

INDOMITABLE

SANTIAGO RAMÓN Y CAJAL

1852-1934



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B

Based on Santiago Ramón y Cajal's original drawing (1885):
glial cells in the mouse spinal cord.



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Thematic biography text (english version also) : © Santiago Lamas.

Translation into English: © Isabel Álvarez.

Scientific advice and supervision:

Santiago Lamas, MD, Research Professor at the CSIC.

Reading comprehension and pedagogy supervision:

Garazi Lizarralde, specialist in early childhood education and reading comprehension programmes.

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www.tw-group.com/en/cajal

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SANTIAGO RAMÓN Y CAJAL

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WRITING: VANESSA LIZARRALDE

ILLUSTRATIONS: NURIA HACHE



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ADVOCATE

Let me introduce you to our advocate: **Belén Garijo**.

Belén is a doctor, and she speaks a language you won't find in any dictionary: the language of science. The same language spoken by our main character, Cajal. That's why she understands him so well.

She started out working in a hospital, caring for people one by one. Until one day, she asked herself: "What if I could help many more people?"

So she changed direction. She began leading large companies that develop medications—**medications that travel all over the world, reaching millions of people at the same time.**

She has lived in very different countries—France, Germany, and the United States—where the words may change, but science sounds the same everywhere, like one big family.

Today, she makes it onto the list of world's top people with superpowers—real-life superpowers!

But if you talk to her, she will tell you she's not a superhero... and she will convince you that you can be one.

Because her world needs powerful minds.

Curious minds.

Brave minds.

Just like yours.



Dear Little Big Reader,

I have an experiment for you.

Next time you go to the doctor, ask if they know Santiago Ramón y Cajal. You don't need to say much more. Just say, "Cajal," and you'll see how something changes.

I'm telling you this from experience. I have worked with scientists in many countries, in many different languages, and there are names everyone understands without needing an explanation. Cajal is one of them.

A scientist who would be 174 years old today... and who is still famous.

Do you know why?

Because he dared to think differently from everyone else.

The great scientists of his time believed the brain was a messy and dark place. But he couldn't believe that. He felt sure that it had to be neat and brilliant. So he got to work to prove it.

It took years for him to **discover that our minds are full of independent cells—neurons**—neatly arranged, communicating with each other by sending tiny flashes of light.

It was a complex and beautiful discovery that he was able to draw with extraordinary precision, and share it with the whole world. Thanks to him, today we understand how something as fascinating as our brain works.

Read his story. Then, if you also feel indomitable, do what Cajal did. Lie down on the grass, look up at the sky, and let your mind explore.

Ask yourself what you would like to discover. What you would like to change. And when you know... go for it!

Because important things never happen all by themselves. You have to work hard, prepare yourself, and be brave enough to go out and look for them.

A big hug,

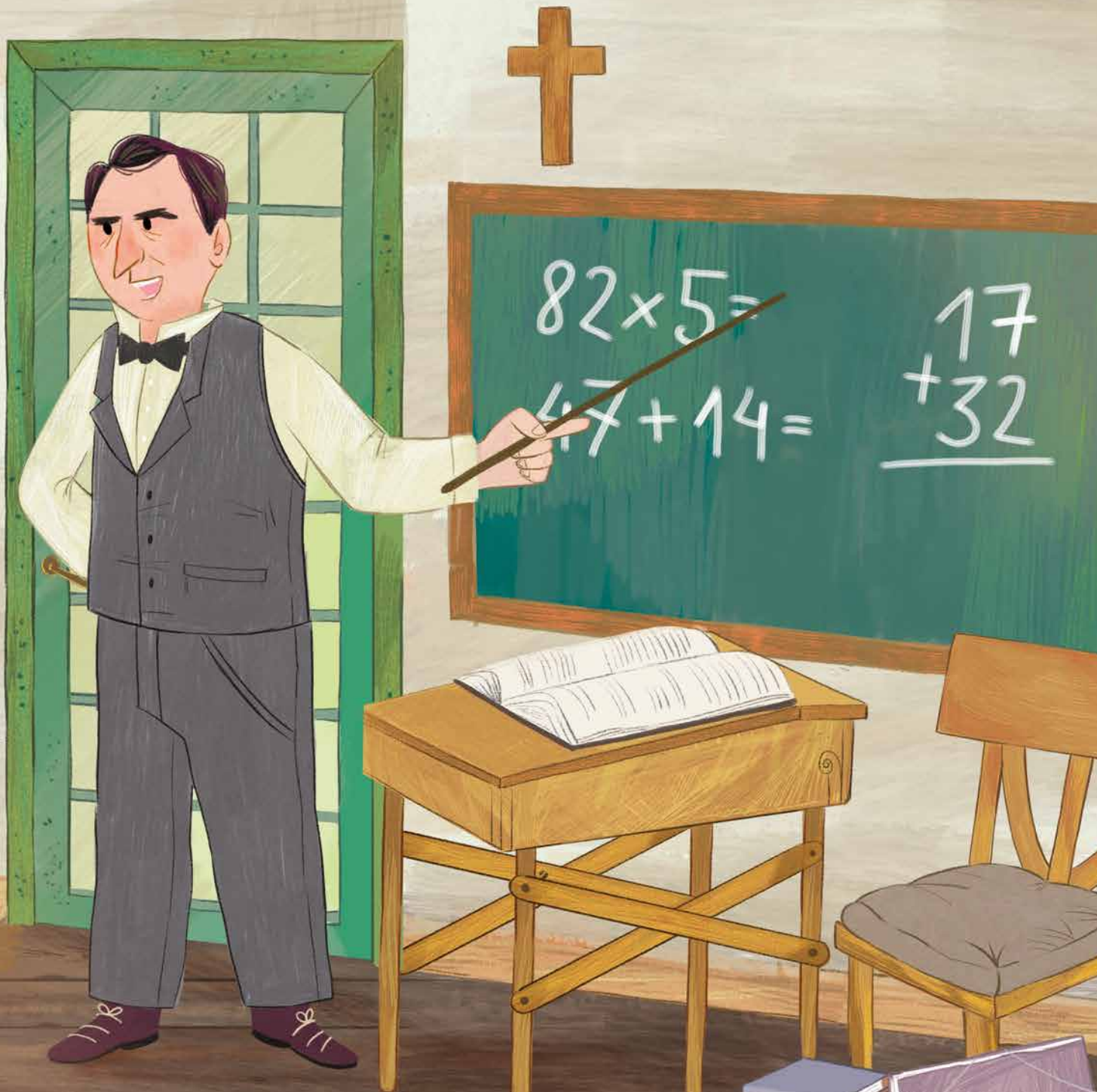
Belén Garijo



Can you imagine that a humble boy, born on the top of a mountain, could change forever the way we understand the brain? Well, it happened. He came into our world almost 200 years ago, in a little village in Navarre called Petilla de Aragón.

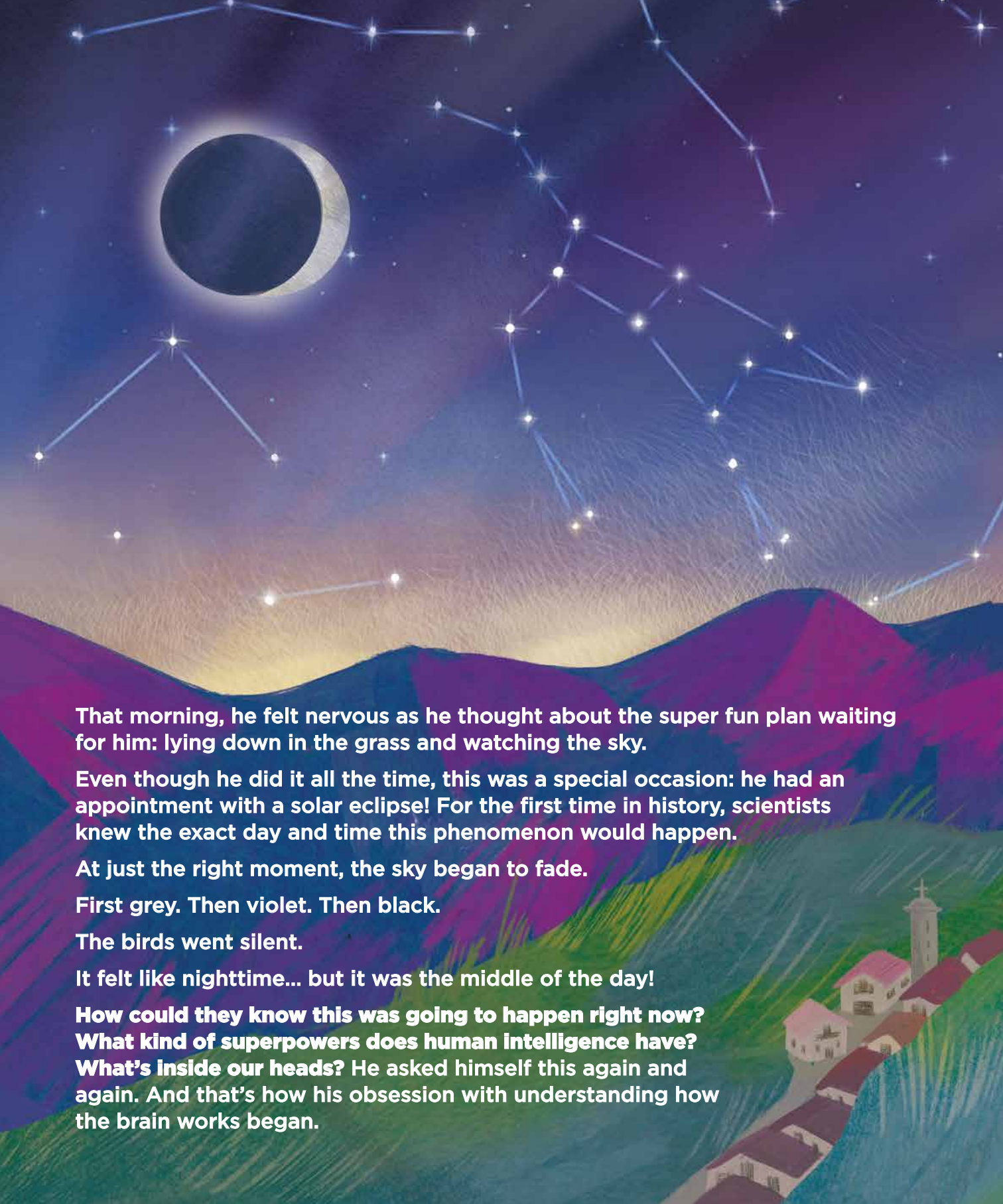
His name was Santiago. And his last names were Ramón y Cajal. Let me tell you his incredible story!





From a very young age, our protagonist put all his passion into art, while his father put his into science.

As his father was also his teacher until he was six, they didn't exactly see eye to eye from the very beginning.



That morning, he felt nervous as he thought about the super fun plan waiting for him: lying down in the grass and watching the sky.

Even though he did it all the time, this was a special occasion: he had an appointment with a solar eclipse! For the first time in history, scientists knew the exact day and time this phenomenon would happen.

At just the right moment, the sky began to fade.

First grey. Then violet. Then black.

The birds went silent.

It felt like nighttime... but it was the middle of the day!

How could they know this was going to happen right now?

What kind of superpowers does human intelligence have?

What's inside our heads? He asked himself this again and again. And that's how his obsession with understanding how the brain works began.





Those thoughts grew stronger when his family moved to another town and real school began. With real problems.

A group of bullies welcomed him with jokes and mean teasing. They laughed at the way he spoke, at the long overcoat his mother had sewn for him, and at his interest in drawing...

Santiago ignored them. He didn't need friends like those. He preferred to wait and meet the interesting ones—the ones with curious minds.





Perhaps that's why, our protagonist stood out for his curiosity... and for his rebellious streak too!

In class, he never stopped asking questions, always wanting to know how things worked. He refused to learn things just by memorizing them; it was so boring for him. He drove his teacher nuts.

That attitude made him a bit of a star at school, helped him gather followers, and he got up to all sorts of mischief around town.



COPY
REPEAT
SILENCE!

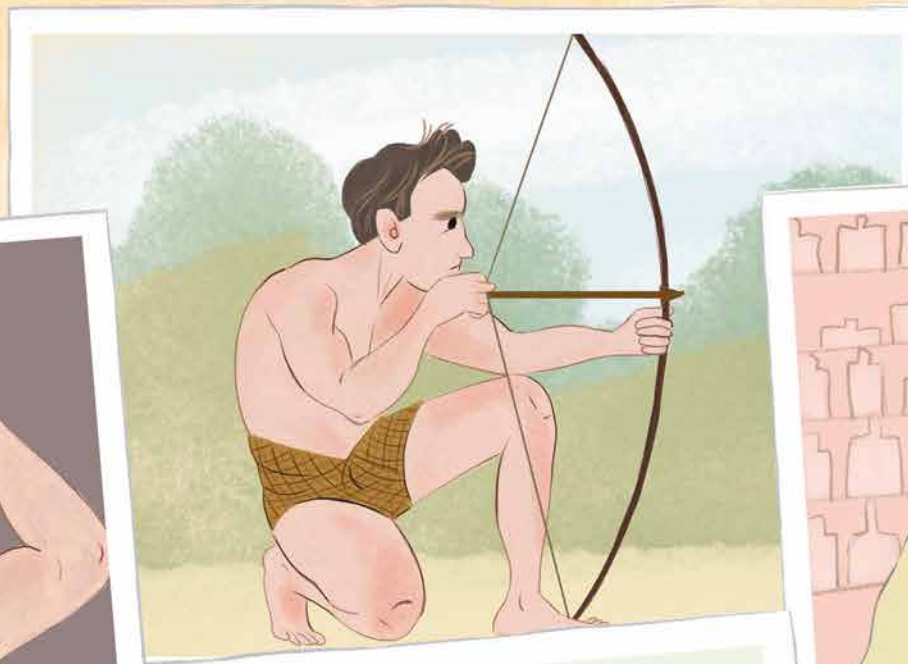
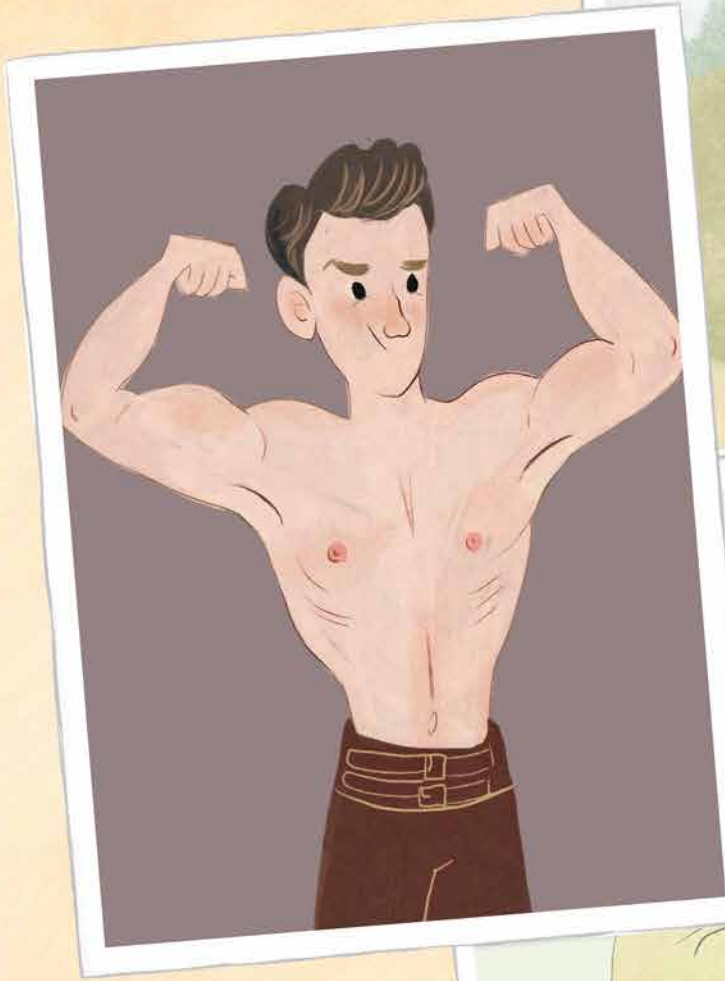


His father, desperate, decided to take him out of school.

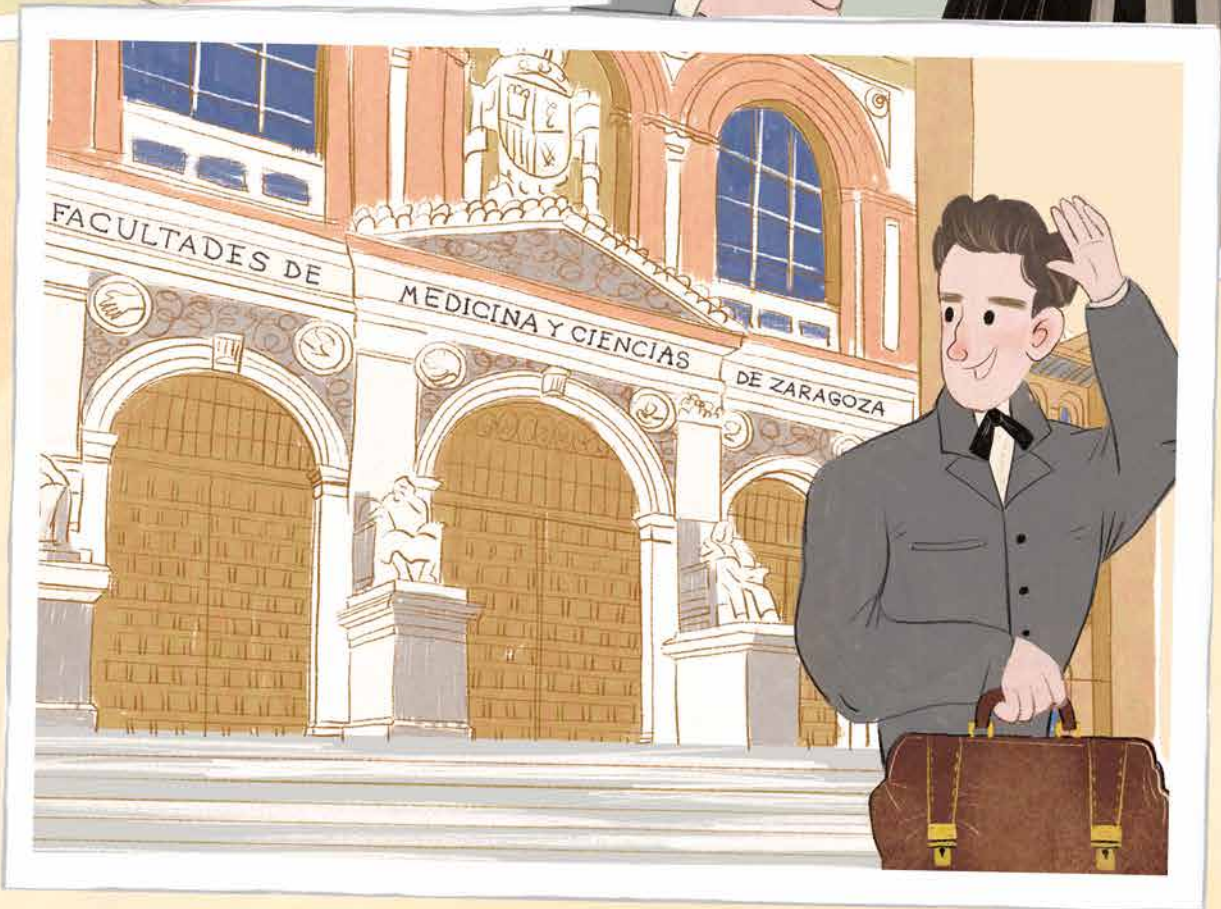
He found him a job as a barber. At night they used to go to the cemetery to look for bones. Under a tree, there was a pile of them that didn't belong to anyone. Together, they would pick the best ones and build skeletons.

With this crazy idea, little by little, his father finally sparked Santiago's interest. He would teach him anatomy while the boy listened, watched, and drew every tiny detail. Fascinated by what he had learned, Santiago went back to school. This time, with a purpose: to become a doctor.





At university, he devoted himself to studying, photography, and doing sports, including bodybuilding. He wanted to train both mind and body. He finished medical school looking like an athlete. Santiago became Doctor Santiago Ramón y Cajal, known simply as Cajal.





Mosquito Anopheles - Malaria

Parasite

True to his rebellious spirit, he began his life as a doctor and soon found himself swept into a dangerous adventure: the war in Cuba.

He sailed off to the island to save lives. Until he was attacked by a nasty mosquito carrying a deadly parasite, and he lost the battle. He returned home so thin he looked like one of the cemetery skeletons.



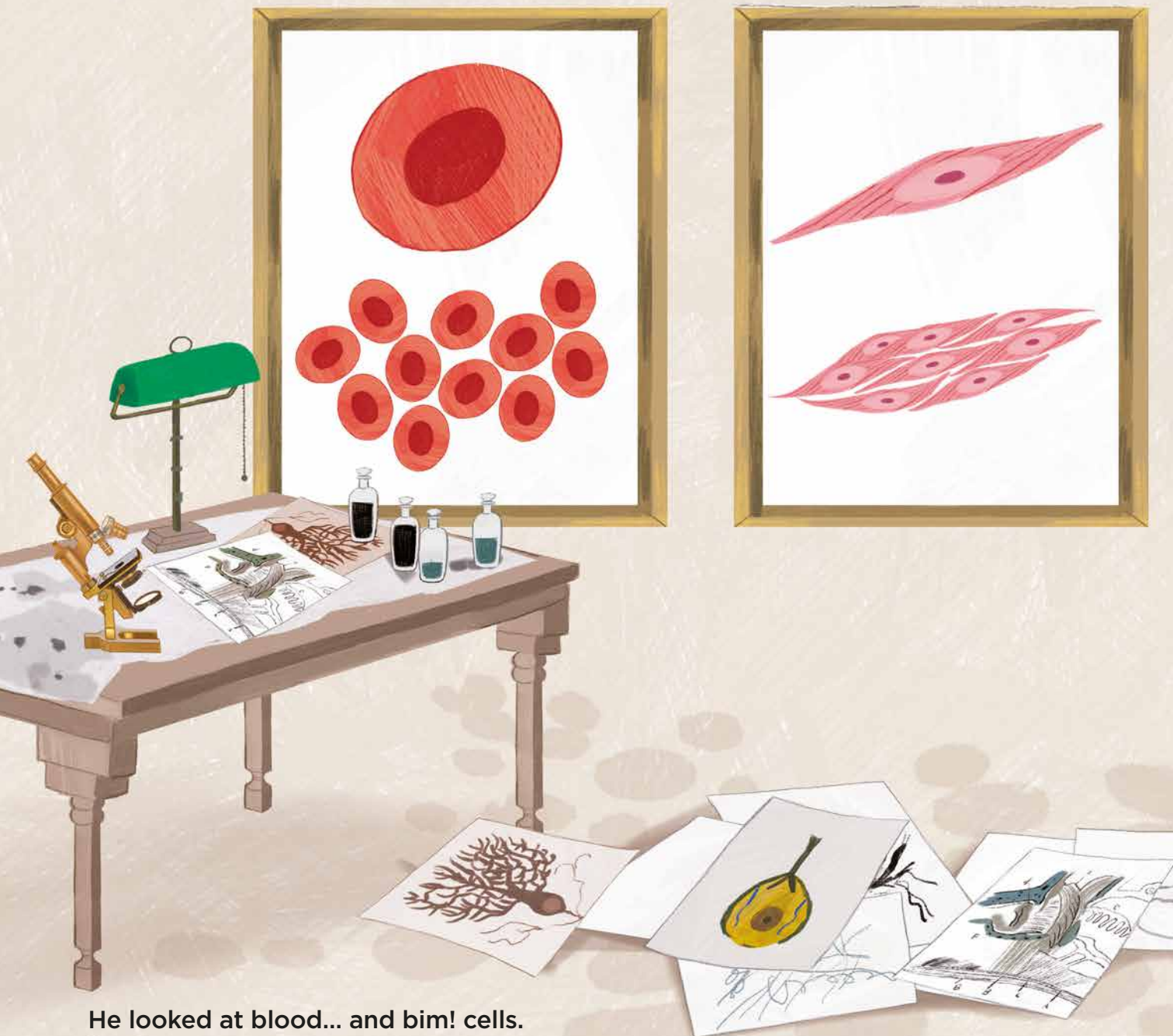


Back in Spain, he decided to settle down. He fell in love with Silveria. They had 7 children together and she gave him the stability he needed to devote himself to research.



His new challenge was to understand the cells that make up our bodies. A tough job, because we are packed with cells. In a tiny part of our body, the size of a grain of sand, there are as many cells as people in a fully packed football stadium.

With the family savings, he bought a microscope. Looking through it, the cells became huge, but they were still hidden among the body's tissues. To see them better, he would add drops of ink, staining them dark, and... they would appear as if by magic! Finally, he would draw them with great precision.



He looked at blood... and bim! cells.

He looked at muscle... and bam! cells.

He looked at skin... and boom! cells.

He looked at the brain and... **Where are the cells?**—he wondered.

The most important scientists in the world saw the inside of the brain as a tangled web. They called it a nerve reticulum.



Cajal rebelled against these reticularist scientists. The brain couldn't be a mess. The most extraordinary organ in the body had to be made of extraordinary cells. They just had to be found.

He worked from dawn to dusk for years, using different approaches... until he finally succeeded!

There, hidden from the eyes of other humans, he discovered the universe of the mind, inhabited by independent cells: neurons.



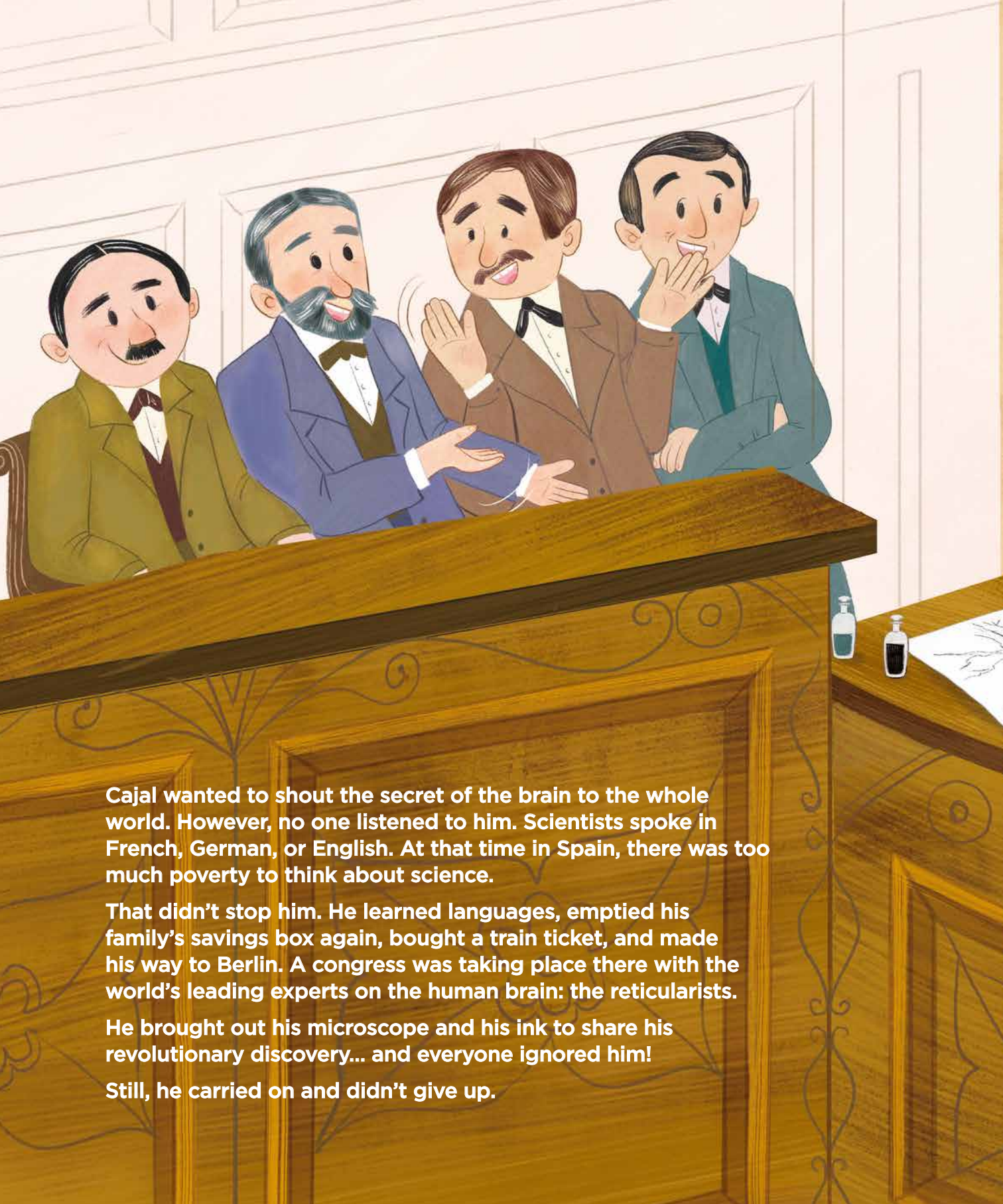
Cajal discovered that our brain is packed with different neurons shaped like trees, bushes, butterflies, and flowers. They play together. They get very close to one another, and just when they are about to touch... zap! they connect through a tiny spark, from which a shining star is born. This is how they communicate with each other.



mind to it, can be

the sculptor of their own brain

Each person grows their own garden of neurons in their head. It changes as you exercise your brain. You just have to train it to get more branches and more lights, to brighten your life.



Cajal wanted to shout the secret of the brain to the whole world. However, no one listened to him. Scientists spoke in French, German, or English. At that time in Spain, there was too much poverty to think about science.

That didn't stop him. He learned languages, emptied his family's savings box again, bought a train ticket, and made his way to Berlin. A congress was taking place there with the world's leading experts on the human brain: the reticularists.

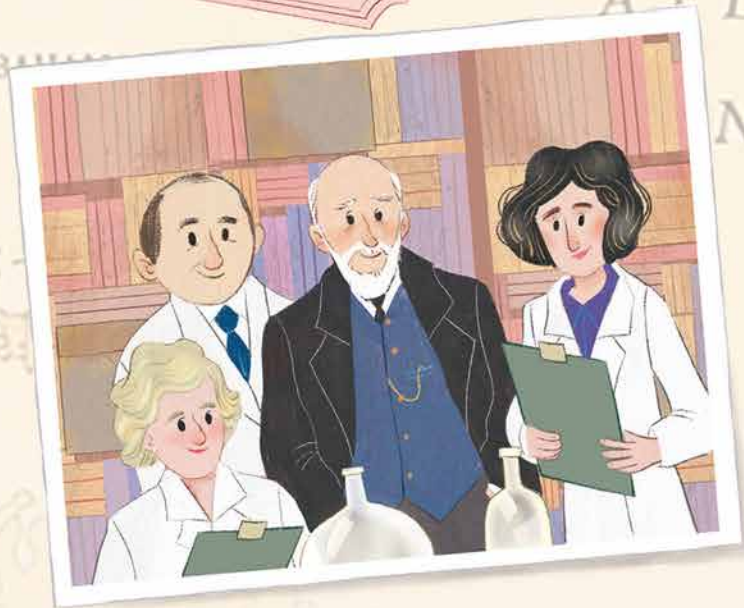
He brought out his microscope and his ink to share his revolutionary discovery... and everyone ignored him!

Still, he carried on and didn't give up.



He showed his meticulous drawings and revealed his garden of neurons. Then, a white-haired man with a big moustache approached him. People followed him. It was the famous German scientist Kölliker. An international idol.

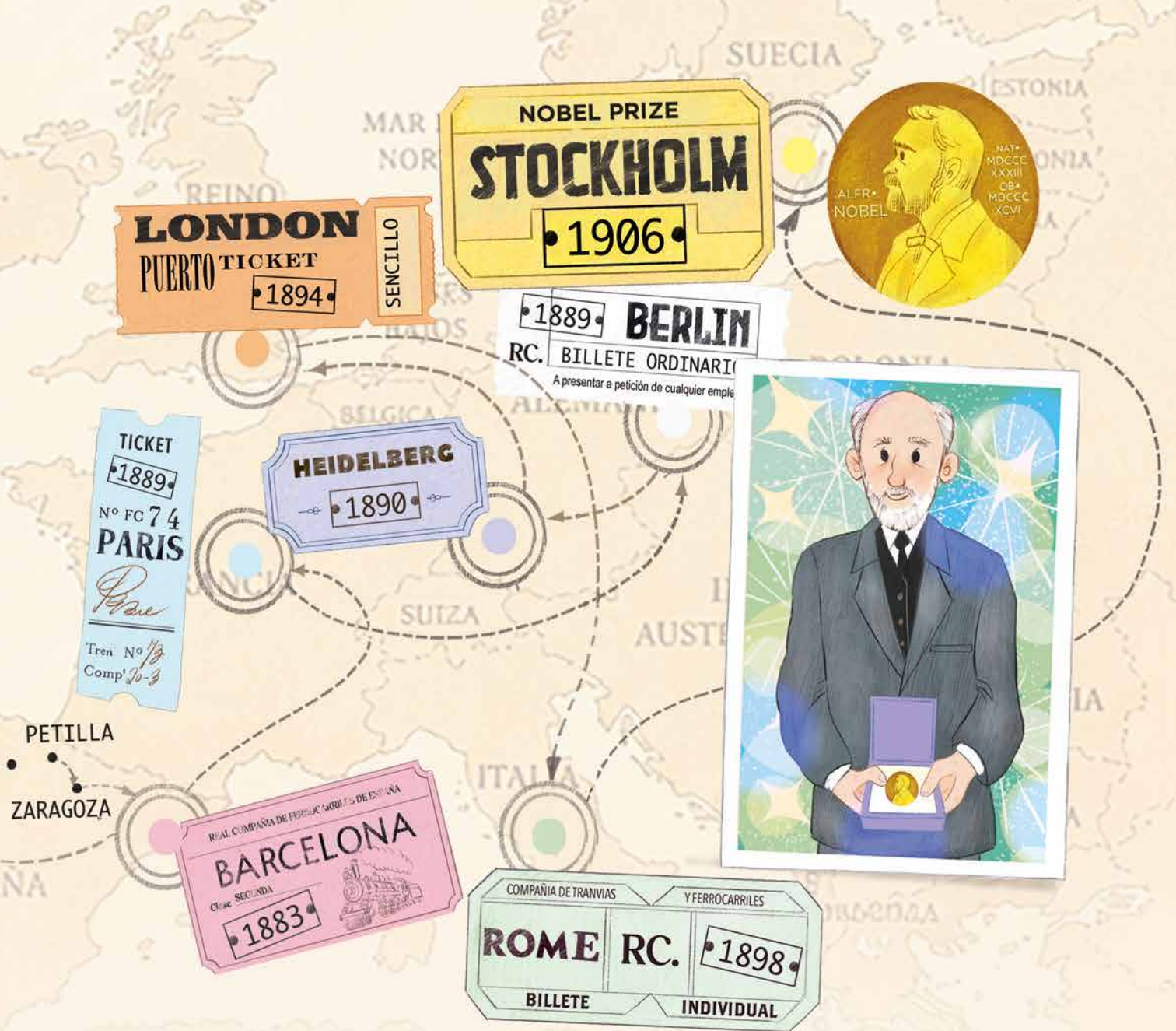
He looked through the microscope, listened to Cajal, smiled, and said: **This changes everything!**



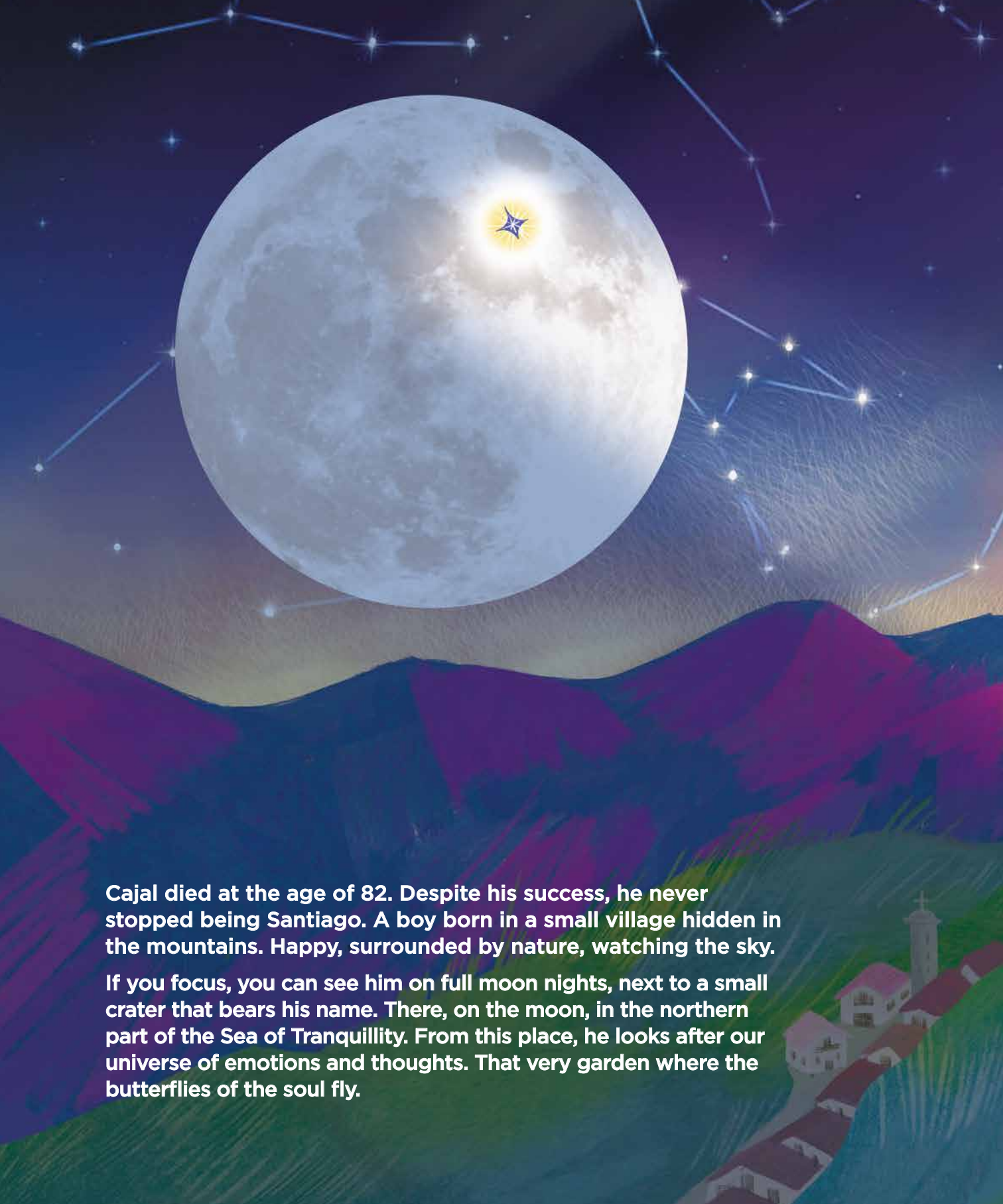
Suddenly, scientists from all over the world wanted to meet him.

He started travelling to share his knowledge with others.

And one day, the most important recognition arrived: the Nobel Prize in Medicine. The first ever won by a Spanish scientist.



A prize he shared with his colleague Camillo Golgi, who had shown him how to use the inks, known in science as staining techniques. Cajal collected it in Stockholm, thanked them, and never again left his country. He shared his discoveries with humanity and retreated to the Neurological School in Madrid. A place where his students could ask questions without fear, listen carefully, and think differently.



Cajal died at the age of 82. Despite his success, he never stopped being Santiago. A boy born in a small village hidden in the mountains. Happy, surrounded by nature, watching the sky.

If you focus, you can see him on full moon nights, next to a small crater that bears his name. There, on the moon, in the northern part of the Sea of Tranquillity. From this place, he looks after our universe of emotions and thoughts. That very garden where the butterflies of the soul fly.



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HOW TO TRAIN YOUR BRAIN

So your garden can grow strong and bright

1

Breathe like an explorer

When you feel nervous:

- Close your eyes.
- Breathe in slowly through your nose until the air reaches your belly.
- Let the air out slowly.

Repeat 5 times.

3

Move your body

Run, jump, dance, play.

4

Pay attention... focus

Choose something and look at it, listen to it, smell it, and touch it calmly:

- A garden with freshly cut grass.
- Sea foam on the waves.
- Frogs croaking in a pond.

2

Learn something new every day

It can be:

- A word in another language.
- A drawing technique.
- A trick.
- An interesting question.

5

Rest and dream

Your brain uses that time to:

- Organize ideas.
- Make connections.
- Grow.

How to train your brain

The exercises to train the brain are inspired by the discoveries of great scientists such as Santiago Ramón y Cajal, Nazareth Castellanos, Richard Davidson, John Ratey, and Matthew Walker, among others, who have shown that the brain can change and grow throughout life.



THIS IS HOW YOUR NEURONS TALK

When your neurons want to talk to each other, they get very, very close... until they almost touch.

Between one and the other there is a tiny space. It is called a SYNAPSE. Something exciting happens there: one neuron sends a message, another receives it, and... a new connection lights up!

There are many types of neurons. All of them have the same parts but different shapes. These ones you see here are Purkinje neurons. They are in the cerebellum.

DENDRITES

SOMA

AXON



It is the part of the brain that helps you to:

- Coordinate movements.
- Keep your balance.
- Learn skills (like riding a bike or dancing).



THEMATIC BIOGRAPHY

By **Santiago Lamas**

Santiago Ramón y Cajal (1852–1934) is, with little doubt, one of the most universally renowned Spaniards of all time. His relevance is immense, and he has transcended not only because of the significance of his scientific discoveries but also because of the extraordinary circumstances in which they were made.

Until very recently, Spain could not be considered a country where scientific research was a political or social priority. However, Cajal changed the paradigm of neuroscience forever on barren ground. It is worth pausing to reflect on the meaning of a paradigm shift. This expression—trivialized to exhaustion—was coined by Thomas S. Kuhn, an important twentieth-century philosopher of science, to convey the idea of a “conceptual revolution,” whereby an entire theoretical framework fully accepted by the scientific community is abandoned and replaced by another completely new set of concepts. The most classic example is the Copernican revolution, which entails the transition from geocentrism to heliocentrism. In very few cases, therefore, is this expression justified. In Cajal’s case, it is.

As this book very adequately illustrates, his microscopic studies of the nervous system banished the idea that it was a diffuse network, instead focusing attention on individual cells—neurons—and laying the groundwork for understanding the

transmission of the nerve impulse, which would be defined years later. This discovery earned Cajal many recognitions during his lifetime, among them the Nobel Prize in Physiology or Medicine, making him the only Spaniard to have received it in a scientific field for work carried out on Spanish soil.

Among Cajal’s many scientific merits, one key aspect is technical innovation. This consisted essentially of applying new staining methods to tissues, so that visualizing cells under the microscope made possible a precise definition of the cells of the nervous system—something previously unknown. There is no doubt that his great talent as a draftsman and his interest in photography were essential for effectively conveying his discoveries. Throughout his career, Cajal continued to innovate and adapt his own histological techniques or improve those of other scientists, so that some of them are still used today. He never ceased to inspire his disciples with this innovative spirit, particularly necessary for scientific progress.

Cajal’s life has been the subject of many studies and biographies, one of the most interesting being the one he himself wrote, capturing both his personal memories and his scientific life.

An extraordinarily multifaceted and curious person, he took an interest in many fields beyond his profession, including philosophy, politics, and art—an interest for which he also had great gifts, but which was frustrated early on. In many respects,

his personal life was not easy, and the figure of his father left a deep mark on him, not always a positive one.

From a human point of view, he had to learn to confront the difficulties of his environment in order to carry out cutting-edge research, as well as his own contradictions and the historical moment—something inherent to every human being. I would like to highlight among his brightest facets his commitment to and affection for Spain as a country and homeland, always pursuing any path that might place it on the road to progress and with a profound international vocation.

He chose science as the means to uphold this spirit, and without a doubt he succeeded, to the point that in the history of modern Spanish science one can clearly distinguish the periods before and after Cajal.

May this book awaken everyone’s curiosity—girls, boys, and adults alike—and inspire a passion for knowledge, a passion that shaped the brain of Santiago Ramón y Cajal, one of the greatest neuroscientists in the history of our species.

MY CONNECTION WITH CAJAL

I am a Research Professor at the Spanish National Research Council (CSIC), and I have devoted almost my entire professional life to investigating the molecular mechanisms of disease, particularly in the cardiovascular and renal fields. Although I have not worked directly on the nervous system, my connection with Santiago Ramón y Cajal

began very early and stems essentially from my father.

My father, Francisco Lamas López, was a physician who corresponded with Don Santiago and also worked with distinguished members of Cajal’s school for two periods in his life, specifically with Gonzalo Rodríguez Lafora and Fernando de Castro. Until very recently, I had preserved letters, portraits, and many first editions of Cajal’s works, which I had the opportunity to read and consult, and which have now been donated to the CSIC.

Through Cajal’s books and through my father’s ties to him, I always found models that inspired me at many moments in my professional life, along the path of research — a fascinating and often arduous journey, as Cajal himself noted in a well-known quote.

The scientific landscape in Spain today is undoubtedly far more encouraging, and pursuing a scientific career is increasingly viable and valued by our society.

In the field of neuroscience, Spain is unquestionably a major force. Without Cajal, it is highly unlikely that this transformation would have been possible.

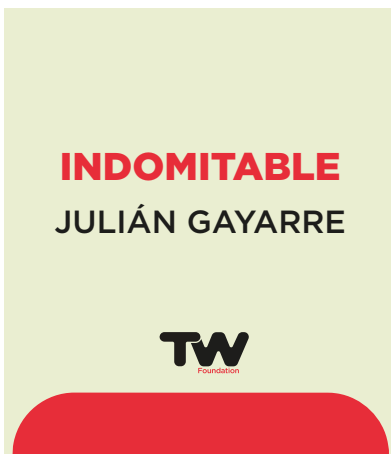


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UNCOMING TITLES



ACKNOWLEDGEMENTS

To **Belén Garijo**, for her indomitable vision.

To **Santiago Lamas**, for his words, his technical support, and for sharing his vast library with us. A world that brought us closer to Cajal, to poetry, to history, and to research.

To **Eugenia Arribas**, another brilliant scientist who collaborated on this project from her editorial role and through her personal support. Because you always make things possible.

HISTORICAL NOTE

Santiago Ramón y Cajal was born in Petilla de Aragón, a small Navarrese enclave completely surrounded by Aragonese territory.

According to legend, its unusual position dates back to the Middle Ages, when King Peter II of Aragon lost these lands in a game of cards to Sancho VII of Navarre —a story that, in reality, amounts to a loan between the two kings that was never repaid after King Peter II's death.

That explains why Petilla belongs to Navarre today despite its location. An origin that curiously connects two regions in Cajal's personal history.

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“My work began at 9 a.m. and usually lasted until around midnight. The most curious thing is that the work gave me pleasure. It was a delightful, irresistible intoxication. For (...) the garden of neurology offers the researcher captivating spectacles and incomparable artistic emotions.

In it, my aesthetic instincts finally found full satisfaction. Like the entomologist hunting for butterflies of vivid hues, my attention pursued, in the orchard of grey matter, cells of delicate and elegant forms. The mysterious butterflies of the soul, whose beating wings may one day shed light on the secret of mental life.”

Santiago Ramón y Cajal
Recollections of My Life



B

Based on Santiago Ramón y Cajal's original drawing (1885):
glial cells in the mouse spinal cord.



INDOMITABLE

This collection draws on the lives of inspiring people who had the curiosity to explore things in depth, the ingenuity to uncover treasures in everyday life, and the courage to promote critical thinking.

“A story of effort, curiosity and a rebellious spirit. Of someone who brought together art and science to understand the invisible. Someone who believed in himself and became one of the world’s most important scientists”.

Carlos Llonis
TW Group Chairman

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