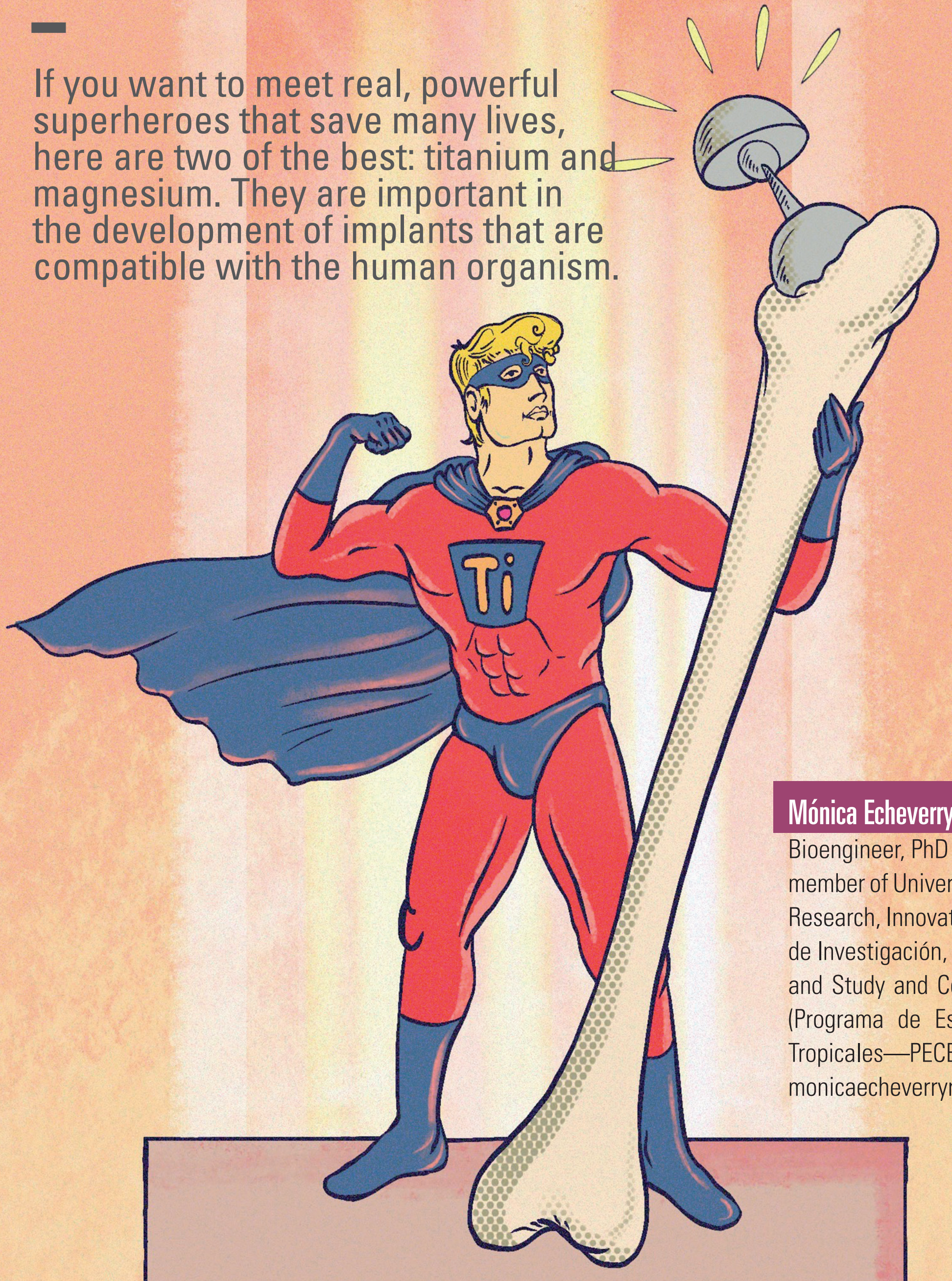
Powerful Metals that Save Lives

If you want to meet real, powerful superheroes that save many lives, here are two of the best: titanium and magnesium. They are important in the development of implants that are compatible with the human organism.



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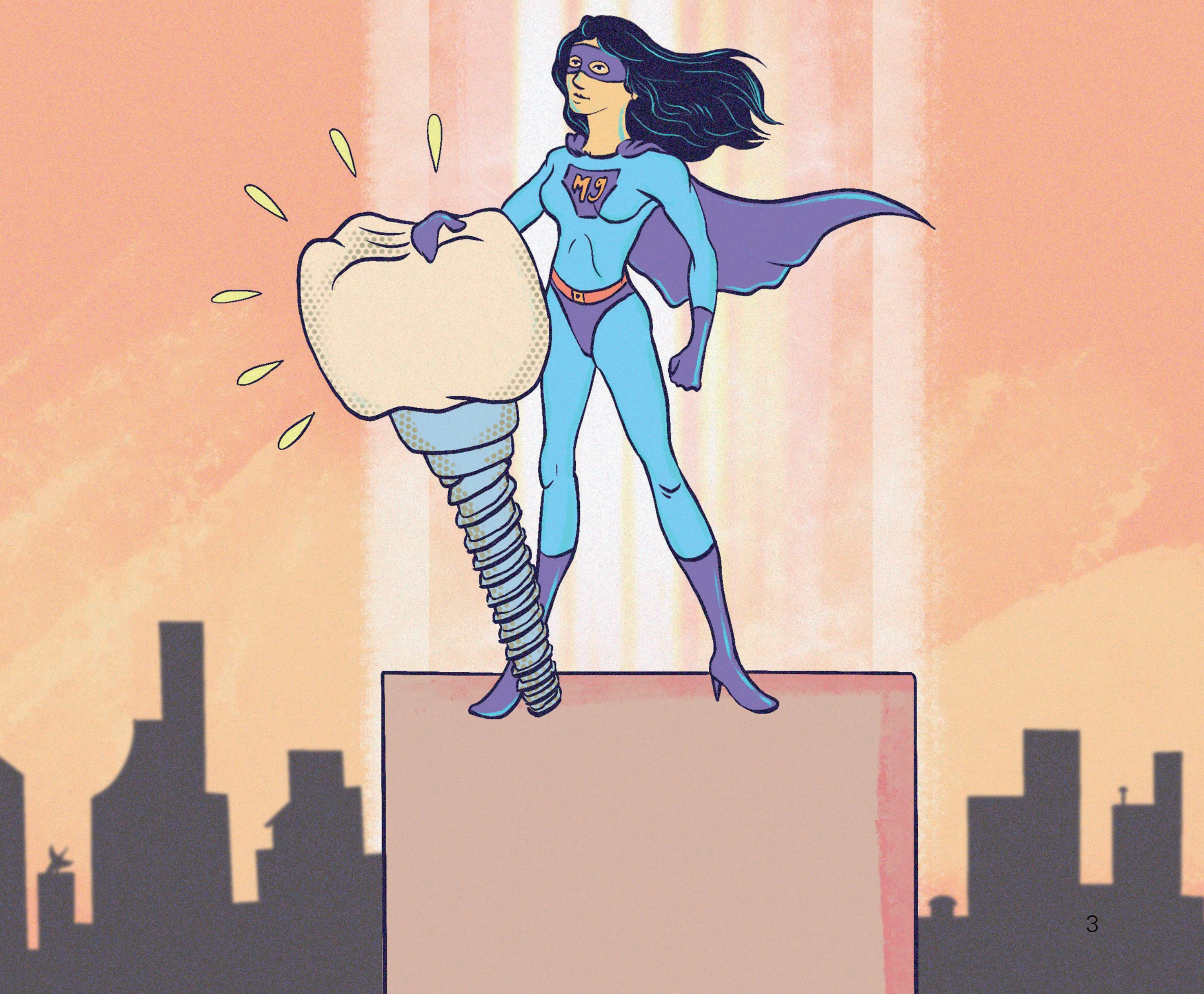
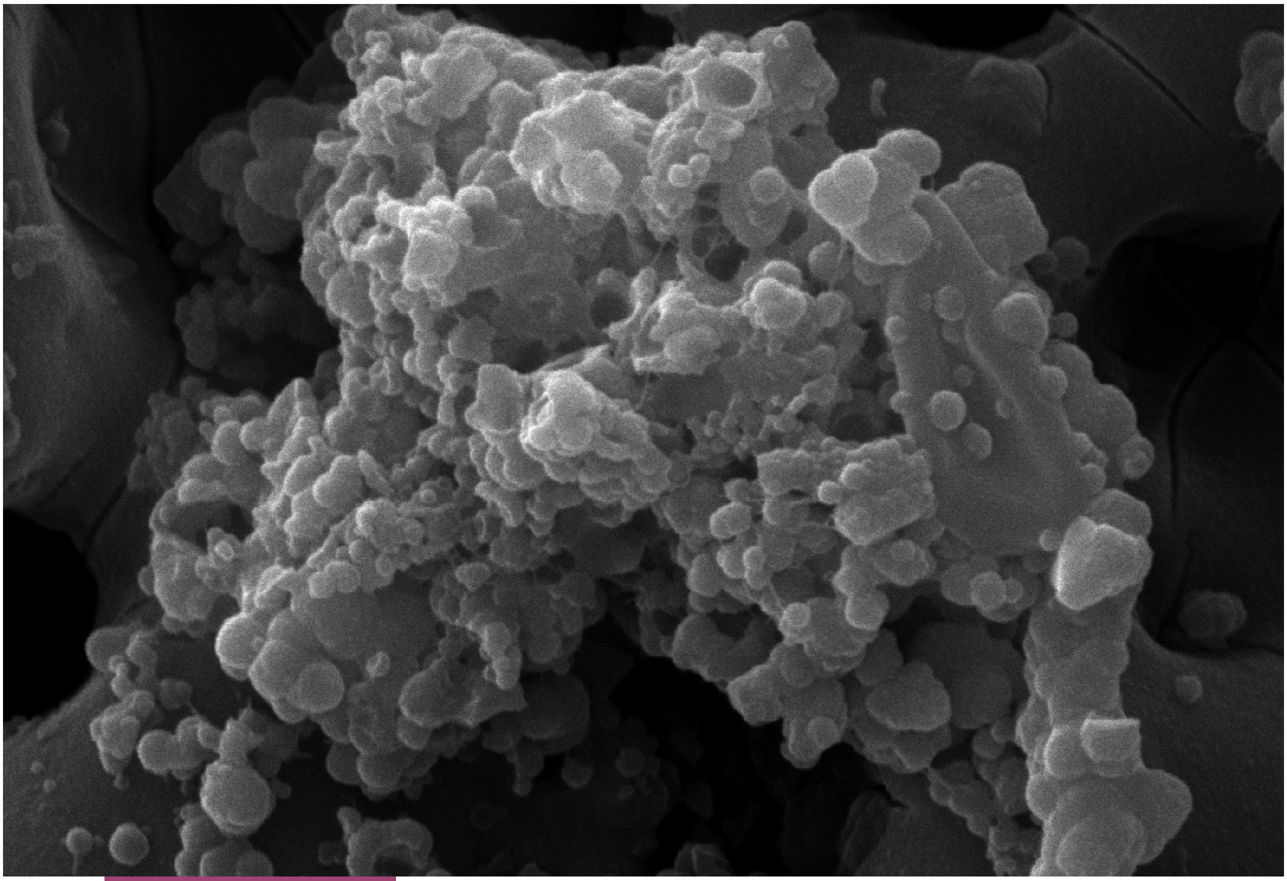
Talking about superheroes is fashionable right now. One of my favorites is Ironman. It is strong, hard-wearing and uses technology. Of course! It was inspired by a metal! Today, we're going to talk about two metals that are undoubtedly the real superheroes of our time since they save millions of lives around the world—titanium and magnesium.

The episode we will relate today takes place in hundreds of hospitals around the world, where organ donation and use of transplants to repair or replace tissues and organs is at a critical point. There are fewer and fewer donors, while waiting lists grow longer.





Microphotograph of a Ti-Mg alloy developed at U de A. Photo | CIDEMAT Group.

Unfortunately, there is another unfavorable factor in this equation, and that is the complexity of biocompatibility between individuals. Biocompatibility is the capacity of a tissue to be accepted by an organism without causing rejection. Nonetheless, as a gift from nature, our heroes turn up from the *Super League of Metals*. They can be used to make implantable biomedical devices that increase the chances of rehabilitation for a great number of patients.

The "titan" of metals is titanium (Ti). Its atomic number is 22 and it belongs to Group IVB of the periodic table. This element was discovered by William Gregor in 1791. Since then, its use has been diversely explored, especially in the automotive, military, industrial and biomedical sectors. Titanium is found in nature in its oxidized form—titanium dioxide or rutile—since it is a more stable state than the pure element. Among the superpowers of titanium are its low density, which makes it very light, its high resistance to corrosion and its good mechanical properties. In medical terms, this inert and stable material is very biocompatible. This is why, in recent years, it has been widely researched and used in the making of orthopedic and dental implants, as well as in the form of nanoparticles. Another material that is also in the group of light metals is magnesium (Mg). This element, discovered in 1618, with atomic number 12 and located in Group IIA of the periodic table, is an essential element for the human body and many organisms in nature. Magnesium participates in basic tasks related to the nervous system's function, bone growth and formation, muscle movements and the regulation of the circulatory system. On a cellular level, magnesium, in its ionic form, regulates homeostatic and biochemical processes and is involved in the equilibrium of DNA and energetic processes. As a material, magnesium is widely used in the aerospace industry and the manufacture of automotive parts and sporting goods. In recent years, the use of magnesium in biomedical applications has increased significantly.

Among the superpowers of titanium are its low density, which makes it very light, its high resistance to corrosion and its good mechanical properties.

Magnesium's superpowers come from its high capacity to be molded—ductility—which makes it easy to handle, machine or turn into materials with complex and specific shapes as needed. Another power is its low density, which makes it a very light material. However, the most remarkable of magnesium's superpowers is its capacity to degrade in aqueous media. In addition, since it is an essential element for life, it is a highly biocompatible material. For both these reasons, the use of magnesium in the biomedical field aims at the generation of temporary three-dimensional platforms, similar to scaffolds, around which cells and tissue can grow. The purpose is that, once the tissue has been repaired, the material slowly disappears without adverse effects. The idea of having an implant that degrades as the tissue regenerates is quite a challenge since magnesium is a highly reactive material. In aqueous solutions, its resistance to corrosion is low. Therefore, the mechanical properties of the material can deteriorate over time. Titanium and magnesium are superheroes that work on a daily basis and are part of a new generation of metals. The metals of this new generation show a more efficient biomedical behavior than traditional metals such as stainless steel and cobalt-chromium alloys.

At Universidad de Antioquia, these superheroes, titanium and magnesium, are objects of daily research. In two research groups, the Research, Innovation and Development Center (CIDEMAT) and the Study and Control of Tropical Diseases Program (PECET), there are teams that work together in a multidisciplinary way to design and generate knowledge that revolves around these metals. The solutions that have emerged have implied the combination of concepts from materials engineering, biology and medicine.

The contributions from such fields make these materials more efficient when they are used as implants. As a result, the rehabilitation of implanted patients is quicker and safer. One of the strategies that have been suggested to improve these materials is the creation of coatings and control of surfaces to make the processes

Magnesium in its natural form as magnesium carbonate

Magnesium's superpowers come from its high capacity to be molded—ductility—which makes it easy to handle.

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between cells and implants more harmonious and effective. This kind of technology could then be used in the making of permanent and temporary medical devices such as dental implants, osteosynthesis elements, hip prostheses and cardiovascular implants. In the CIDEMAT group, titanium and magnesium have featured in diverse research projects in which a superficial modification technique called anodizing has been used to create coatings through the regulated oxidation of said metals. In this process, it is possible to control both the composition of the layers obtained and their morphology and physicochemical characteristics through the variation of parameters such as voltage, current density, immersion time and immersion environment. The design of surfaces through electrochemical techniques such as anodizing makes it possible to generate topographies—reliefs—for cells to have greater affinity and be in optimal conditions to grow and regenerate tissue. Once the materials are superficially modified, a biological validation and biocompatibility tests are performed in the PECET group. Cells are initially cultivated with the material evaluated to verify that it is not toxic and fosters tissue repair. If promising results are observed, a more advanced and profound evaluation is performed through implantation in animals. Once these filters are gone through, we can use the materials in humans. Today's story ends by asserting our two heroes' power and generosity and by concluding that metals are an incredible world to explore. Science uses verbs such as "discover", "understand", "evaluate", "modify" and "validate". Superheroes are fashionable right now, and all too often we ignore the fact that nature is full of them. All we have to do is recognize and study them. ✕