

3D Printing

For
stronger
bones!



RÉSEAU DE RECHERCHE EN SANTÉ
BUCCODENTAIRE ET OSSEUSE

Martin M

FOREWORD

Science is intimidating for the average person. Scientific studies are all too often explained in a clinical manner, the subject matter is advanced and complicated to understand... Consequently, it is easy to believe, wrongly, that researchers are disconnected from the general public. Their projects, therefore, remain generally unrecognized and unappreciated, while false information flourishes and becomes more attractive.

Research into oral and bone health is particularly unpopular. There is a general tendency toward denial: this field of expertise elicits aversion, since it is too often associated with pain (fractures) or even disgust (oral infections, oral cancer, etc.).

This collection has the mission of reversing this tendency by informing you of major advances in the field. We want to show you what health research is and share our passion with you. Research is one of the drivers of humanity, but researchers must better communicate and explain how their work contributes to the welfare of individuals, the environment, and society.

In order to highlight the research and its members in an original way, the Network for Oral and Bone Health Research (RSBO for "Réseau de recherche en santé buccodentaire et osseuse") retained two artists in residence, Daniel Ha and Martin PM. For more than a year, Daniel and Martin met with our researchers across Quebec and visited their labs. In the following pages, you can read and enjoy their comics, and thereby discover along with them, the extraordinary work being done by our researchers.

We hope that these pages will inspire you and allow you to see the scientific research in the field of oral and bone health with new eyes. Perhaps it will elicit among the younger crowd the desire to study the sciences and, who knows, become researchers themselves?

RSBO Art and Science Committee

Dr. Christophe Bedos, RSBO Director

Dr. Argerie Tsimicalis, Researcher and RSBO Member

Dr. Marta Cerruti, Researcher and RSBO Member

Dr. Andrée Lessard, RSBO Manager

Martin Patenaude-Monette, RSBO Artist in Residence

Daniel Ha, RSBO Artist in Residence

WHAT IS IT?

WHAT IS THE RSBO?

For more than 25 years, the Network for Oral and Bone Health Research (RSBO for “Réseau de recherche en santé buccodentaire et osseuse”) tirelessly supports Quebec researchers and their students in the pursuit of excellence in fundamental, clinical, and epidemiological research. The Network numbers more than 100 researchers and over 300 students predominantly from McGill University, Université de Montréal and Laval University, as well as their affiliated hospitals (notably CHU Sainte-Justine, Shriners Hospitals for Children-Canada, Montreal General Hospital, Jewish General Hospital and Montreal Sacred Heart Hospital).

The RSBO network is funded primarily by the “Fonds de recherche du Québec – Santé” (FRQS). It also relies on partnerships with associates from different backgrounds, notably professional organizations in the field of oral and bone health as well as associations which represent the most underprivileged people in our society. This is how the RSBO network brings together the stakeholders in our social fabric – scientific community, clinicians, populations and users of healthcare services, as well as administrators, decision makers and industries – with an eye toward producing knowledge on health and oral and bone diseases, but also to take this knowledge and apply it.

The actions of the RSBO network fall within the national strategies for promoting health as well as those set forth by the World Health Organization. The Network aims to promote the health and welfare of the Quebec population, to reduce inequalities in healthcare, but also to contribute to the economic and social vitality of Quebec. Actions taken by the RSBO network can, in fact, stimulate the retention or return to employment of more vulnerable people, develop highly qualified personnel, generate the development of new technologies, or encourage scientific entrepreneurship and the production of patents.

Transmitting knowledge is one of the major goals of the RSBO network. This is why we created the Art and Science Committee, which promotes scientific research and health of the Quebec society through the arts. The RSBO network considers that sciences and the arts, far from being antithetical, can in fact mutually feed each other, combine, and ultimately, benefit the entirety of the population.

This comic collection is a creative and original way to raise awareness in our fellow citizens about research done here, especially on a subject like oral and bone health, which can be quite off-putting for the uninitiated. And yet, the research we are doing is fundamental for all of us.

The idea of doing a collection of comics is exactly right coming from the RSBO Art and Science Committee, and a great approach to demystifying everything that happens in our mouth, from the effect of sugar on our teeth to oral ecology, as well as 3D technology to foster stronger bones, and other activities which take place between our nose and our chin...

Due to its excellence in research, the Network is supported by the “Fonds de recherche du Québec – Santé” (FRQS). It seems so very pertinent and important to me that the general public better understand the research being done since, in the end, it is they who benefit from it, even if they don't realize it.

At a more basic level, it is important to raise awareness concerning science and research in the general population: the methods, approaches, questions, and uncertainly, but also the discoveries, results, and accomplishments! It is important to increase the number of opportunities to present science to the population, young or old, so that scientific expertise becomes the first instinctive source we turn to when we ask questions on any particular subject. Calling on art is definitely a good way to stimulate curiosity.

I commend the Network for its initiative in raising awareness for its expertise and projects, and perhaps generating interest among the new generations of students who are wondering about their future. Who knows? Perhaps, despite a little bit of apprehension, this comic collection might help you better appreciate your next visit to the dentist!

*Rémi Quirion,
Chief Scientist of Quebec*

3D PRINTING



DEREK ROSENZWEIG, PH. D.

Assistant Professor, Department of Surgery, McGill University

We can now dream: Can we regrow a damaged organ using a 3D printer? Not yet, but bioprinting is no longer only science fiction! Discover the latest developments in Dr. Derek Rosenzweig's lab at Montreal General Hospital.

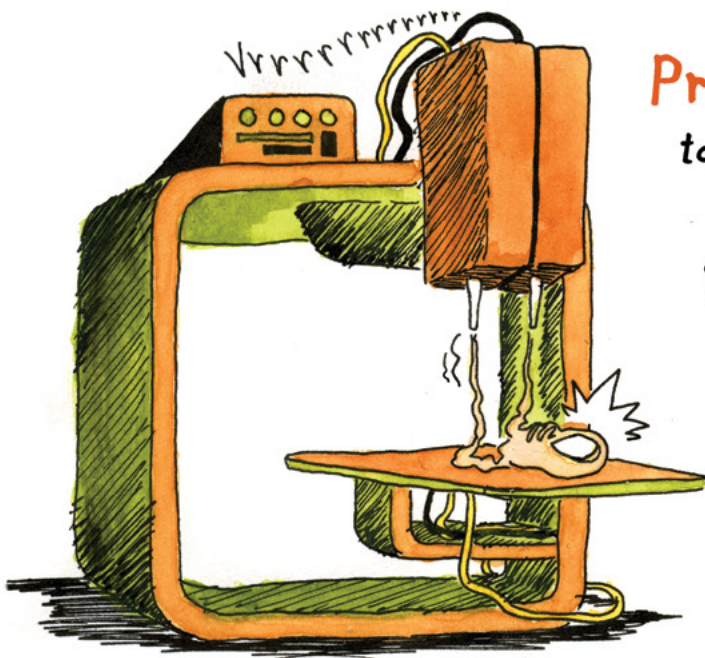
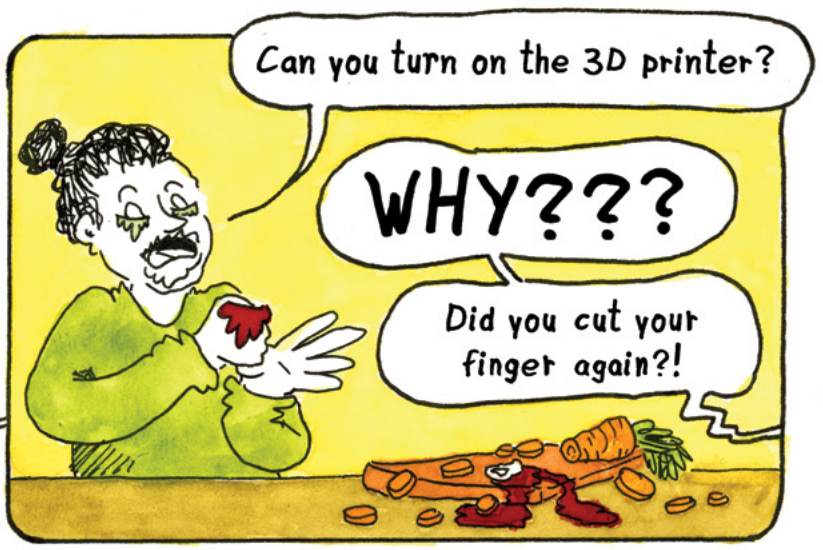


MARTIN PM

Martin Patenaude-Monette, also known as Martin PM, hails from Montreal. He brushes his teeth at least twice a day, but usually three times. However, he is not quite as rigorous when using dental floss, which he consents to using occasionally, especially when he has a piece of popcorn stuck between his teeth. Curious by nature, he is interested in scientific research, social issues, and politics. He sees comics as a powerful medium for addressing scientific and social issues, by combining text and images.

www.martinpm.info

[instagram.com/martinpm.bd](https://www.instagram.com/martinpm.bd)



Printing limbs or organs in order to replace them: has reality caught up to fiction?

Yes, we can print human cells with the help of bioprinters.

No, we are still not able to print whole limbs.

Let's use an example: you tear a ligament in your knee.



It will be repaired with a piece of ligament taken from elsewhere.



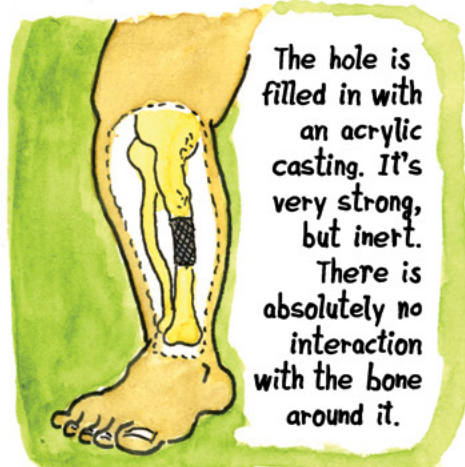
Unfortunately, this procedure weakens the zone where the ligament was taken from.



And the risk of injuring your knee again is high.



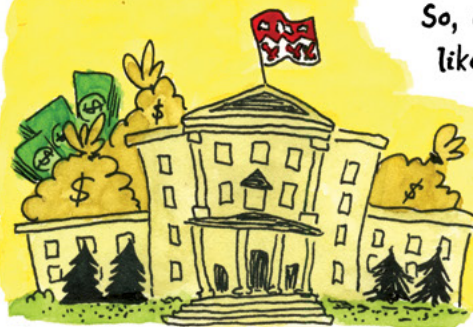
Another example: when we remove a bone tumour...



The healing of the bone at the junction of the casting is not optimal and the tumour can recur.



So, can a rich university, like McGill, at the cutting edge of technology and with very expensive equipment, help us do better?



In fact, the devices we use are fairly cheap. I have one...



The type of 3D printer we use costs less than \$1000 USD...



The bioprinter is more expensive, but we chose one of the least expensive ones, around \$50,000 USD.



Derek Rosenzweig is a researcher at McGill University's Department of Orthopaedic Surgery at Montréal General Hospital.

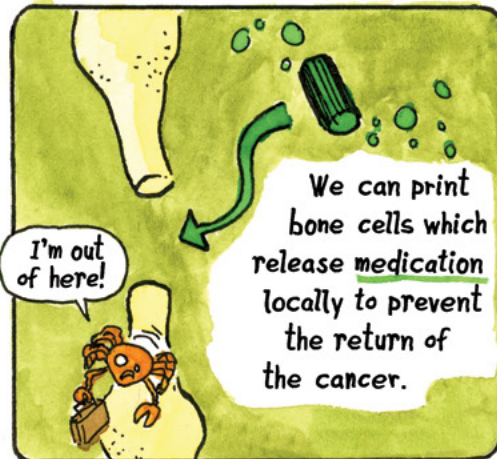


The software we use is open source and we share our scripts with other teams elsewhere in the world.

In short, all of this allows us to print

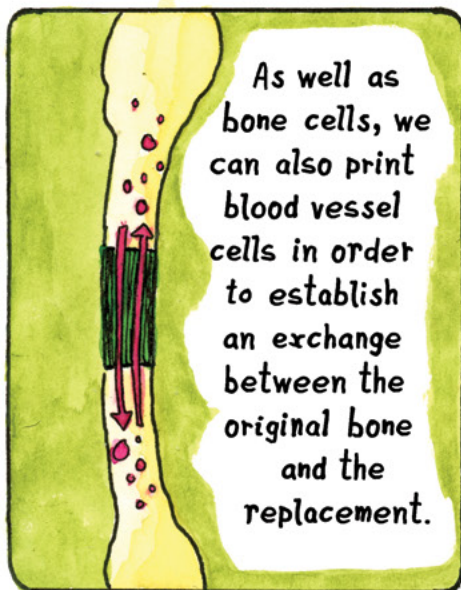
cells!

Let's get back to the tumour which left a hole in the bone.

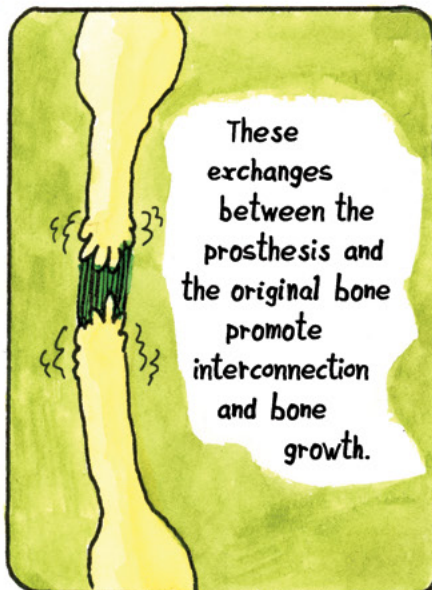


I'm out of here!

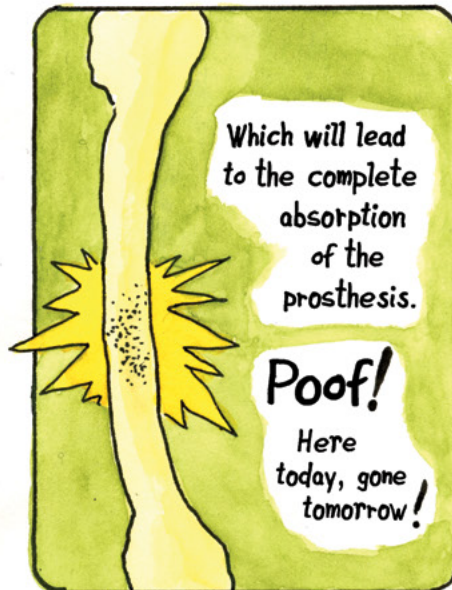
We can print bone cells which release medication locally to prevent the return of the cancer.



As well as bone cells, we can also print blood vessel cells in order to establish an exchange between the original bone and the replacement.



These exchanges between the prosthesis and the original bone promote interconnection and bone growth.



Which will lead to the complete absorption of the prosthesis.

Poof!

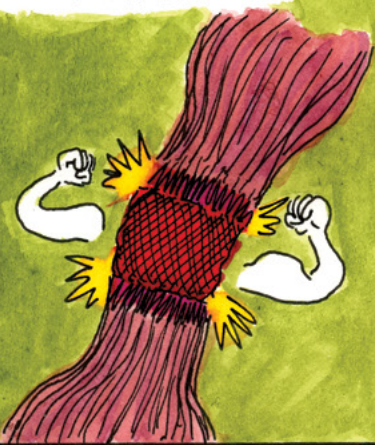
Here today, gone tomorrow!

Bioprinting can also save our ligaments.



No more need to butcher our backside!

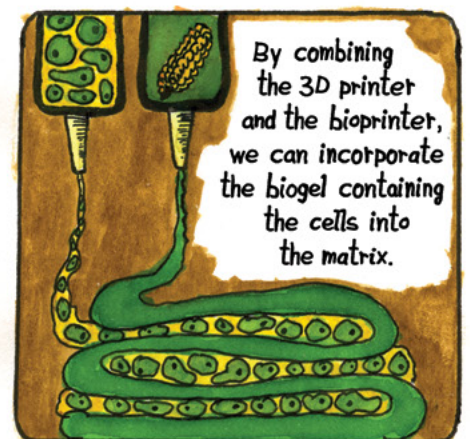
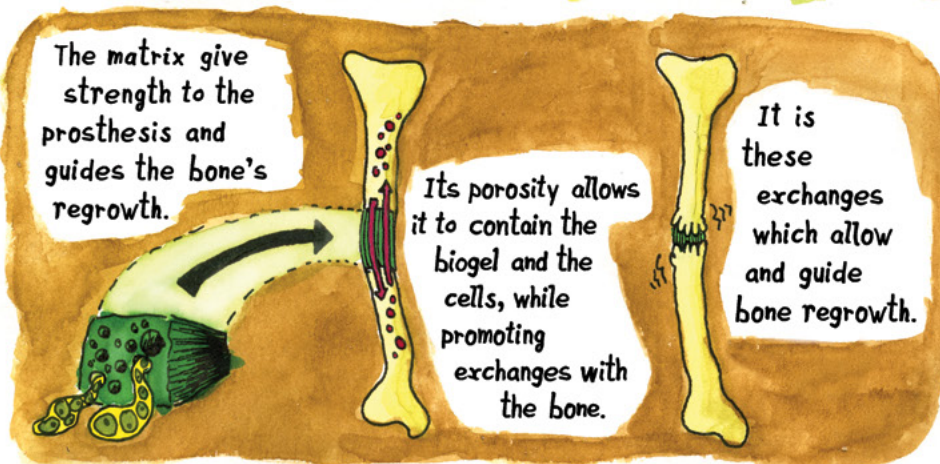
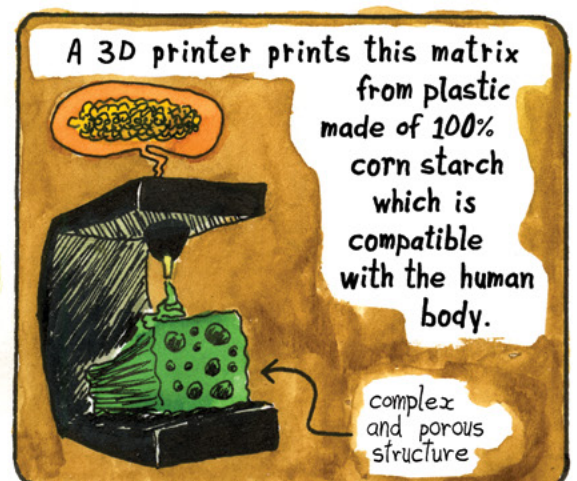
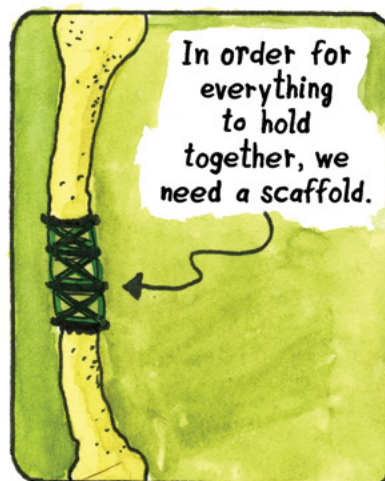
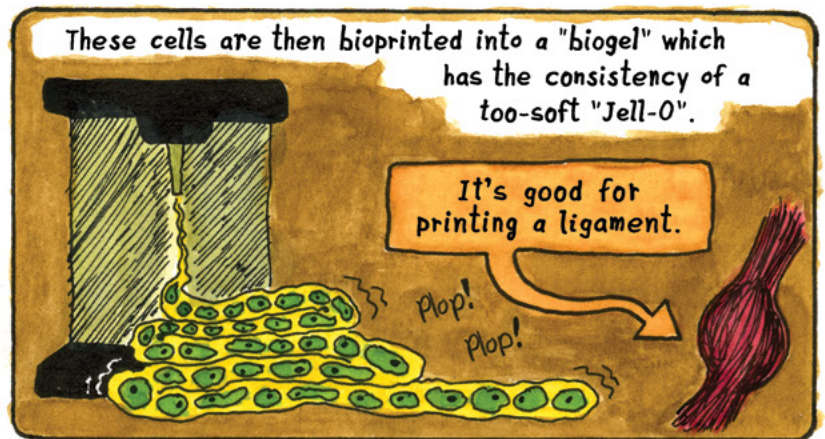
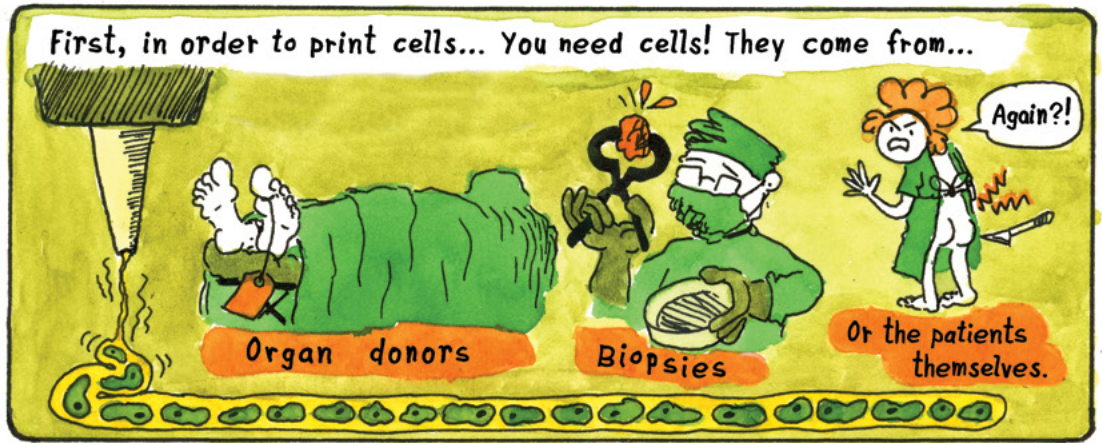
Bioprinting blood vessels in the replacement ligament allows for a better attachment.



This is still all a theory. However, we are working hard to make it a reality!

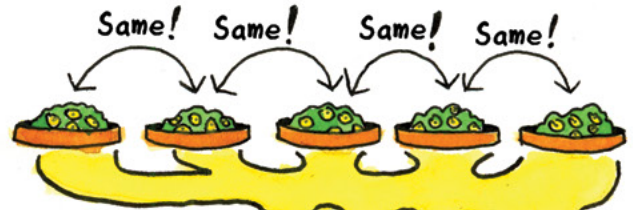


Okay, but
how does
bioprinting
really
work?



Among the real innovations is the improvement and acceleration of experiments and of research.

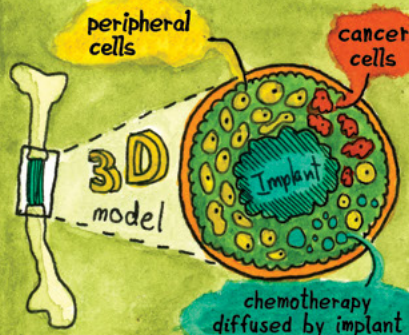
3D printing and bioprinting allow for the serial production of 3D cellular models with great precision.



A 3D cellular model is a miniature assembly of different cell types which imitates reality.



For example, we can imitate the implant which closes the hole left in a bone when a bone tumour is removed.



We can produce many identical ones to test the optimal dose of chemotherapy.

We can therefore develop robust experiments with the help of this precise and reliable procedure in order to evaluate all sorts of treatments and interventions.



We can easily print a large number of samples. The more samples we have, the more significant our results will be.



And this large number of samples also reduces the number of animals needed for research.

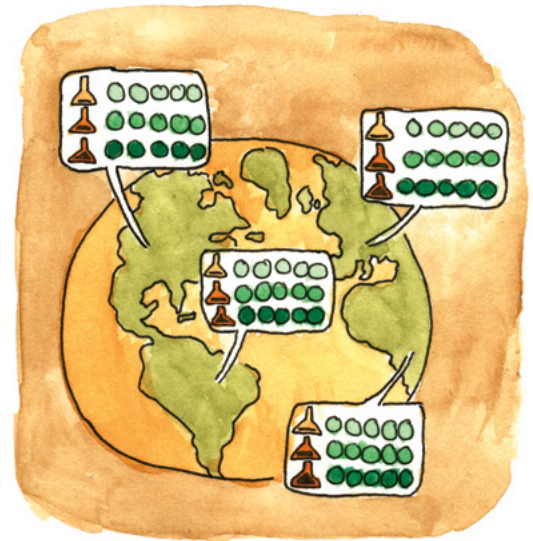


Since the software is free and open source, researchers share their scripts and procedures with colleagues.



With inexpensive high-performance printers...

... these colleagues around the world can reproduce the same experiments. This allows them to check that they get the same results as Derek.



This is what we call

REPRODUCIBILITY.

This means the ease with which one can repeat the experiment by following the same recipe.

A large number

of samples

and reproducibility which allows repetition of the same experiment, that's what makes...



In short, 3D printing and bioprinting lets us carry out experiments...



which are closer to what happens in the human body.

More quickly and more easily.



With better results.

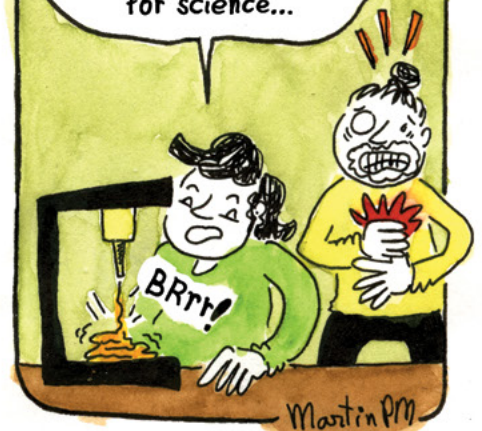


They will allow us to test better matrix designs, in order to print ligaments, implants, etc.



Sorry! It's not yet possible to print a finger!!

But you could give your cut finger to Derek... for science...



Martin PM

ACKNOWLEDGEMENTS

The RSBO network thanks its partners

Fonds de recherche
Santé

Québec



Faculté de
médecine dentaire



UNIVERSITÉ
LAVAL



McGill

Faculty of Dentistry Faculté
de médecine dentaire

Université
de Montréal

Martin PM

I would like to thank the RSBO network, particularly Christophe and Andrée, for having had the courage to begin this artistic endeavour. Thank you for the freedom to create. Thanks go to Daniel for having shared his ideas and his experience with me all during these months of creation. Thanks to the members of the RSBO network who welcomed me into their laboratories. Thanks to Laurène, Estelle, Jacinthe and Lucile for their comments, rereads, and suggestions. Thanks to Laurène for sharing their story. Thanks to Cécilia and Martin, who greatly helped us climb the last summit toward the publication of this collection.

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