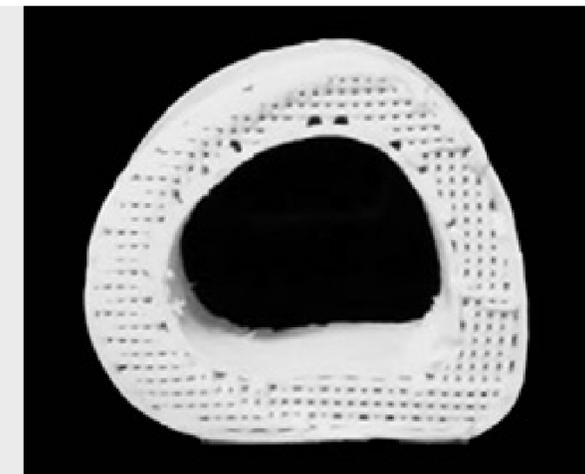
The result is a 3D printed model of a right humerus bone to suggest the idea of flexible bones that the pictures on the right portray.

## Conclusion

In creating a 3D model consisting of a mixture of hydroxyapatite and a polymer, scientists can create a structure that the human body will not reject. Furthermore, with the structure being flexible, doctors will be able to adjust the implant to fit any patient. Flexible material made of a calcium found in bones will replace previously used implants. These new plants will reduce if not eliminate complications for the patients.

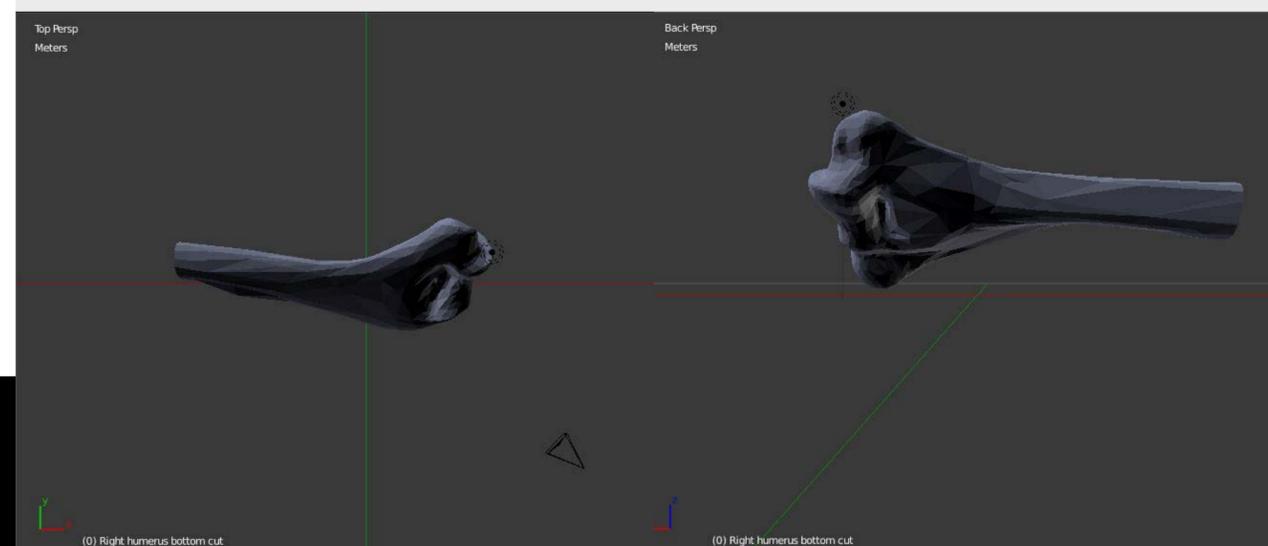


This image is showing the elasticity and durability of a structure made of hydroxyapatite.



In this image, one can see the porosity of the structure which allows for blood vessels to form inside.

The image on the right is portraying new bone cells growing in an implant placed inside an animal. It rebuilt the injured area with the structure which is now part of the body.



The images above are of the bone model in the Blender software.

## References

MORRIS, AMANDA . "Promising Biomaterial to Build Better Bones with 3-D Printing." *McCormick Northwestern*, [www.mccormick.northwestern.edu/news/articles/2016/09/promising-biomaterial-to-build-better-bones-with-3d-printing.html](http://www.mccormick.northwestern.edu/news/articles/2016/09/promising-biomaterial-to-build-better-bones-with-3d-printing.html). Accessed 28 Sept 2016.

"Print-on-demand bone could quickly mend major injuries." *Youtube*, uploaded by Science Magazine, 28 Sept 2016, [www.youtube.com/watch?v=5-VdPeoVCAI](http://www.youtube.com/watch?v=5-VdPeoVCAI).

## Acknowledgements

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