Something's Missing

Giulio Brunetti Becky Hackett Jamie Somers
Illustrated by Philip Elliott

AMBER
Advancing Materials for Impact

Advanced Materials and BioEngineering Research (AMBER) Centre, hosted at Trinity College, Dublin is a multi-disciplinary, multi-university centre for world-class materials science research. The mission of our 300+ team members is to drive excellence in materials science research for people, planet and prosperity. A fundamental aspect of AMBER's work is our Education and Public Engagement (EPE) programme, which aims to inspire, facilitate and celebrate engagement between AMBER and the public to encourage authentic involvement in materials science and bioengineering research for societal improvement. We provide multiple inclusive pathways for the public to engage with AMBER's research, with particular attention given to underrepresented and underserved communities. We aim to foster young people's STEM identities, with the aim of enhancing their agency and active citizenship in a rapidly changing world.

FIGHTING WORDS
The write to right.

Fighting Words is a creative writing organisation that aims to help children and young people, and those who did not have this opportunity as children, discover and harness the power of their own imagination and creative writing skills, strengthening their ability to be resilient, creative and successful shapers of their own lives. It has twenty centres across the island of Ireland.

RCSI UNIVERSITY OF MEDICINE AND HEALTH SCIENCES

TERG
TISSUE ENGINEERING RESEARCH GROUP

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Preface

Something's Missing was conceived and written through a partnership between Fighting Words and AMBER Centre. The project aimed to make complex science and STEM concepts more accessible to the public through the medium of creative writing. Through a series of four creative workshops, researchers from Department of Anatomy and Regenerative Medicine in the Royal College of Surgeons Ireland, and the School of Physics in Trinity College Dublin, worked with Fighting Words facilitators to write this science story for children.

Throughout the process we were struck by synergies between scientific thought and creative writing in their ability to evoke wonder and curiosity with both disciplines encouraging us to see the world afresh. We hope this playful approach to exploring the sciences will evoke the same curiosity and wonder in the reader.

Heartfelt thanks to AMBER's researchers and authors Giulio Brunetti, Becky Hackett and Jamie Somers for embarking on this creative quest with us with such enthusiasm and openness. We are greatly indebted to Philip Elliott and Brigid Sweeney, expert illustrators, storytellers and Fighting Words volunteers. Warm thanks also to proof-reader and Fighting Words volunteer, Lucy Taylor, for her eagle eye.

We hope you enjoy the quest of royal rabbits Kevin and Joshua to defend their kingdom, using the latest developments in PCR and NMR!

Mairéad and Nora

Dr Mairéad Holden, Education & Training Manager / Bainisteoir Oideachais & Oiliúna, AMBER, SFI Research Centre for Advanced Materials and BioEngineering Research, Trinity College, University of Dublin

Nora Nic Con Ultaigh, Education Director/ Stiúrthóir Oideachais, Fighting Words.

Sometime long ago in the mists of time, two rabbits were born, heirs to the throne of The Emerald Island. All of the island came together in celebration of the joyous event and festivals sprung up in every warren around the land. The names of Kevin and Joshua, the young rabbit princes, were on the tips of everyone's tongues.

However, it soon became apparent that something wasn't quite right. The fear of Professor Owl was confirmed by the ancient technique of Polymorase Chain Reaction.

'The technique of Polywhat?" asked the King.

"A Polymorase Chain Reaction or PCR is a magical analysis where I take small sections of rabbit DNA. I place it on a stone, add some magical chemicals. After many steps of forging it over the fire and cooling it, it grows and I can read it with my special sight," said Professor Owl.

"Quit the gobbeldegook and get to the point," demanded the King.

The sad truth was soon revealed. One rabbit was born without a heart and one without a brain. But thanks to the advancements of Professor Owl's magical arts each rabbit was given what they needed to live – one a 3D printed heart and the other a 3D printed brain. Professor Owl used the only type of material left in his laboratory.

"Here we go," declared Professor Owl.

"Are they not a bit small?" asked the Queen.

"No," explained the Professor in hushed tones, "because they will expand over time with the right environment."

With the pride of the royal family at stake, the Queen whispered darkly: "No one can know this, professor."

She tucked the PCR results in a chest and buried it under a flagstone in the family castle.

Years passed and Joshua and Kevin grew up remaining unaware of their affliction. But as they grew not all went according to plan. Neither Joshua's heart nor Kevin's brain expanded as expected.

As they reached maturity, the Emerald Isle was divided equally between the two brothers, to rule over as

they saw fit. Soon enough, each of their reigns, reflected the defects evident within their bodies.

Joshua, although a wise and tactical leader, was callous and uncompassionate towards his people. While Kevin, who grew to become passionate, was prone to outbursts of anger and violence in the name of the honour of his people, and he led without the gift of foresight.

Their differences fed the resentment between the two brothers. From a young age they were prone to arguing. The differences in their reigns became more pronounced over time.

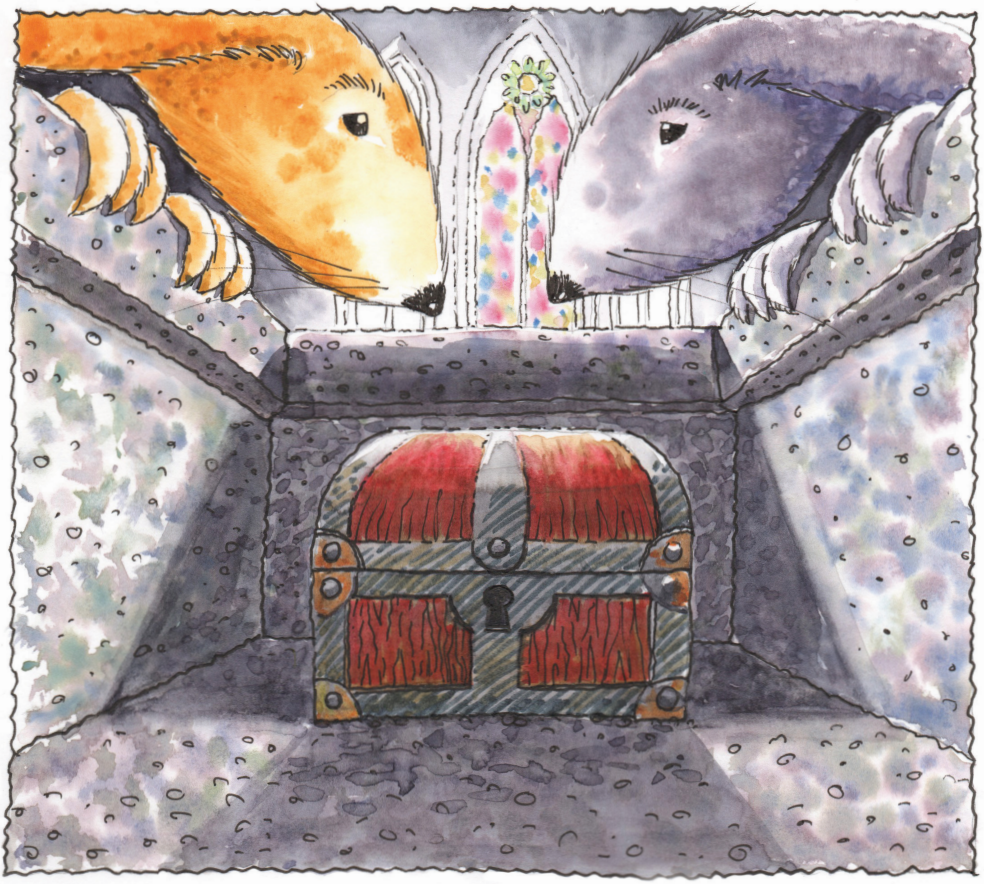
Seasons passed and the brothers grew more and more distant. The two reigns were split now by high walls and poisonous words.

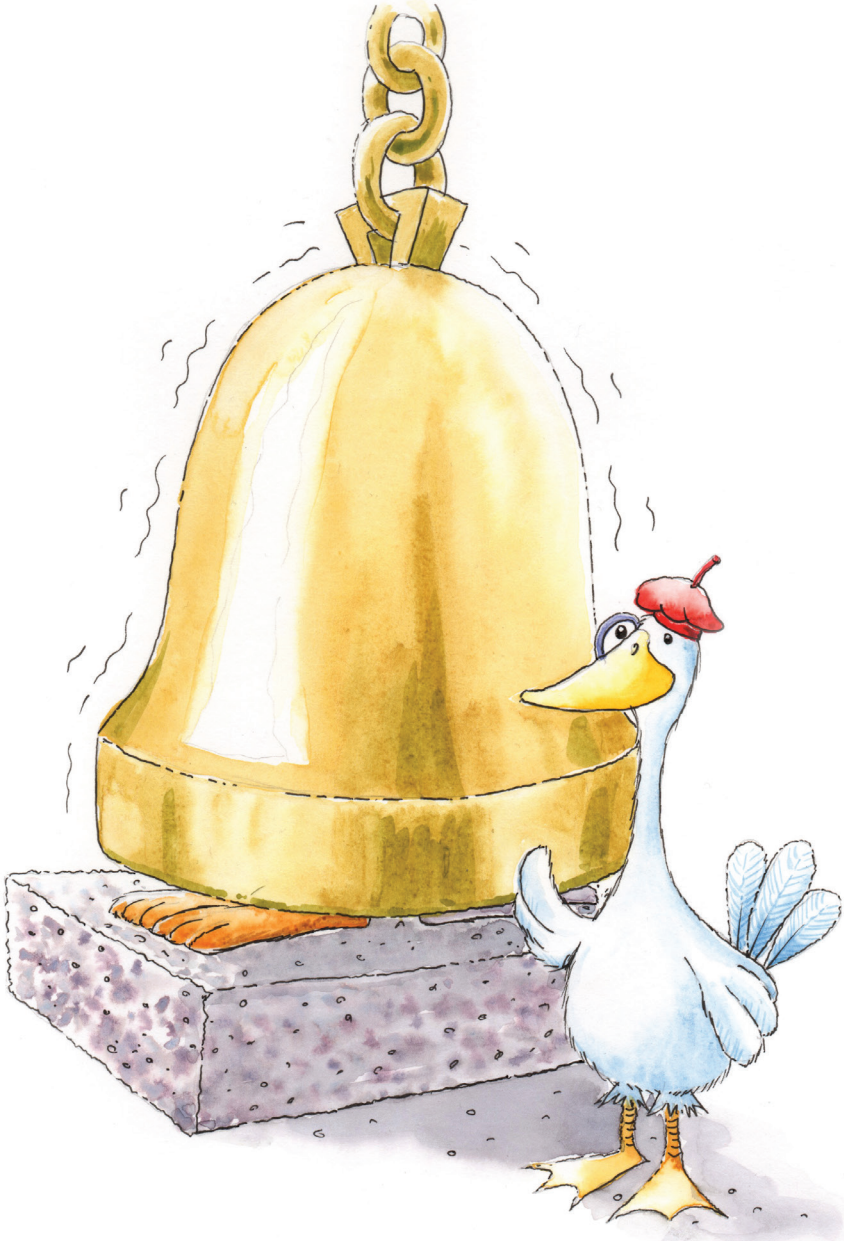
Despite the conflict between them, the Emerald Isle became renowned for its beauty and its stories. The news reached the ears of the foxes from the Far North and they sought the sun-soaked fields of green for their own uses. As dawn broke on the first morning of Winter, they landed in their boats to launch their attack on the rabbits' land.

The rabbit brothers, suddenly under threat, convened a council in the family castle to address the imminent threat of the foxes. As the discussions between the brothers grew heated, Kevin began to pace furiously about the room. He paid no attention to the uneven ground under his feet and tripped over a disturbed stone on the flagstone floor. In his anger he ripped up the stone from the floor and threw it across the room. It landed with a crash on the other side of the chamber.

Where the stone had been the rabbits saw a hidden cavity. Inside was a chest with the family crest on top. Joshua opened it slowly. The PCR results were lying inside it.

Joshua withdrew the sheet, not quite believing his eyes. He turned to Kevin and explained the situation. Immediately they summoned old Goose Laroose, the King's wise and ancient apothecary.





"The only way to unravel the true depth and extent of this story is to run an NMR," said Goose Laroose.

"Ah yes, a Nuclear Magnetic Resonance Spectroscopy," said Joshua.

"Ah you speak Gobbledegook," said Goose Laroose.

"Showing off as always," said Kevin under his breath and rolling his eyes.

'"Pea-brain," Joshua retorted.

Thanks to the advances of Goose Laroose over the years in the field of NMR imaging, he had built an imaging device in the clocktower of the castle. The tower bell was now capable of generating a magnetic field at his command. This magnetic field, interacting with the molecules in the bodies of the two rabbits, was able to generate an image that reflected what was occurring within.

Having stepped inside the bell, Joshua and Kevin elbowed each other as they vied for space.

"You need to stand still," ordered Goose Laroose.

Soon he had the diagnosis at hand. "Mmm... interesting," he said, scratching his head.

"Joshua, it appears that your heart hasn't grown and Kevin your brain is still the size of a pea."

"Well we didn't need the NMR for that!" scoffed Joshua. "I could have told you that."

There was no time to waste. The foxes were advancing and amassing steadily. The brothers knew they would have to join forces to defend themselves against the incoming menace. To do this, there was only one solution. They needed to travel to the mist-covered lair of Long Tooth, the legendary She-Wolf of Wisdom.

They travelled as fast as they could, through glens and woodlands, over mountains and plains to the fog-covered land of the East. It took many long days and bitterly cold nights to find the old she-wolf as she did not care for the company of others. But finally, on the sixteenth day, they came upon her den amidst the sacred stones.

"Help us, oh great wise one of the world," they cried. "We have travelled far and wide to find you. Our people are in danger and we cannot afford to be at odds with each other. We need your understanding and wisdom!"

"It is not I who you seek so anxiously to help you, my children," the she-wolf rasped, her eyes twinkling from beneath the heavy hood of her cloak.

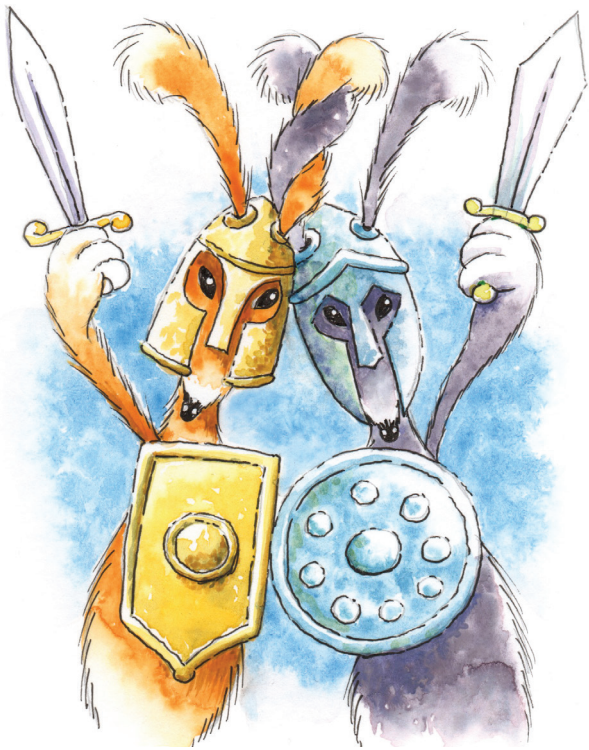
"Do you not see in each other that which you lack in yourself? That together are you not whole?"

In that moment, the brothers looked upon each other with fresh eyes, seeing for the first time the truth in the old wolf's words. They felt anew the treasured link between them that had bound them together over the sands of time and space. They saw that what was missing their entire lives was the simple but essential fact that they were brothers, two sides of the same coin. From this new understanding they felt themselves changing, transforming from the core.

The forging of their link triggered a reaction within both of them, altering the environments of their inner selves, allowing for the material of their hearts and brains to finally grow to their right size.

How magical science is! The special material designed and used by professor Owl allowed the two brothers to realize their special bond and, only after this, for each brother's heart and brain to expand to their fullest dimensions.

Together they left the lair of Long Tooth, and from that day forth, no one could defeat the combined might and understanding of the brothers. Soon, the foxes were banished to the far icy north, and the rabbits combined their lands under one single, brotherly banner, allowing the Emerald Isle to flourish and prosper for the entirety of their long reign.



Giulio Brunetti
Dr Giulio Brunetti is a postdoctoral researcher in the Tissue Engineering Research Group (TERG) in the Royal College of Surgeons in Ireland (RCSI), one of the largest advanced biomaterials and tissue engineering/regenerative medicine research groups in Ireland led by Prof Fergal O'Brien. Following undertaking a BSc and MSc in Chemistry at the University of Rome, La Sapienza (Italy), he moved abroad to achieve a MRes with distinction in Advance Genomic and Proteomic Science at the University of Nottingham, UK. Subsequently, he moved to Ireland in 2017, where he earned his PhD in Physics, at Trinity College Dublin, based on developing a microcantilever-based biosensor for the study of label-free nanomechanical assays, targeting real-time detection of specific infectious disease biomarkers (malaria and COVID-19) in a physiological environment under the tutelage of Professor Martin Hegner. Following his arrival in TERG, his research has primarily focused on the development of natural polymer scaffold-based therapeutics for tissue engineering with target clinical applications in skin and neural tissues.

Becky Hackett
Becky Hackett is the research coordinator for the Tissue Engineering Research Group (TERG) in the Royal College of Surgeons in Ireland (RCSI). Becky studied Science in Trinity College Dublin, specialising in immunology. Following this she undertook a Research Masters on translational neuroimmunology, focusing on potential therapeutic targets for multiple sclerosis in Trinity College Dublin. Following her MSc, Becky came to work in TERG. She spends her days working on grant writing and management, outreach and public engagement for TERG, and research development.

Jamie Somers
Jamie graduated from Dublin City University (DCU) with a B.Sc (Hons) in Applied Physics in 2023. In his third year, Jamie won a chemistry scholarship allowing him to gain international research experience at the University of Kansas, an R1 University in the United States. For his final year research project, Jamie studied 'Simulating Laser-Induced Dynamics in Next Generation Photo-Acid Materials for Extreme Ultraviolet Lithography' using High Performance Computing and Density Functional Theory calculations. He is now working with both the Bradley Photonics Group at TCD and the Centre for Biochemical Sensors at the Imperial College London, under the supervision of Prof. Louise Bradley and Dr. Ali K. Yetisen. The research involves using a non-linear optical process known as Two-Photon Polymerisation to print photonic structures using responsive materials.

Philip Elliott
Philip is an illustrator and graphic designer living in Dublin. He has worked for many years in the Irish advertising industry, as an art director and creative director, creating stories for many of Ireland's leading blue-chip companies. In recent years he has become a professional illustrator creating work for children's books and for his own clients and projects. He is a member of Illustrators Ireland and is a regular volunteer at Fighting Words, helping to mentor and develop children's imaginations.

Definitions from our story

PCR

PCR, or Polymerase Chain Reaction, is a fascinating technique used in science to make copies of DNA. Imagine you have a treasure map, but it's very small and hard to read. PCR is like making lots and lots of copies of that map so everyone can see it clearly. First, scientists take a tiny piece of DNA, like a clue from the treasure map, and put it in a special machine called a PCR machine. Then, they add ingredients called primers and a special enzyme called DNA polymerase. The PCR machine heats up and cools down, which helps the DNA copy itself. Exactly like Professor Owl has done in our story. After a few cycles of heating and cooling, you have many copies of the original DNA. PCR is used in lots of cool ways, like solving crimes and diagnosing diseases.

NMR

NMR, or Nuclear Magnetic Resonance, is a powerful technique used in science to take pictures of the inside of things, like our bodies or even molecules! Imagine you have a magic camera that can see inside objects without opening them. That's what NMR does. First, scientists place the object or sample inside a big magnet, represented by the old bell in our story. This magnet makes the tiny particles inside the object line up like little magnets themselves. Then, the scientist sends in radio waves, which make the particles wobble. When the radio waves stop, the particles go back to their original positions, and as they do, they give off signals. These signals are then turned into images. These images show the inside of the object in great detail, kind of like an x-ray when you pass your luggage through airport security. NMR is used in medicine to look inside our bodies and diagnose diseases, and in chemistry to study the structure of molecules and even to make sure food is safe to eat.

3D printing

Imagine you have a magic pen that can draw objects, not just on a piece of paper, but in front of you in the air! That's what 3D printing is like. Instead of using ink, 3D printers use special materials like plastic and they build these objects layer by layer, just like stacking Lego bricks. First, you create a design on a computer, like drawing a picture. Then, you send your drawing to the 3D printer. The printer reads the design and starts making the object, layer by layer, following the instructions from the computer. It's like making a cake, but instead of mixing ingredients in a bowl and baking them, the printer squirts out tiny bits of material and builds up the object from the bottom to the top. Once the printing is finished, you have a real, solid object that you can hold in your hand. 3D printing is used to make all kinds of things, from toys and gadgets to medical implants and even houses. If you can think of it, you can 3D print it!

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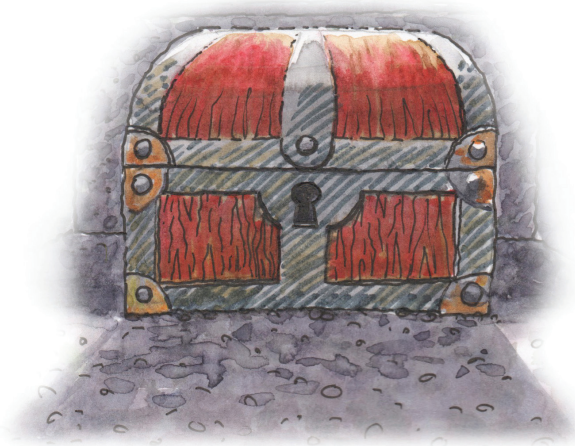

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