Loss of the function or architecture of an organ can lead to significant impairment, such as can be seen in cases of oncologic surgery, trauma, or end-stage organ failure. Surgical reconstruction and solid organ transplantation constitute an ambitious, yet not always successful, attempt to overcome these problems. Even so, significant obstacles remain, not limited to the shortage of available organs, the technical difficulties of reconstruction, and the need to overcome rejection of immunologically foreign tissue. These concerns have led to the concept of tissue engineering. First introduced by Langer and Vacanti in 1993, tissue engineering was described as a multidisciplinary field with the goal of repairing, replacing, or reconstructing missing or destroyed tissue or organs in a manner that closely resembled the original function and architecture [1]. Essentially, engineering principles are combined with biologic sciences to cultivate or create new tissues and organs in vitro and in vivo, with the obvious advantage of avoiding prosthetic material as much as possible and using autologous genetic material so that the drive for repair and regeneration does not fall victim to immunologic rejection. The three original pillars of tissue engineering, as stated by Langer and Vacanti [1], included isolated cells, tissue-inducing substances, and matrices. Although these basic principles remain the same today, what has changed is the great variety of cell-based applications (especially with the use of stem cells), our increased understanding of the biochemical and molecular environment in which the new tissues and organs will function, and the ability to create more advanced extracellular matrices or scaffolds to support the biologically active construct. Surgeons have been critical to this line of research, because they occupy a central position, with surgical disease and treatment very often intimately interconnected to the need for organ and tissue regeneration. Variations of the concept of tissue engineering have been developed to address the needs in the different organ systems, including the gastrointestinal system, specifically, the stomach.

In the report by Maemura et al. [2], the authors used the premise of the multiple comorbidities associated with partial and total gastrectomy for gastric cancer to discuss their experience with stomach tissue engineering. Specifically, they developed a tissue-engineered stomach by combining cells from a collagen-digested stomach from neonatal rats, thus obtaining stomach epithelium organoid units, which were then seeded onto the inner luminal surface of microporous biodegradable polymer tubes made of fibrous polyglycolic acid.
mesh. These were then implanted into the recipient rats. When examined, they were found to have appropriate cellular development and specialization and patency when connected to the rest of the gastrointestinal tract. Although no difference was seen in the weight gained between the experimental group and the control (Roux-en-Y reconstruction) group, a lower incidence of anemia was present in the experimental group, suggesting the production of intrinsic factor. Despite the significant challenges, which the authors readily mentioned, the importance of this work is that they showed functional adaptation and a good blood supply for the neo-stomach in, essentially, a model of in situ tissue engineering. Additionally, the report by Maemura et al. [2] serves to highlight the trail that the authors, as well as some other teams, have followed in this quest to achieve progress in stomach tissue engineering at some of the top centers in the world in the field of regenerative medicine.

Certain points are worth making. The goal in this endeavor is that through tissue engineering we can end up with an organ or tissue that will achieve the architecture and function of the original and thus become a successful replacement. The report by Maemura et al. [2] is a huge step in the right direction, although several limitations, that the authors themselves acknowledged, remain. Specifically, the lack of innervation (which is also common in transplanted organs) can cast a shadow on the long-term functionality of the tissue-engineered stomach. Additionally, the issue of long-term vascularization remains, because it becomes critical for the newly engineered organ to maintain a sufficient blood supply as it grows in its new environment. Researchers have tried to manage this issue by using collagen-based scaffolds containing vascular endothelial growth factor to augment neovascularization [3,4]. The concern regarding the need for immunosuppression remains, because their model is essentially an autologous one, with the new stomach formed in the abdominal cavity of the recipient. Whether the microporous scaffolds with appropriate modifications can create an immunologically privileged environment remains questionable. Despite these potential limitations, the enthusiasm is significant, because the continued progress in engineering and the biomedical sciences have opened new prospects, such as the use of stem cells as the source of cells. Although they might not have the specialized function of differentiated adult cells, stem cells have the advantage of an intrinsic regenerative potential that can make them protagonists in tissue engineering. The usefulness of stem cells can be further augmented by the existence of paracrine communication between them and differentiated cells [5]. Scaffolds represent the other half of the tissue engineering equation, and, again, advances, such as the improved understanding of cell–scaffold interactions and the ability to increasingly manipulate matrix characteristics, have led to matrices that can play an active role in the activity of the cells and adjust to the environment [6]. All these improvements can help create or engineer a chimeric organ that will be able to modulate the rejection phenomenon, and, with the addition of gene induction, be able to provide us with a patient-tailored organ.

The limitations that can be seen in this work are simply the hallmark of the early steps of progress, and they should embolden, rather than discourage, research along these lines. More importantly, it is critical for surgeons to be at the forefront of this research, because this is a unique opportunity to shape the future such that will decisively help our patients.

REFERENCES