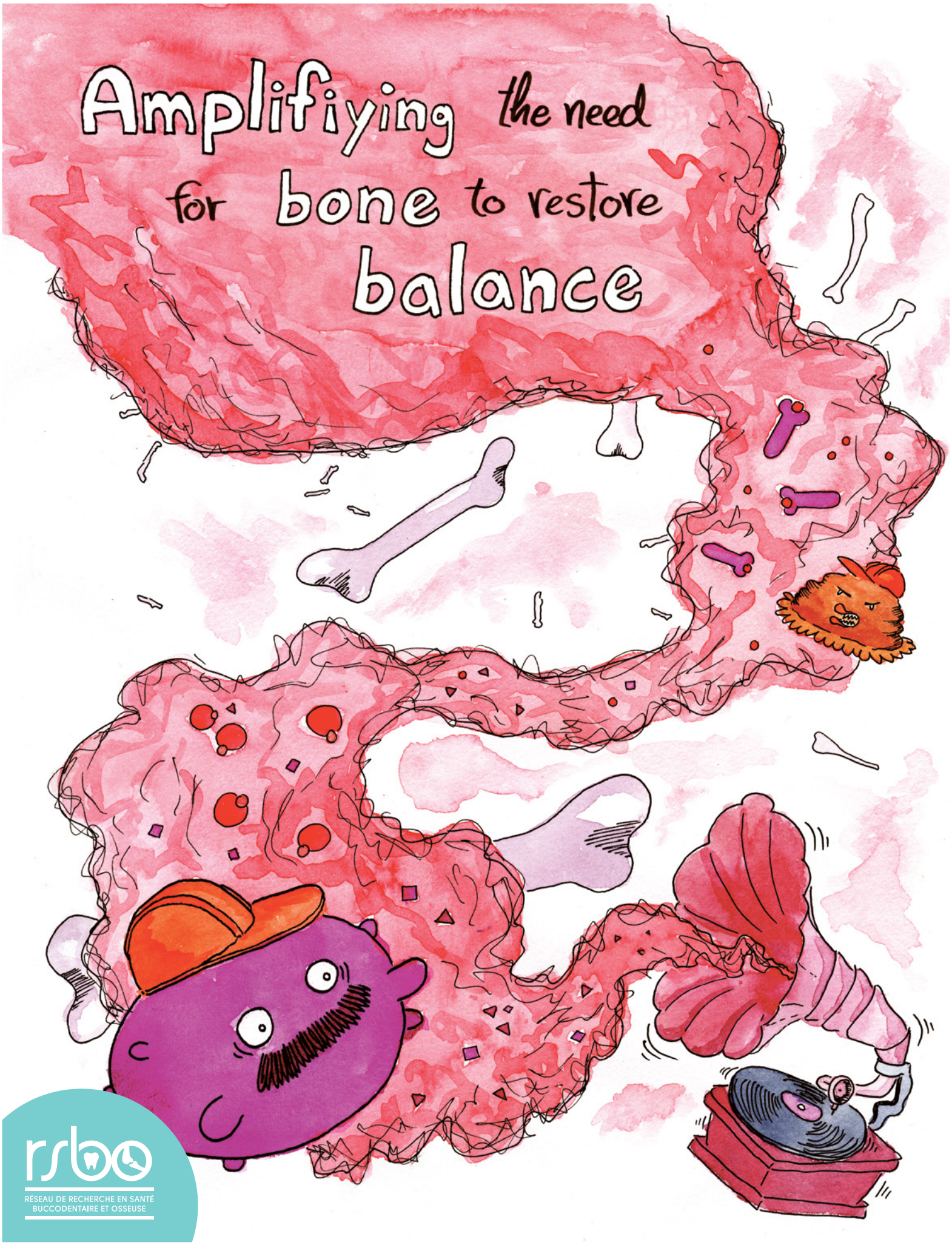


RÉSEAU DE RECHERCHE EN SANTÉ BUCCODENTAIRE ET OSSEUSE

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

AMPLIFYING BONE TO RESTORE BALANCE

RENÉ ST-ARNAUD, PH. D.

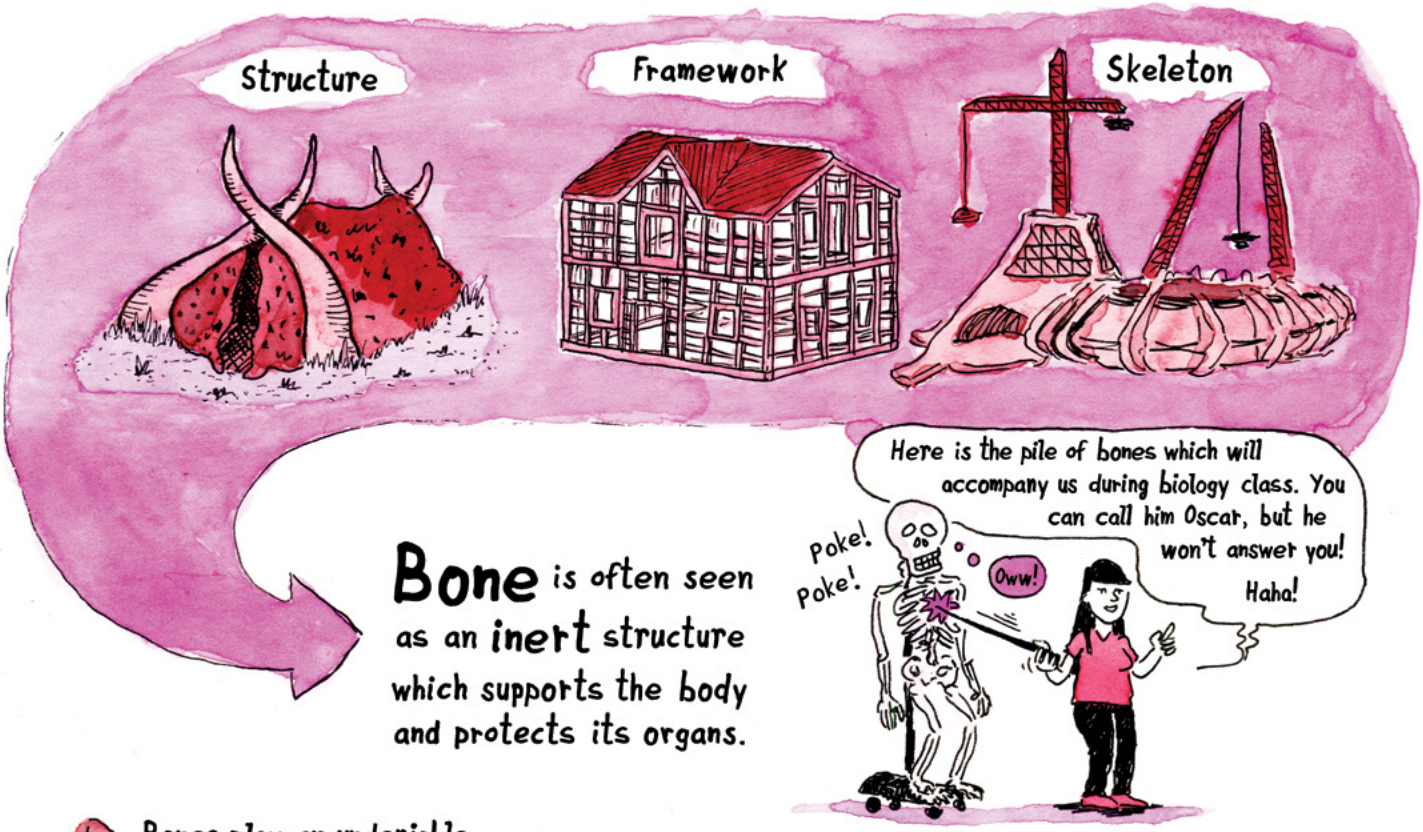
Tenured Professor, Department of Surgery at McGill University
Director at Montreal's Shriner's Hospitals for Children Research Center

What is the connection between bones and teeth? Both are solid! But, why? Because of calcified, mineralized cells. It's easy to believe, wrongly, that the skeleton is an inert framework. But in reality, bone cells are just as active as any other cell in our body. With age or because of certain diseases, bone mass diminishes, making the skeleton more fragile. Dr. René St-Arnaud, an expert in molecular biology, explains how bone is a dynamic and complex tissue. His projects aim to discover strategies for increasing bone mass.

MARTIN PM

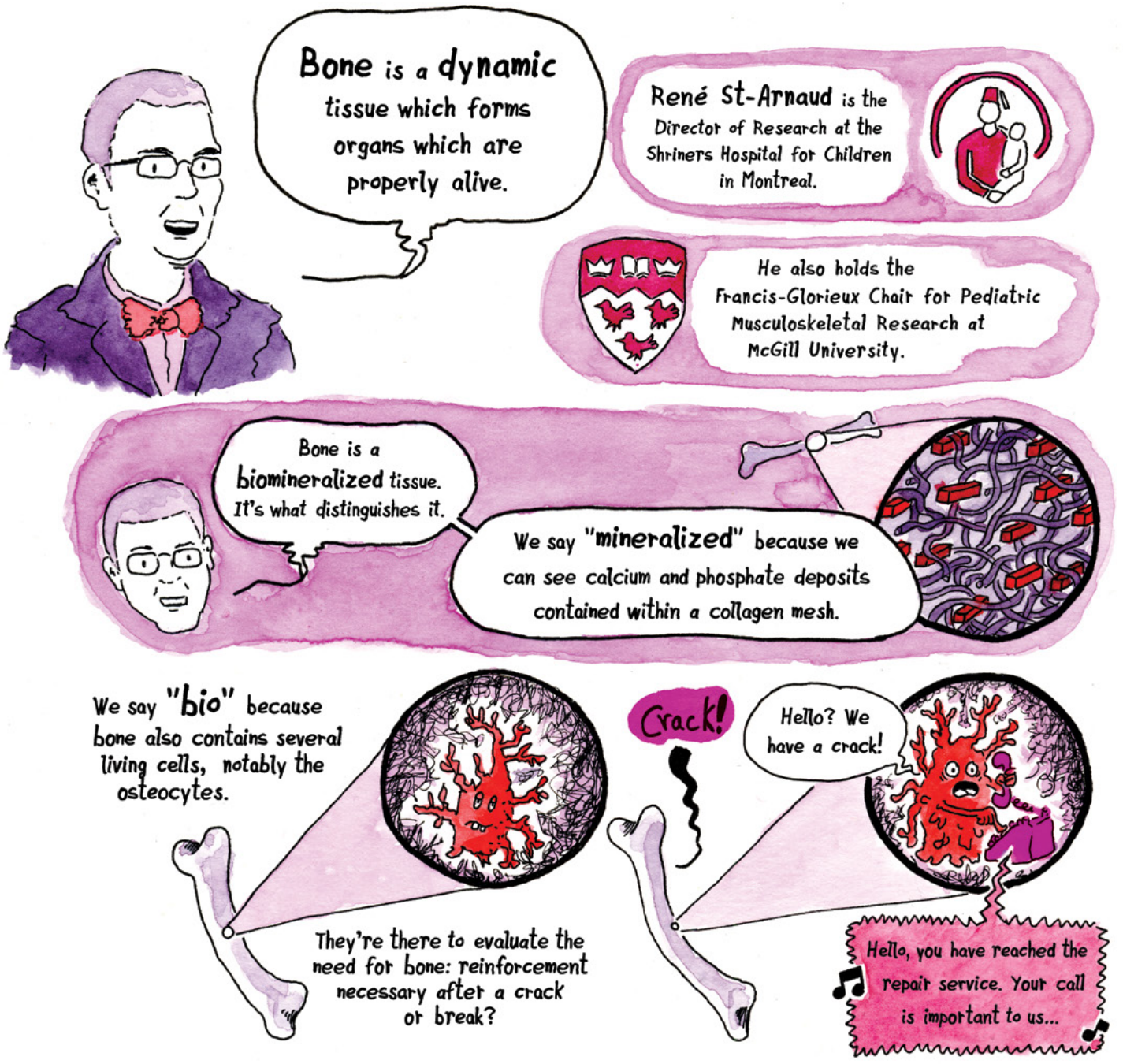
Martin Patenaude-Monette, also known as Martin PM, hails from Montreal. He brushes his teeth at least twice a day, but usually three times. However, he is not quite as rigorous when using dental floss, which he consents to using occasionally, especially when he has a piece of popcorn stuck between his 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

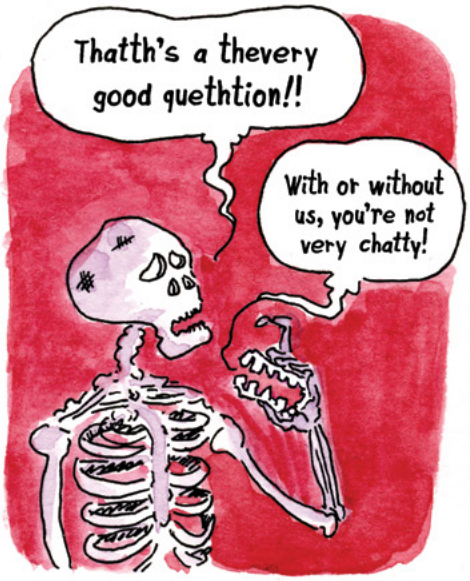

Structure
Framework
Skeleton
Bone is often seen as an inert structure which supports the body and protects its organs.
Here is the pile of bones which will accompany us during biology class. You can call him Oscar, but he won't answer you! Haha!
Poke! Poke!
Oww!


Bones play an undeniable biomechanical role.
Levers
CRACK!
Oops!
Despite a certain fragility...
SNAP!
Oww!


...they can be repaired by a good carpenter.
Today with Dr. Tinker, we're going to learn how to screw a rod into an ankle!
Buzzz! Buzzz!
It's true that Oscar isn't very chatty, but his vitality could surprise you.
It's because I don't want to scare the kids.
I don't like that mister!!!
Whaaaaa!
Tap! Tap!

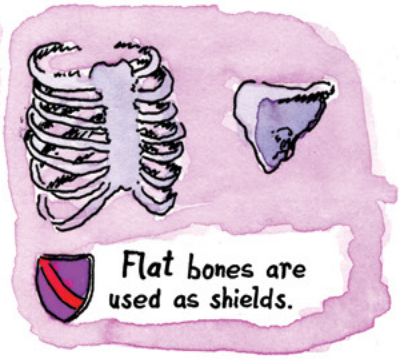


What about teeth? Are they also bones? It's a good question because researchers like René St-Arnaud have come together within the RSBO network with other scientists who also work on teeth, bones, and the mouth.

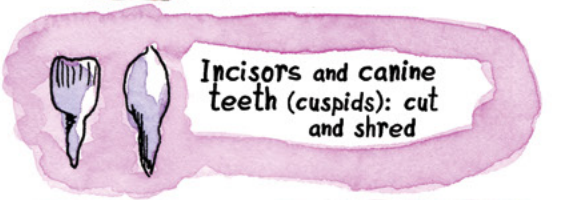


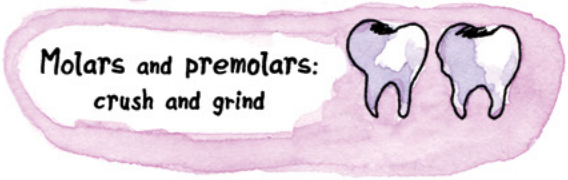
If we compare their shapes and their functions, it's not easy to see what they have in common.

Most **bones** serve as support for the body, for its mobility, or for the protection of its internal organs.

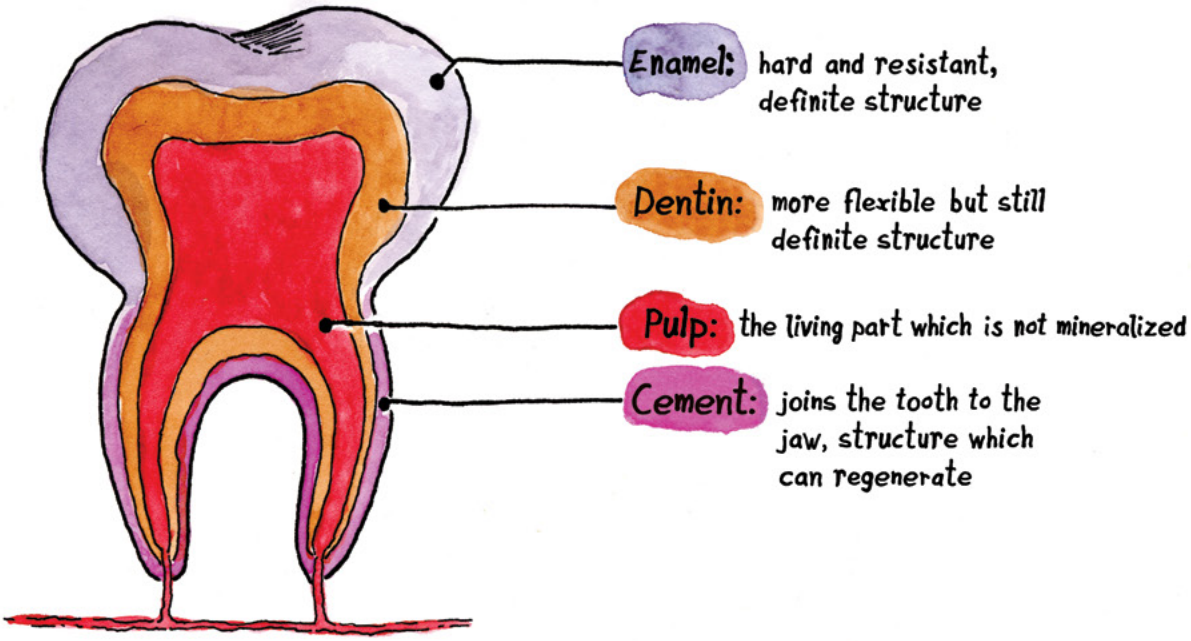


Teeth play a nutritional role.





Yes, teeth are **bones**, but their function requires a different composition.



A tooth is therefore a less dynamic bone, but the biomineralization processus that leads to its formation is the same.

Being **dynamic**, bone is an organ which adapts according to its function.

For example...

SLAM!

The bones in the arm (the one which holds the racket) of a tennis player are **larger**...

If an increased stimulation on the limbs leads to an increase in the size and density of bones, the reverse is also true...

The absence of gravity in space reduces the pressure exerted on bones.

After staying a long time in space, astronauts can lose from 1 to 2% of their bone mass per month.

Before

After

As we've seen before, it's the **osteocytes**, the cells which live in bone, who evaluate the need for bone and send signals to two other types of cells: those who remove bone and those who synthesize it.

Slam!

The hits are hard! We need more bone!

We have to add new bone!

Osteoblast

from the Greek for "germinate"

Always lazy... you can remove bone.

We have to remove old bone!

Osteoclast

from the Greek for "break", "fragments"

Even in adulthood when growth is finished, there is this constant remodelling. It's to maintain bone and adapt to its function, like maintaining and repairing our roads.

Vrrrrrrr!

Ew rrrrrrrich!!

Normally, this dynamic is balanced.

old bone removed
=
new bone added

Certain conditions lead to an imbalance where there isn't enough bone production, or too much removal.

Zzzzzzz

Munch! Munch!

This is the case with **osteoporosis** which occurs with age and different risk factors.

Result: fragile bones and + risk of fractures

Crack!

Certain conditions occur also in children. It's one of the reasons the Research Centre at the Shriners Hospital for Children in Montreal exists.

Hôpitaux Shriners pour enfants

Opened in 1925 by the Shriners, a masonic organization with orientalist symbols, the Hospital offers orthopaedic care to children.

Children who have **osteogenesis imperfecta** (OI) are the main patients at the Hospital.

The cause of this disease is a genetic mutation which, in most cases, affects the synthesis of collagen.

collagen matrix

inadequate mineralization

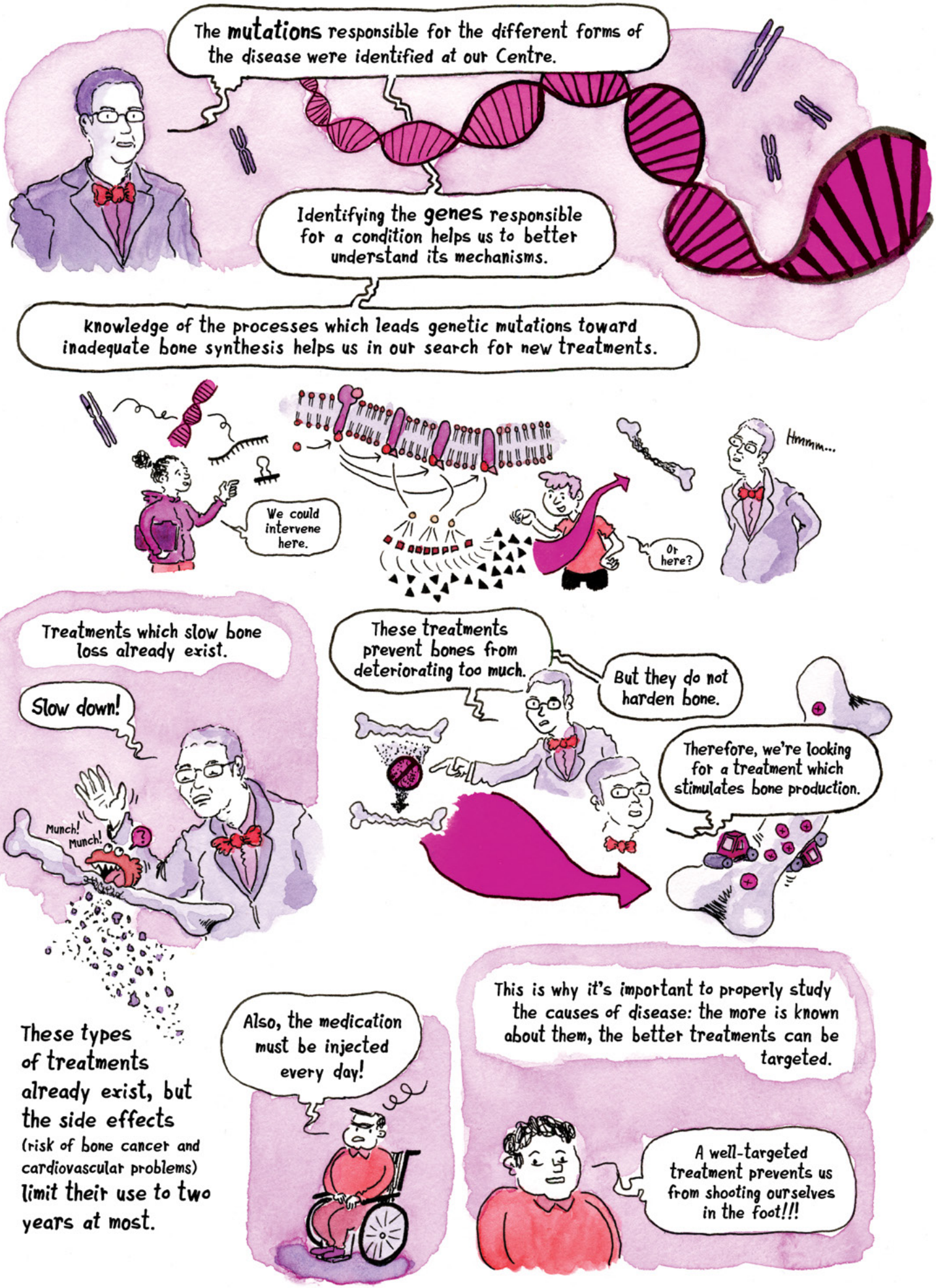
normal bone

= fragility

It can result in deformities like **curved** or **crooked** bones...

...and a **fragility** which leads to fractures.

Oww!


The mutations responsible for the different forms of the disease were identified at our Centre.
Identifying the genes responsible for a condition helps us to better understand its mechanisms.
Knowledge of the processes which leads genetic mutations toward inadequate bone synthesis helps us in our search for new treatments.
We could intervene here.
Or here?
Hmmm...
Treatments which slow bone loss already exist.
Slow down!
Munch! Munch!
These treatments prevent bones from deteriorating too much.
But they do not harden bone.
Therefore, we're looking for a treatment which stimulates bone production.
These types of treatments already exist, but the side effects (risk of bone cancer and cardiovascular problems) limit their use to two years at most.
Also, the medication must be injected every day!
This is why it's important to properly study the causes of disease: the more is known about them, the better treatments can be targeted.
A well-targeted treatment prevents us from shooting ourselves in the foot!!!

When a treatment is either not targeted or badly targeted, there's a risk of undesirable effects on other organs or biological processes.

Yikes!!!

By applying a treatment to a precise target, the risk of unexpected negative effects is greatly reduced.

In order to find the proper target, René St-Arnaud's team studied signal transmission from the osteocyte up to the production of bone.

No need for bone!

Stop!

Zzzzz

Plop!

As long as the need for bone is low, the **osteocyte** enables the emission of an inhibitor which stops the work of the osteoblast.

We need more bone!

Go!

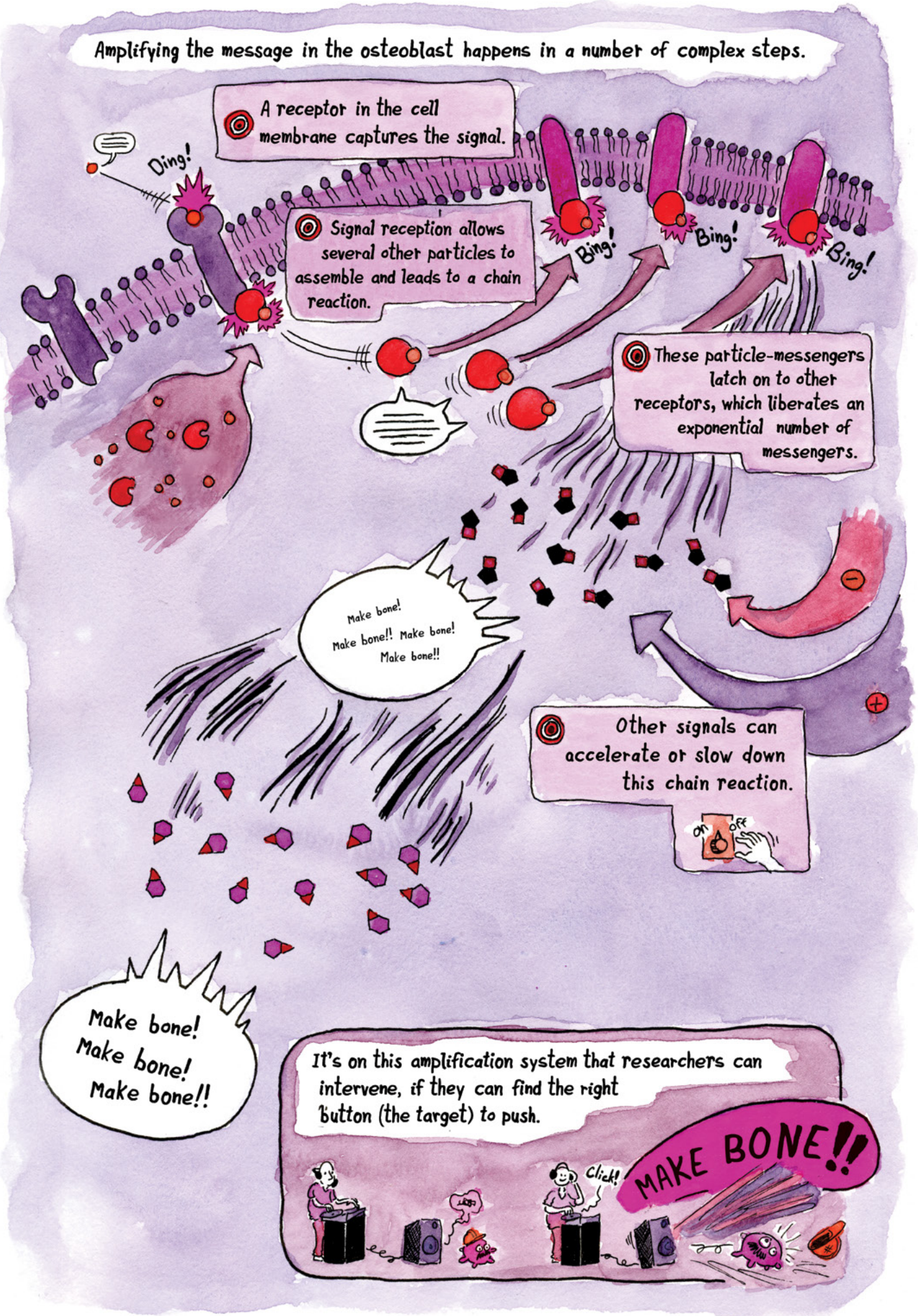
More bone!

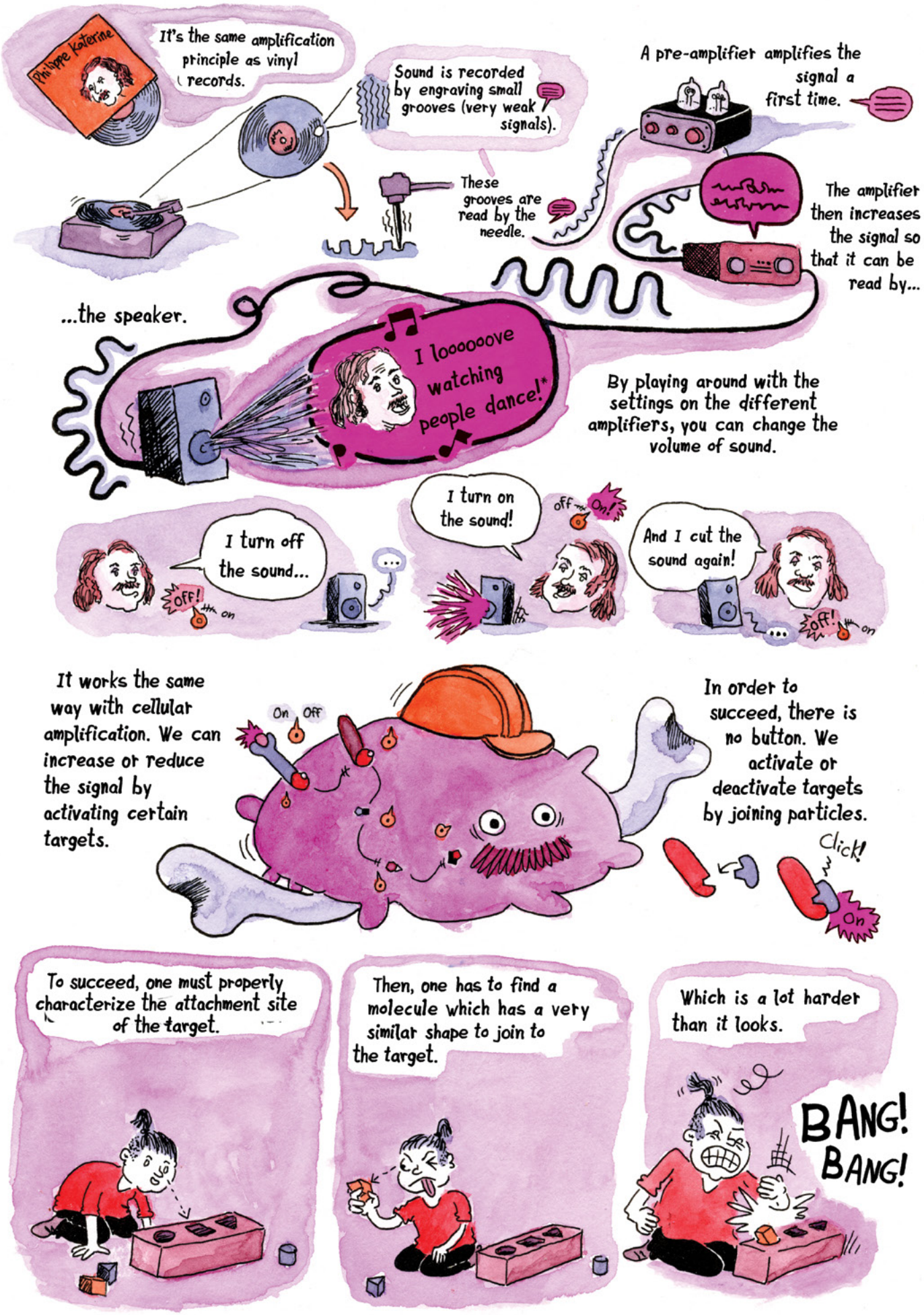
When the need for bone increases, the osteocyte stops emitting the inhibitor. It's a message that the **osteoblast** hurries to amplify.

Once the message has been received and amplified, **osteoblasts** are activated and produce bone.

Vrrrr!

The different steps in transmission of the message are each potential targets which can be hit to activate bone production.


Amplifying the message in the osteoblast happens in a number of complex steps.
A receptor in the cell membrane captures the signal.
Ding!
Signal reception allows several other particles to assemble and leads to a chain reaction.
Bing!
Bing!
Bing!
These particle-messengers latch on to other receptors, which liberates an exponential number of messengers.
Make bone!
Make bone!! Make bone!
Make bone!!
Other signals can accelerate or slow down this chain reaction.
on
off
Make bone!
Make bone!
Make bone!!
It's on this amplification system that researchers can intervene, if they can find the right button (the target) to push.
Click!
MAKE BONE!!



"Louxor, j'adore", a song by Philippe Katerine

René St-Arnaud's team found a specific target: a protein which slows bone production by osteoblasts.

They also found how to intervene with this protein in order to remove the brake.

receptor

Finally, they have identified a molecule which has the proper structure to disarm the brake and let the osteoblast do its work.

molecule

click!

Vrrr Vrrr!

In order to ensure that this molecule can become an efficient and safe treatment, it will have to go through a series of clinical tests.

Cellular model

3D model

Animal model

Clinical tests on patients

APPROVED

At the Shriners Hospital, patients can contribute directly to research by participating in these studies.

My team has been working on this project for 15 years.

In research, we need to show **perseverance** and **resilience**.

When I evaluate candidates in an interview, I ask them how they react to **failure**.

Because these research projects are essentially trial and error.

Often, researchers need to take a step back in order to better go forward. Research is a dynamic process, just like bone growth!

The effect is very positive!!

A promising result!

Yes!!

And that only increases the **joy of discovery** when it happens. We must learn to savour it as well.

Knowledge Cup

MartinPM

ACKNOWLEDGEMENTS

The RSBO network thanks its partners

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Fondation de l'Ordre des dentistes du 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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