MMI

McMaster Medical Illustration

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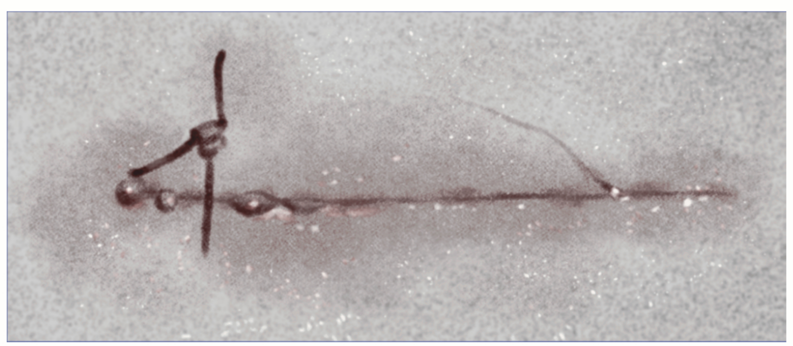
The first cervical vertebrae (C1) - 'The Atlas'



The first stitch

An embryo from the first trimester

01

And in your hands right now... ***our first volume***

Foreword:

Thank you for picking up the first volume of *McMaster Medical Illustration*. As an emerging journal created by a team of 20+ students, we're grateful for your attention to this special issue, which represents a summer's worth of dedicated work.

We wanted to create something different from your average literature-heavy journal; one that showcases both the art and science behind a field as rich as medical illustration. Some highlights from this issue include a wide range of digital illustrations highlighting biological concepts, an interview with a Master of Science in Biomedical Communications student from the University of Toronto, and articles exploring the history of different areas within medical illustration.

We hope you enjoy reading this as much as we enjoyed creating it. This marks the beginning of many more projects to come, all showcasing the artistic talents and passions of McMaster students in this field.

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Clearing the Fog: The Journey of Cataracts and Their Treatment

Martina Durcek
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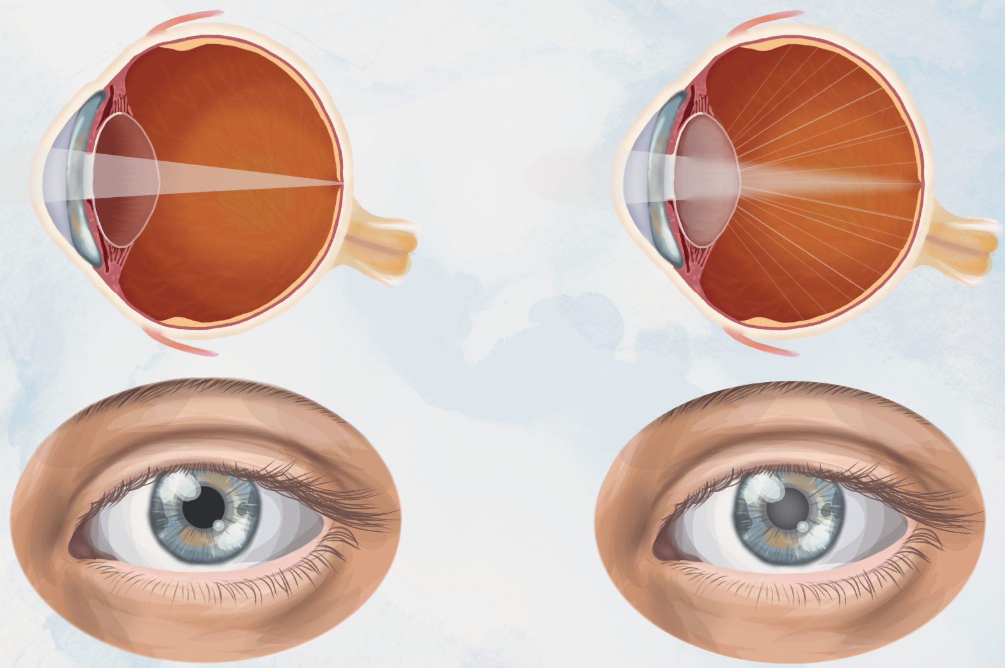
What Are Cataracts?

Cataracts are characterized by the progressive opacification of the crystalline lens of the eye, primarily resulting from the denaturation and aggregation of proteins in the lens as a result of age, injury, or from existing medical conditions. The protein accumulation disrupts the transparency of the lens and leads to a reduction in visual acuity.[1] Normally, the lens is transparent and allows incoming light to focus onto the retinal photoreceptors to perceive a clear image. However, when cataracts are present, the lens becomes less transparent and the incoming light is scattered or partially obstructed before reaching the retina.[1]

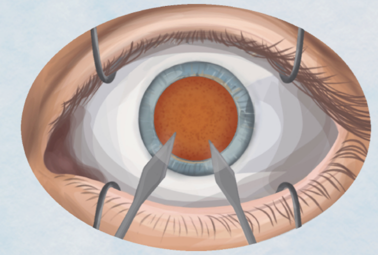


As a result, vision becomes clouded and dimmed with dull and faded colours.[2]

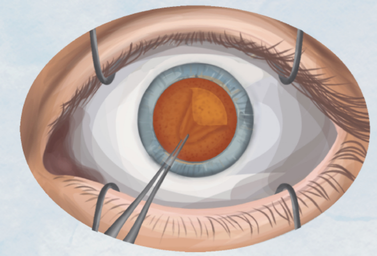
What Are the Possible Treatments?

The treatment for cataracts is surgery, which is only recommended when symptoms affect daily life such as driving and reading. Cataract surgery has a risk of less than 1% and removes the clouded lens and replaces it with an artificial one to improve vision quality.[3]

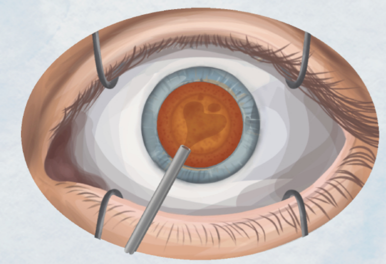
How Does Surgery Work?



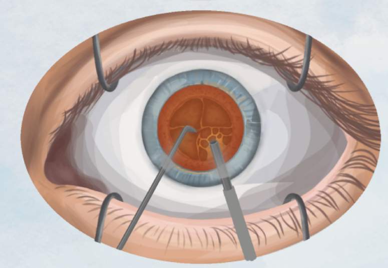
1. A side port incision is created on the surface of the cornea and a viscoelastic gel-like material is injected to maintain eye pressure. The 2.2mm main incision is then created using a blade.[4] The eye appears to be red or orange due to light reflecting off of the retina.[5]



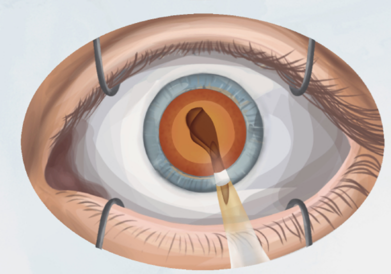
2. A circular opening approximately 5.5mm in diameter called a capsulorhexis is made in the anterior lens capsule using forceps to allow access to the clouded lens.[6]



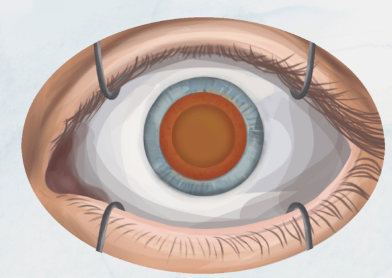
3. A fluid which separates the cataract from the capsular bag is injected between the capsule and cataract in a process called hydrodissection to allow the cataract to rotate and be broken into fragments.[4]



4. The clouded lens is broken down in a process called phacoemulsification, in which ultrasound technology breaks the cataract into fragments for removal. Using a spatula, the central part of the cataract is first divided into halves and then rotated and divided into smaller fragments which are then removed using a small vacuum or probe. The cortex is also removed to prevent possible problems with the artificial lens in the future.[4]



5. The viscoelastic gel-like substance is added again to further maintain eye pressure. The artificial intraocular lens implant is folded and inserted through the 2.2mm incision using a lens injector. The implant unfolds and opens by itself inside the capsule due to the natural support system in the eye.[4]



6. The viscoelastic gel-like substance used to support the eye during the surgery is then aspirated from the eye. The wounds are then hydrated and self-heal over time. An antibiotic is also added to the surface of the eye to prevent infection.[4]

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Stride by Stride: The Phases of Running Gait

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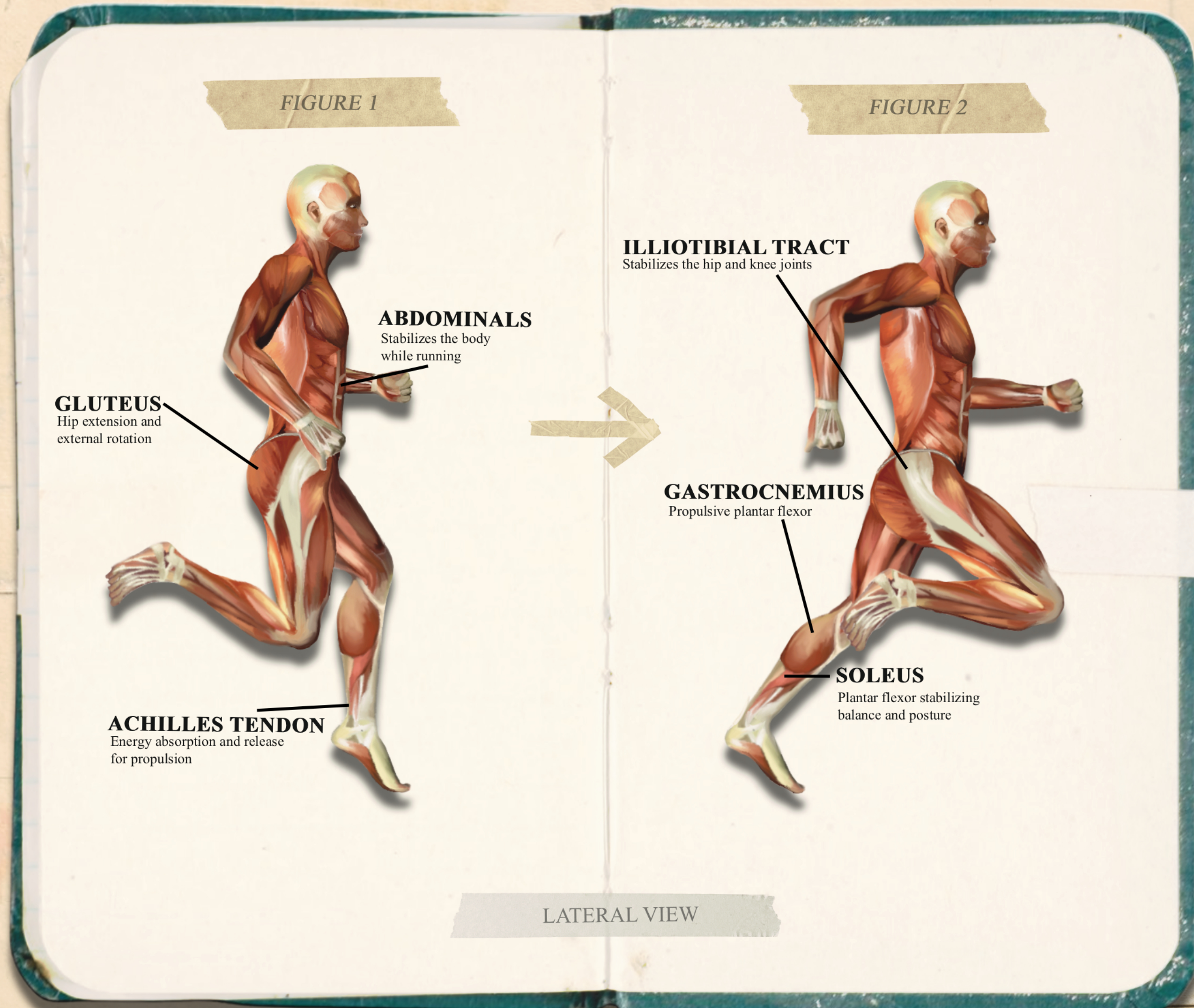

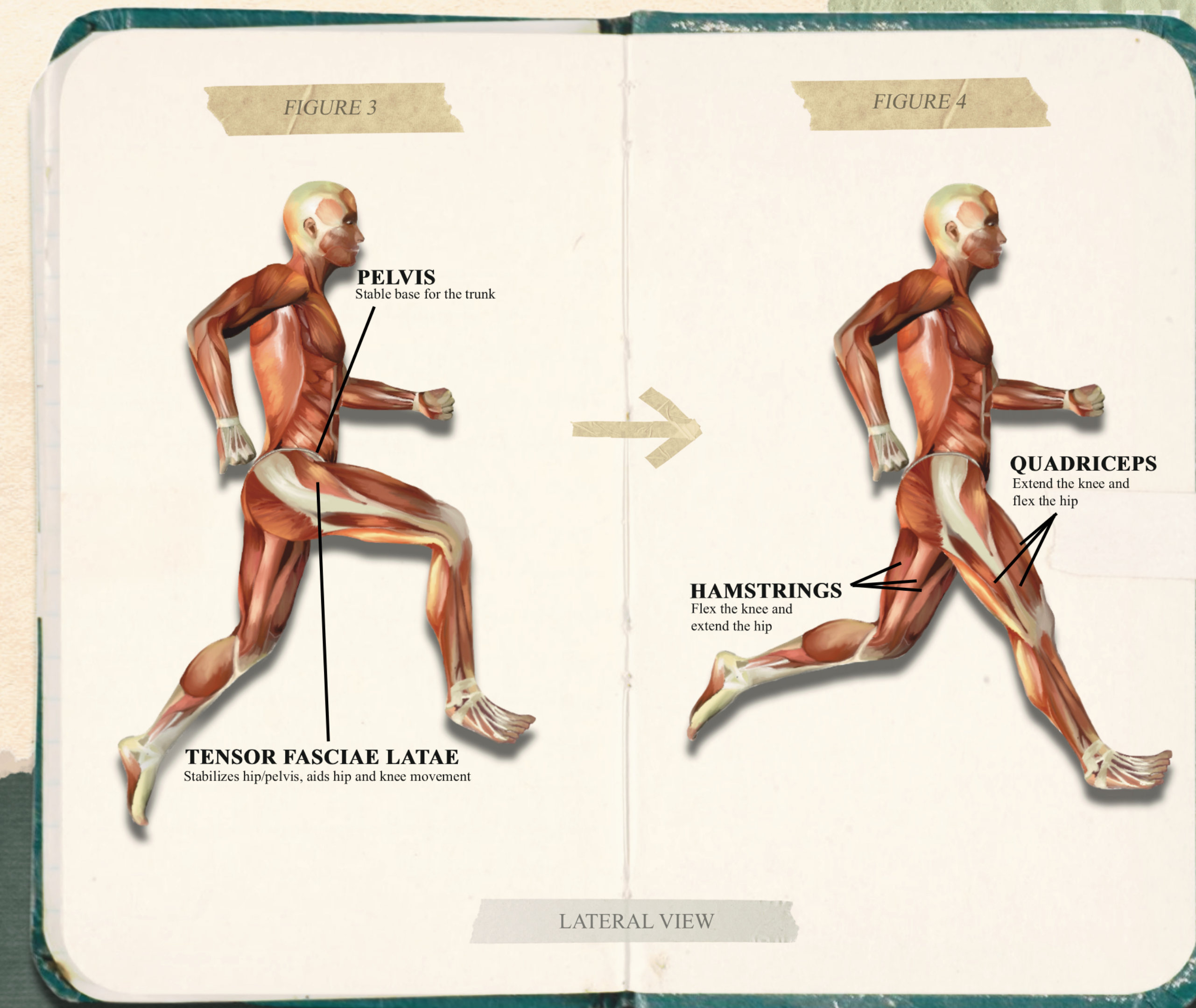

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Surgical Illustration:
Prominent Methods, Artists, and Techniques Throughout History

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Abstract:
Medicine is a rapidly evolving field, with innovations constantly reshaping how we understand the body. Within this constantly changing landscape, medical illustration sits at the intersection of art and science, helping bridge the gap between complex biological systems and human understanding. Given the complexity of the human body and the precision required in surgical practice, visual illustration has historically played a critical role in surgical education.[1] Over many centuries, surgical illustrations have heavily transformed, going from simple depictions to advanced and interactive digital resources, revolutionizing how surgeons are trained and how procedures are performed.[2] This article seeks to explore the historical evolution of medical illustration, highlighting its importance and displaying how medical illustration has constantly re-defined the way medical knowledge is taught and understood.

Historical Foundations:
In ancient times, surgical diagrams were more symbolic than anatomically accurate. They served mainly as educational tools rather than exact representations of the human body. One of the most prevalent figures in this era was Galen, whose writings and illustrations dominated the world of medicine. Galen would often conduct animal dissections and form his conclusions on human anatomy based on his findings.[2] He aimed to prove the existence and emphasize the importance of internal systems such as the nervous and circulatory system.[2] Although his animal-based conclusions are now deemed inaccurate, his work laid the foundation for the role that illustrations play within the field of medicine. During the 14th century, the reintroduction of human dissections in medieval Italy marked the evolution of visual representation of the body. Scholars began to move away from extrapolated information and symbolic depictions and started to focus on accurate illustrations.[3] One of the first surgeons to put this into practice was Mondino de Luzzi from the University of Bologna, where he began to perform and document human dissections. He published the first book dedicated to anatomy, the Anatomia, including diagrams of many organ systems, most notably the respiratory system.[4] Although it was still not entirely accurate, this publication reflected a shift towards more empirical observation within surgical education and highlighted the importance of illustrations within surgery. This growing emphasis on surgical illustrations and direct observation eventually led to a major turning point in the Renaissance era, in which Andreas Vesalius, referred to as the founder of human anatomy, published the De Humani Corporis Fabrica.[5] By collaborating with skilled artists such as Titian, an Italian Renaissance painter, Vesalius was able to create highly accurate illustrations of muscles, bones, organs and overall anatomical structure utilizing depth and proportion.

Mass Production:
The advancements made by Vesalius laid the foundation of medical illustration for many years. With the invention of the printing press, illustrations were mass-produced and standardized, allowing for consistent teaching tools to be used in medical institutions all around the world. Specifically, this paved the way for the first academic program that focused on medical illustration to open in 1911, at the John Hopkins School of Medicine. Max Brödel, a German medical illustrator, was a crucial figure in this program. He pioneered a new technique called "carbon dust drawing", a technique that uses finely ground carbon powder applied with brushes to create soft and realistic shading. This became widely used among medical and scientific illustrators across the world.[3] His program at John Hopkins heavily emphasized the close collaboration between illustrations and medical practitioners in order to create precise scientific illustrations.

Impact of World War I & II:
The impact of World War I and World War II heavily accelerated the need for detailed and accurate surgical visuals.[6] The great number of injuries sustained during the wars required more advanced medical training and treatment methods. As a result, medical illustration gained a newfound importance, not just for education, but also for use in new treatments. For instance, the development of reconstructive surgery to treat injuries sustained during the wars relied on medical illustrators' ability to visualize surgical reconstructions. Additionally, as technologies such as X-ray became much more common during these wars, medical illustrators were vital in the translation of radiographic images into comprehensible visuals that could be used for treatment. A notable illustrator within this era was Duclie Mary Pillers, who was one of the first women to gain recognition in a male-dominated field at the time.[7] She worked closely with surgeons during the two wars, producing accurate and detailed anatomical drawings used for education, publication, and research. She became a founding member of the Medical Artists Association of Great Britain in 1949, an association dedicated to biomedical communication.[8]

Simulations and Augmented Reality:
In recent years, medical illustration has been heavily transformed as the integration of digital simulations, augmented reality, and virtual reality has shaped surgical education. These tools have allowed medical illustrations to become much more interactive and immersive, significantly improving their value and effectiveness. Virtual reality enables students and trainees to practice complex procedures within a risk-free and calm environment, improving the quality of education while also enabling a higher number of students to train simultaneously.[9] In addition, virtual reality simulations allow medical practitioners to visually experience surgery before they ever step into an operating room. This allows them to build important skills such as muscle memory, decision-making, and spatial awareness, all of which heavily improve surgery success rate. Augmented reality is another tool which is being increasingly used within actual medical procedures.[10] Augmented reality overlays during surgeries allow medical practitioners to project digital illustrations and diagnostic imaging, such as CT or MRI, onto a patient's body during operations.[11] This blend heavily enhances precision and provides surgeons with better visualization and navigation.

The Use of AI:
The recent use of AI has also impacted surgical education in numerous ways, such as being used to detect abnormalities in medical imaging including MRI and CT scans.[12] AI can be used to create accurate medical illustrations, specifically delineating structures such as tumors, blood vessels and a variety of cells.[13] While AI has promising potential, the integration of AI into modern medicine has many challenges and factors to be considered. While AI can produce accurate models and offer real-time feedback, it lacks the critical thinking and contextual understanding that humans have. As a result, while it can make models and offer insight into data or information that the AI is trained on, it does not have the actual ability to make innovations or offer new insights within its field. Additionally, AI's dependence on the data it is trained on also raises concerns such as bias, inaccuracies and generalization. Therefore, it is essential that technologies such as AI are integrated thoughtfully, with their current limitations and faults in mind.

Conclusion:
Medical illustration has played a crucial role in the advancement of surgical education and how surgical procedures are performed. From early symbolic drawings to augmented reality and simulations, it is clear that medical illustrations have heavily transformed throughout history. Despite its constantly changing nature, its core purpose of clarifying complex systems and aiding in human understanding has always remained the same. As technology continues to evolve, the future of medical illustration looks ever more promising, with new resources and techniques constantly evolving.

The works cited for this piece can be found on pages 25-26.

How We See Differently:
Colour Vision Deficiency

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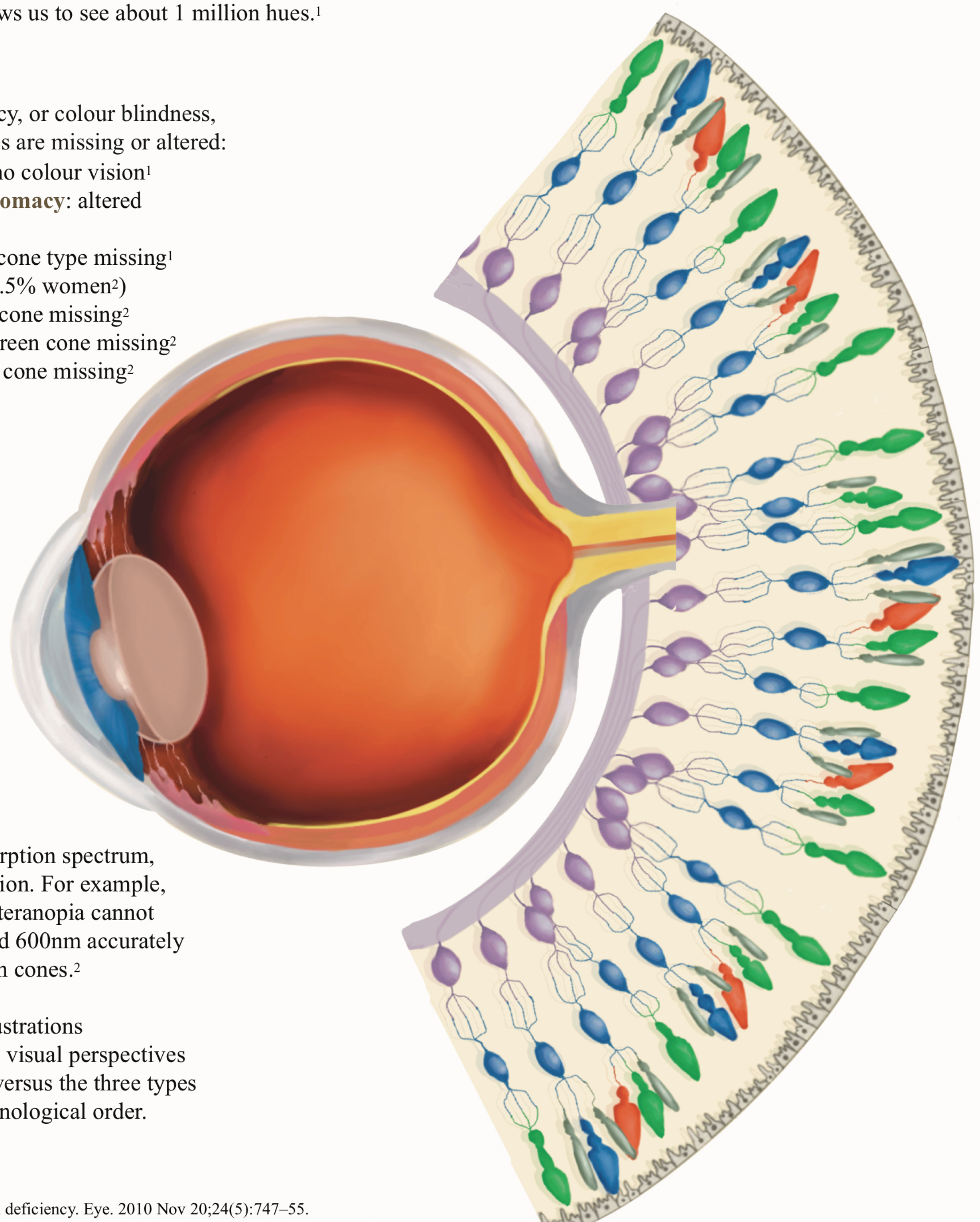
Human colour vision depends on 6.5 million cone cells in the retina – L (red), M (green), and S (blue). This allows us to see about 1 million hues.[1]

Anatomy

Colour vision deficiency, or colour blindness, occurs when cone types are missing or altered:

- **Monochromacy**: no colour vision[1]
- **Anomalous trichromacy**: altered cone sensitivity[1]
- **Dichromacy**: one cone type missing[1] (affects 8% men, 0.5% women[2])
  - ***Protanopia***: red cone missing[2]
  - ***Deuteranopia***: green cone missing[2]
  - ***Tritanopia***: blue cone missing[2]



Implications

CVD disrupts the absorption spectrum, altering colour perception. For example, an individual with deuteranopia cannot distinguish light around 600nm accurately due to absence of green cones.[2]

The accompanying illustrations depict the comparative visual perspectives in the normal version versus the three types of dichromacy, in chronological order.

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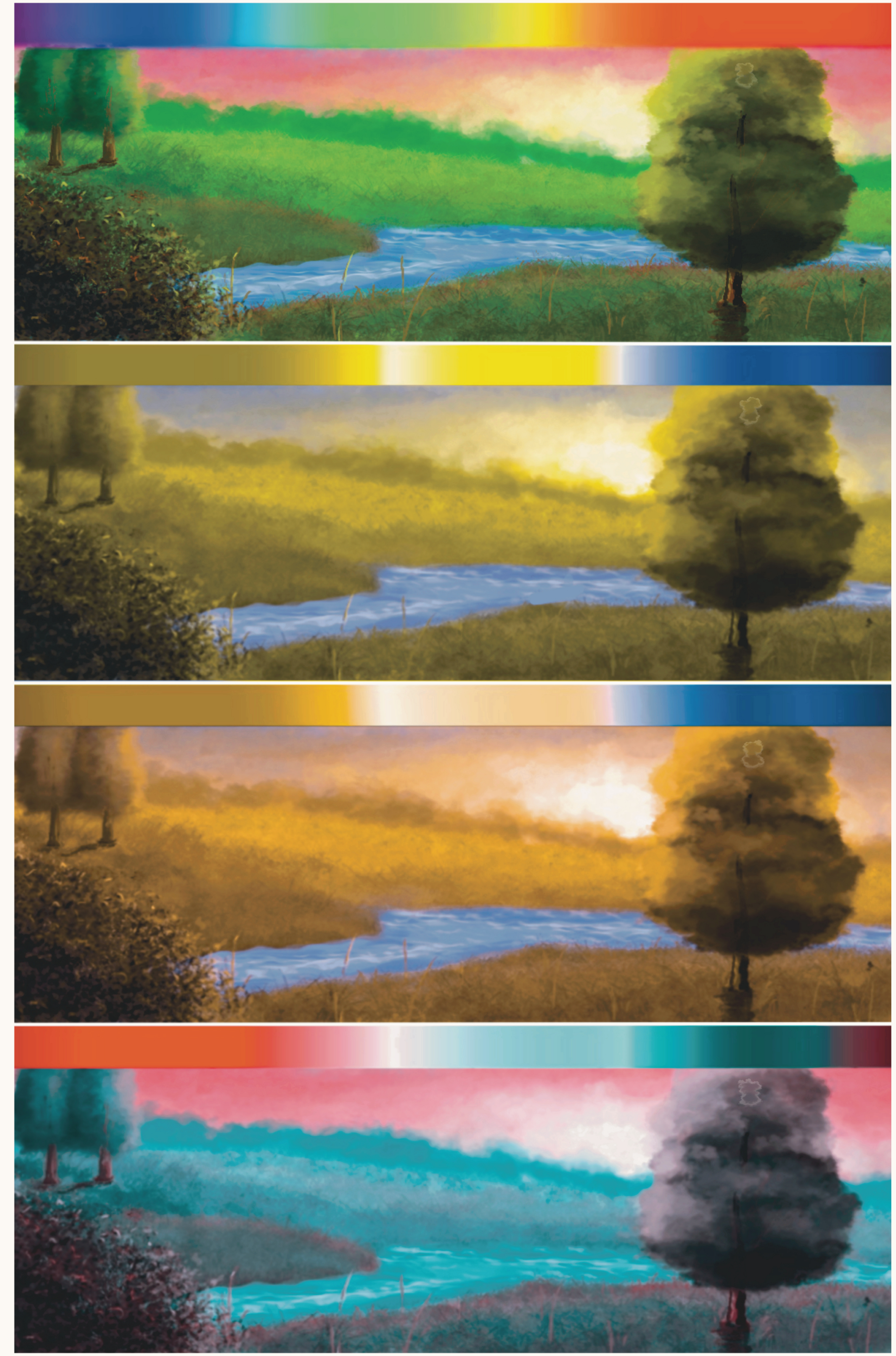

A Silent Disease: Spinal Osteoporosis

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What is Osteoporosis?

Osteoporosis, where "osteo" means bone and "porosis" means porous in Latin,[1] is a bone disease. Bones consist of compact bone tissue, which makes up the hard outside layer, and cancellous bone tissue, which is the less dense, inner layer.[2] Osteoporosis causes changes such as decreased bone mass, bone mineral density, and bone structure, leading to the thinning of compact bone and increased pore size in cancellous bone. These changes can cause weakening of the bones, leading to an increased risk of bone injury, such as fractures.[3]

Osteoporosis is considered a "silent disease" due to a lack of noticeable symptoms. Consequently, it can be undetected until a bone mineral test (BMD) is done, or until injury.[4] This disease can affect anyone of any age, though the risk of developing osteoporosis increases with age. Additionally, other factors such as sex, age, body size, and family history can also influence an individual's susceptibility to osteoporosis.[3]

How is Your Spine Affected?

Spinal vertebrae are one of the most common bones that develop fractures in the case of osteoporosis. Vertebral fractures can cause back pain, especially during movement, and may also lead to changes in posture such as a humped/rounded back.[5]

Treatment Options

Spinal osteoporosis cannot be cured but it can be treated. Osteoporosis treatment depends on an individual's risk of bone injury in the next ten years – tests such as a BMD are done to help gauge these risks. If an individual's risk is low, treatment may be more lifestyle-based. However, if the risk is high, medication is likely to be prescribed. Some of the most common medications used to treat osteoporosis include but are not limited to biophosphonates, denosumab, and hormone-related therapy.[6]

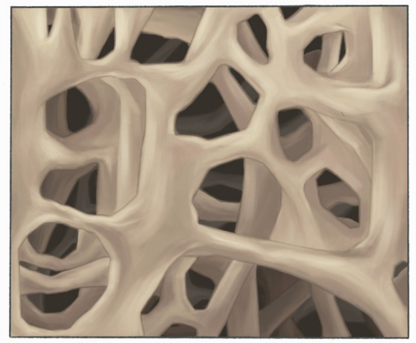

Fig 1. Normal cancellous bone structure is porous and spongy.[9]

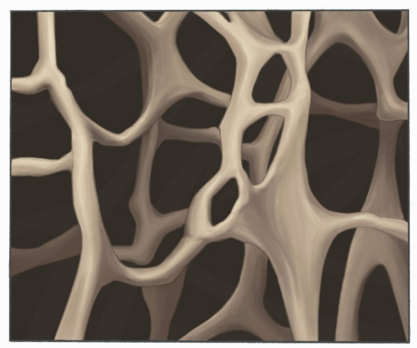

Fig 2. Cancellous bone diseased with osteoporosis. Osteoporotic bones are characterized by large pore size and decreased bone mass.[9]

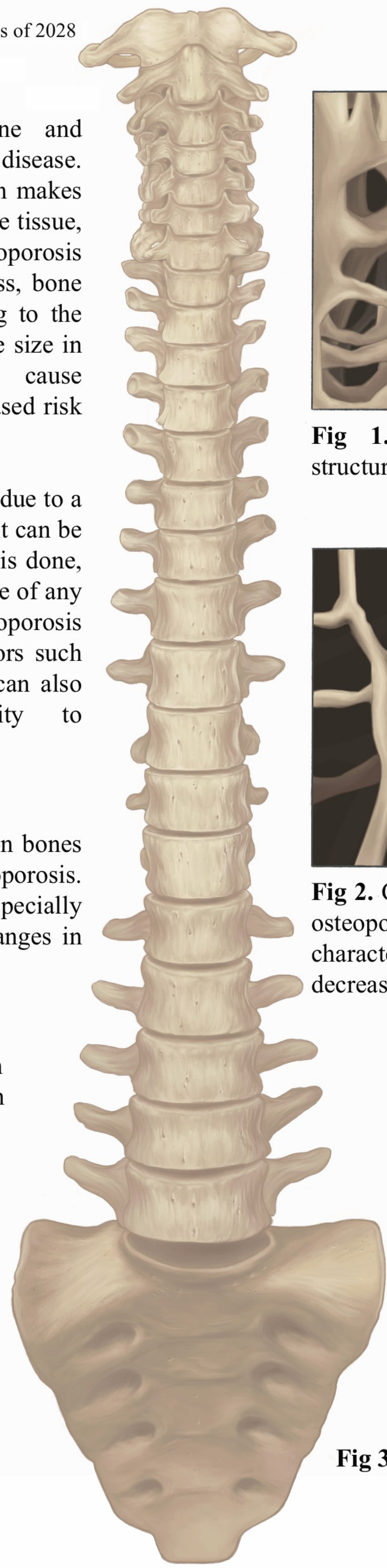

Fig 3. Anterior view of the spine.[7-8]

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Illustrator Interview: Beverly Ng

Medical Illustration Student at U of T

Introduction

Among the few opportunities to formally study medical illustration in Canada, the University of Toronto's Master of Science in Biomedical Communications (MScBMC) program stands out for its innovation and excellence. With over 120+ applicants competing for only 18 spots each year, it remains one of the most competitive programs of its kind.

We sat down with Beverly Ng, a McMaster alumna who completed her Bachelor of Health Sciences in Biochemistry in 2023 and is now an incoming second-year MScBMC student, to learn about her medical illustration journey. She entered the meeting with a smile, her cat's tail flicking behind her as it balanced on her chair headrest.

Q: What inspired you to combine the sciences and arts and pursue medical illustration? How did you find your way here?

I grew up really liking art and always wanting to draw. While doing Biochem for undergrad, I really developed my love for science as well. But, going through that program showed me that I didn't want to do something entirely science related because research was not for me. I didn't think I could do a full career in art either because it didn't feel scientifically challenging enough for me. I discovered medical illustration programs when I was in high school during a careers course. It was a field that just clicked with me because you can combine creativity with intellectual and scientific topics.

It's truly the best of both worlds, especially coming from the foundations of the arts program I did in high school, CyberArts. After undergrad finished, I went to apply for the MScBMC at U of T, knowing that I had my eye on it for a long time. I spent a couple months working on the portfolio requirements while attending figure drawing classes. I didn't actually get in the first year I applied, but I took the year off and tried again. I enjoyed building a new portfolio because I knew this was the career for me. With the amount of time and feedback I had, I worked a lot harder on my second portfolio and got in.

Q: What do you think made your MScBMC application and portfolio stand out?

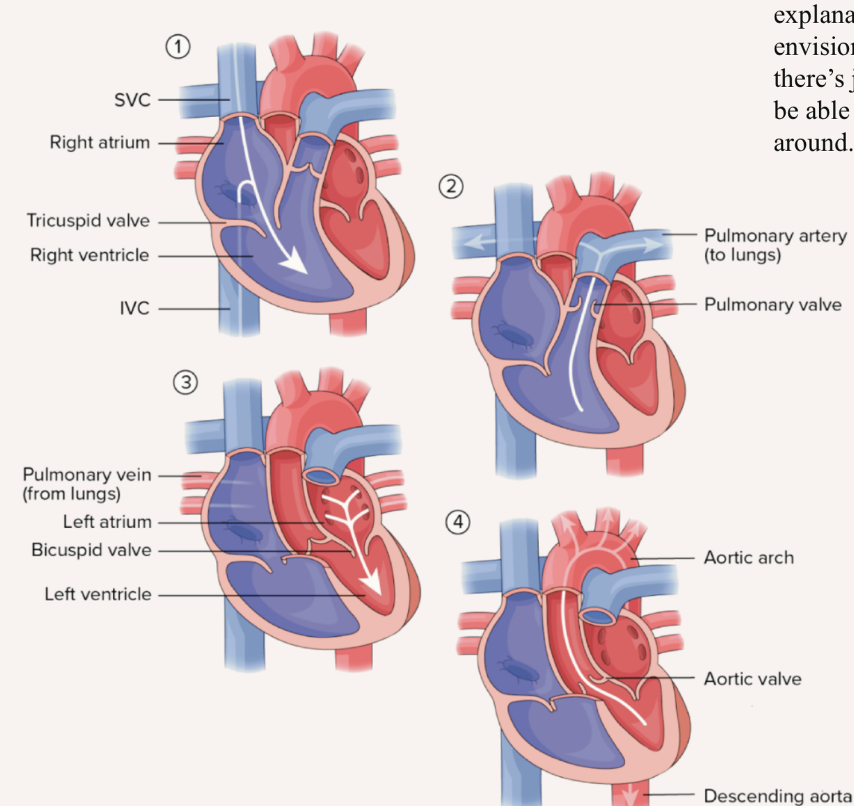
Sketching from life is crucial, since medical illustration demands a high degree of fidelity. Imaginative pieces are also pretty good, because of the variety of things you need to draw without direct references, such as a cross section of a heart. You need to have a good understanding of what something would look like without always being able to see it in real life or have photographs to pull from. That's why having a good understanding of lighting, shadows, and contrast is really important. Telling the story you want in an effective way is also key. They changed the portfolio requirements for MScBMC last year, but my application required a storytelling piece where you had to show how to do something, such as a stepwise illustration on how to do a certain process. Putting your personality into it is also a pretty surefire way to stand out.

Q: What kinds of anatomical tools and artistic skills do you use in your illustrations?

In our program we use a lot of Adobe Suite, like Illustrator and Photoshop. I also personally use Procreate, and am more comfortable drawing traditionally. I did a lot more traditional drawings before entering the program compared to digital, so I'll still often sketch my drawing physically and scan it in to render digitally. In medical illustration, a lot of modern illustrations are done using digital painting software, but there's a lot of traditional media as well. A really classic technique that we practiced in our first semester was using carbon dust, which also immersed us into the history of medical illustration. As for anatomical tools, we use a lot of 3D software like Maya or Cinema 4D for building 3D items such as maquettes. You can oftentimes take digital scans from the internet or from databases and input that into 3D software and have an idea of what, for example, things look like inside of your lungs.

Q: How do you think medical illustration contributes to healthcare, especially in education and patient understanding?

Something that I'm really passionate about in medical illustration is patient education. It's so important because many people don't fully understand complex medical terms or the full extent of their medications, which can lead to a lot of complications and anxiety.

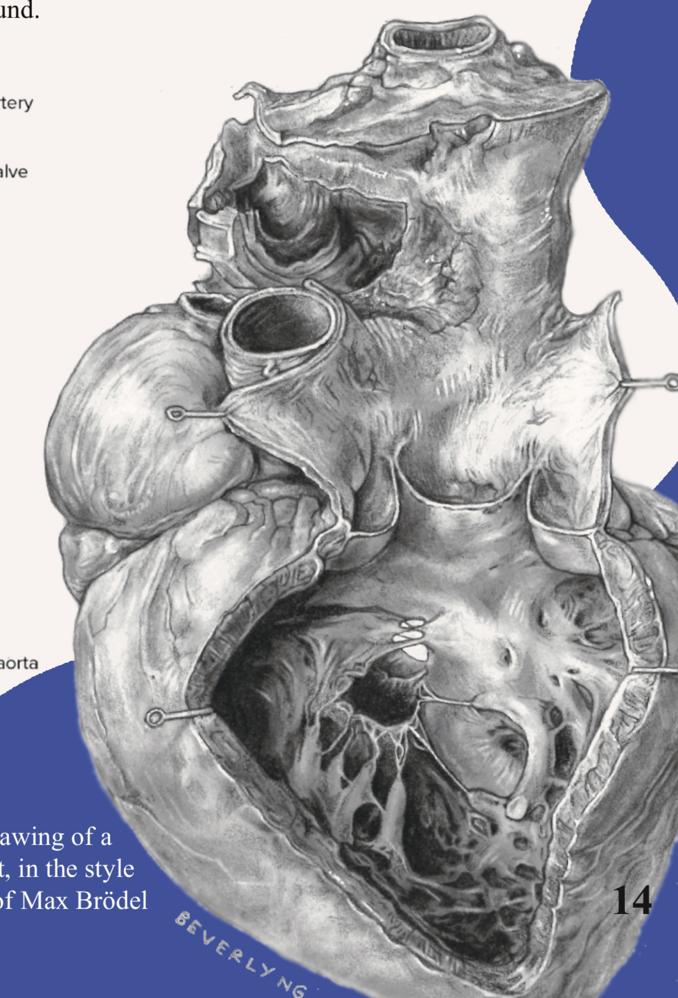


(1-4): A diagram of bloodflow through the heart

Many healthcare providers want the best for their patients, but aren't able to really think like a patient. This concept is really important in medical communication, where you really need to think like your audience, step into their shoes, and view the world how they view it. That's how we can really bridge that communication gap between patient and provider. We want patients to understand: 'This is what's going on in my body, this is what's wrong, and this is what they're going to do to help me.'

> ***"We want patients to understand: 'This is what's going on in my body, this is what's wrong, and this is what they're going to do to help me.'"***

It's a really cool thing to be able to help people understand what's going on, especially because I'm such a visual learner. I don't think I could have gone through undergrad without YouTube video explanations, because sometimes it's very hard to envision things in 3D. For anatomy especially, there's just so much going on that it's really nice to be able to see things in 3D and be able to swirl it around.



Drawing of a heart, in the style of Max Brödel

Q: Can you share a recent project that you're proud of and what you learned from creating it?

We had a project where we had to observe a surgery in the operating room (OR) and draw out the steps of the procedure for surgical residents. We went in, observed the surgery a couple of times and talked with the surgeon, studying everything before drawing it out. You have to make sure you're drawing the eye to relevant places of information, because there's so much going on. In surgery, flesh and blood gets all piled together, and it's messy. The first few times you observe it, you have no idea what you're looking at. That's why it's really important to figure out what's happening.

It's actually one of my favourite things about medical illustration, the intellectual puzzle behind it. You have to figure out not just what's happening, but also who the key players are, what organs you're looking at, and what the surgeons are trying to achieve.

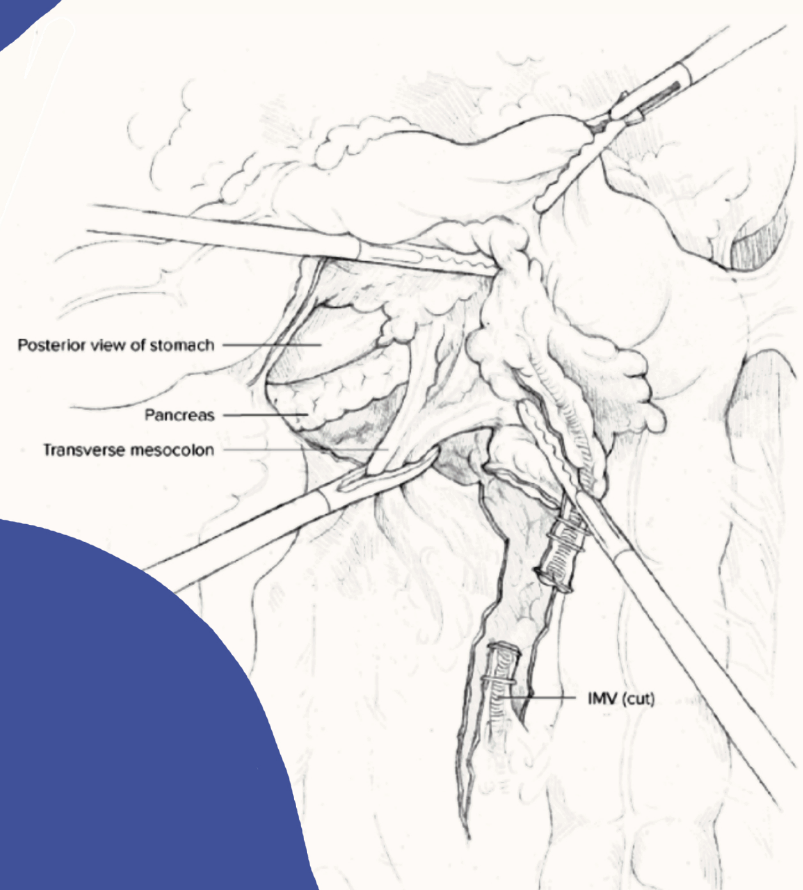
We had four or five rounds of drawn drafts that we went over with our professor and the surgeon to make sure everything was accurate. Surgical illustration is just really cool, with so many considerations you don't initially think about. This was a laparoscopic surgery, so you also have to think about things like; 'Are the tools being shown in the right ports? Would the tool actually be coming from that direction?'. It's a lot of imagining.

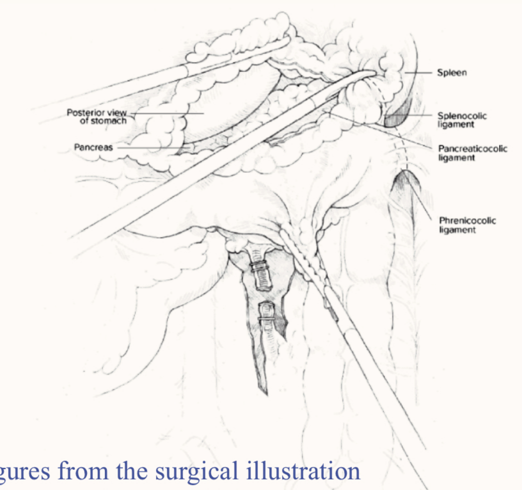
Q: Tell us more about your current job, and any dream projects you'd love to pursue in the future.

Right now I'm working at University Health Network (UHN) as a Biomedical Communications Intern. The lab I'm working in, the Hodaie lab, is developing a surgical education app for residents around the world. I'm creating some modules encompassing a variety of different topics such as surgical foundations, neurosurgery, plastic surgery, and vascular surgery. I'm also helping them with creating patient education booklets. Because the doctor I'm working under specializes in treating a facial nerve disease– trigeminal neuralgia, I get to work in patient education, which I find really cool.

For my future roles, I think it'd be great to continue working in education of any sort, because that's really where my passion lies. It's just so amazing to help people understand things, to help facilitate that sense of accomplishment and inspiration that learners get. I would love to work more in patient and surgical education. The latter really draws me in because there's a higher fidelity of technical skill that it needs, which I really love to do.

Now, this is more like a faraway dream of mine, but I'd also really love to do an interactive museum exhibit of some sort someday. Like the ones they had in the Ontario Science Centre. I would also want to develop other sorts of media as well, such as interactive design and educational games.





Figures from the surgical illustration assignment: 'Sigmoid Resection for Diverticulitis'

Q: What advice do you have for students at McMaster right now who are interested in medical illustration?

I think the most important piece of advice I could give is just to practice. One of my biggest regrets is that I didn't practice nearly enough. There are also a lot of opportunities to work on small self-starting projects for scientific illustration while you're still an undergraduate student. You should ask your professors if they need help visualizing their research for any projects, and there's a lot of opportunity to collaborate with graduate students who are publishing papers.

I think you should also make use of online resources, like podcasts and social media groups. Familiarizing yourself with the space, the culture, and the people in it, is really beneficial. You should also try reaching out to medical illustrators, because a lot of us are very open to having conversations and giving advice because we've all been in your shoes.

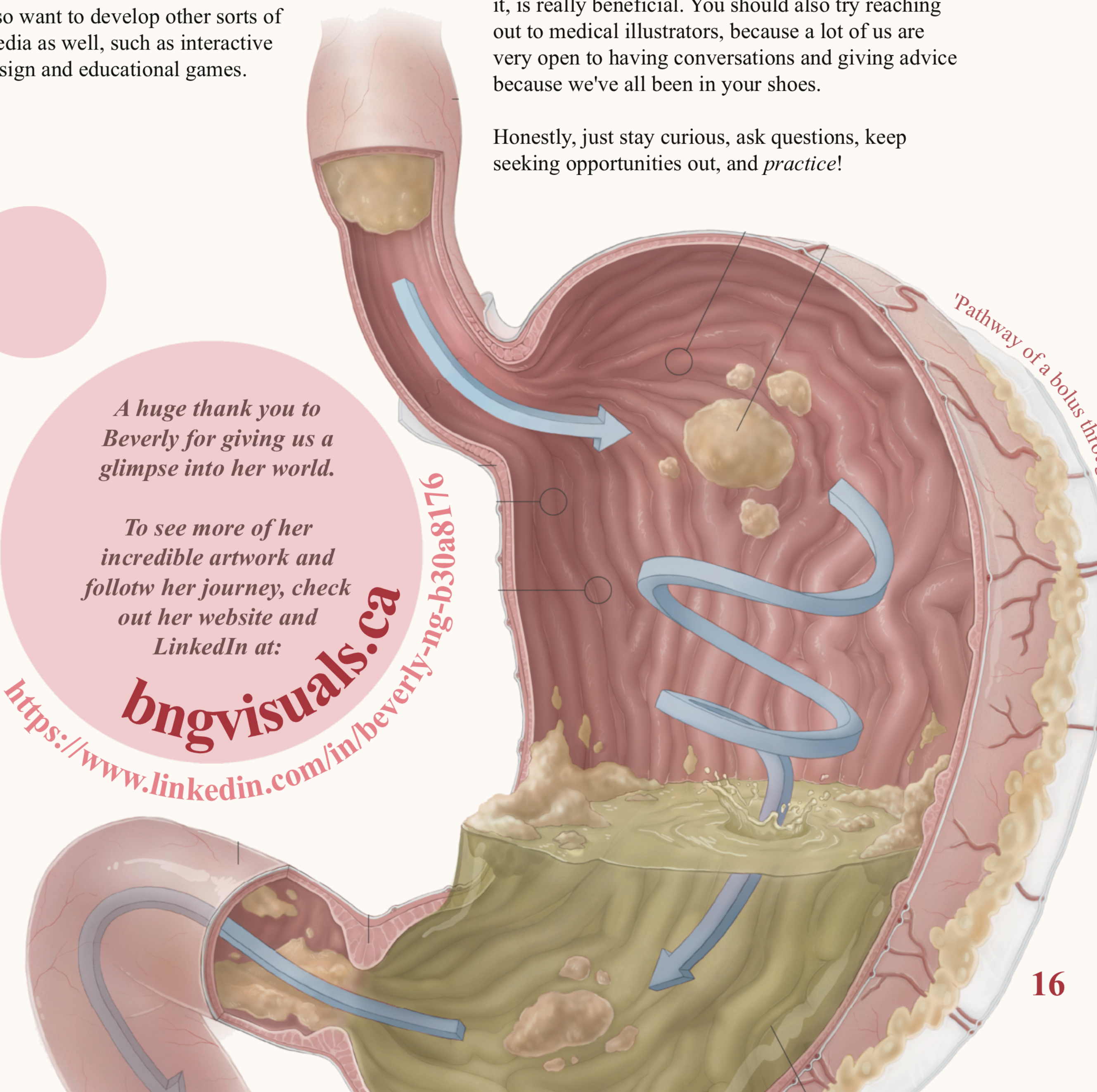
Honestly, just stay curious, ask questions, keep seeking opportunities out, and *practice*!

A huge thank you to Beverly for giving us a glimpse into her world.

To see more of her incredible artwork and followtw her journey, check out her website and LinkedIn at:

bngvisuals.ca

https://www.linkedin.com/in/beverly-ng-b30a8176



'Pathway of a bolus through the stomach'

Brain Matter Loss in Alzheimer's Disease

Ruchi Tilva
McMaster University, Honours Bachelor of Health Sciences Class of 2028
Acrylic on canvas

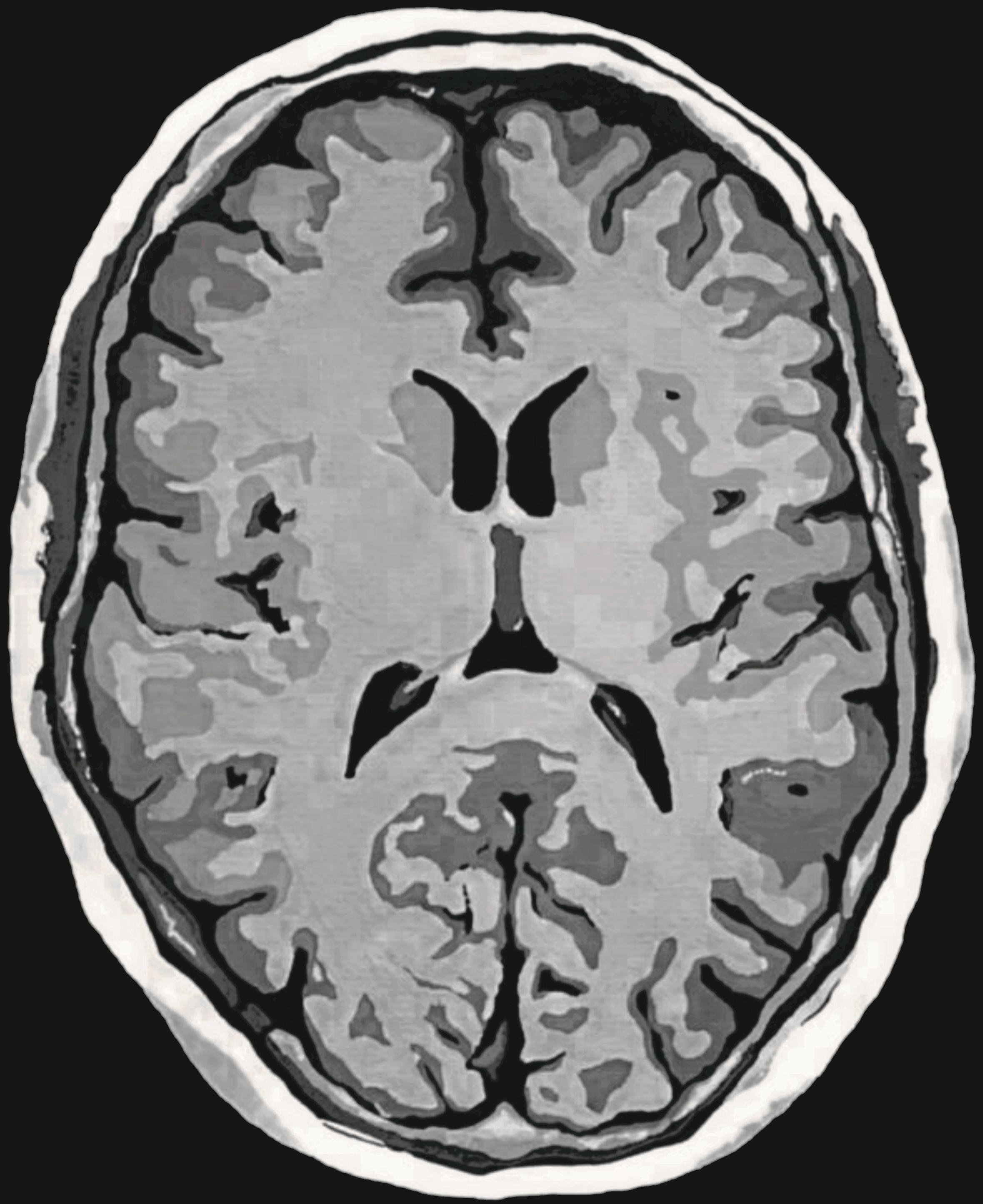


Fig 1. Normal brain MRI shows no grey matter loss.[1]

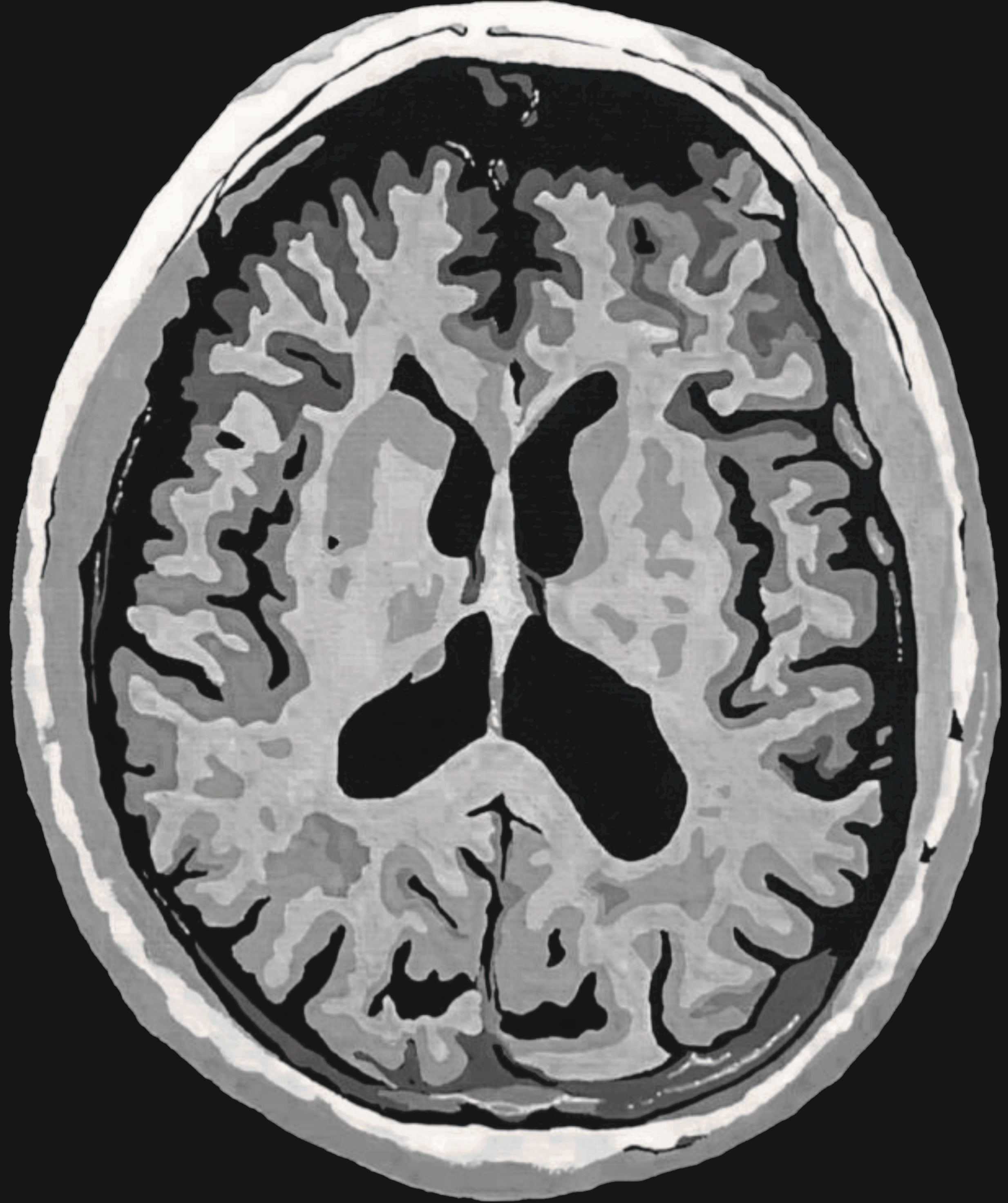


Fig 2. Affected brain MRI shows significant grey matter loss. A volume reduction of 26-27% in hippocampal regions and 38-40% in the entorhinal cortex is detected.[1]

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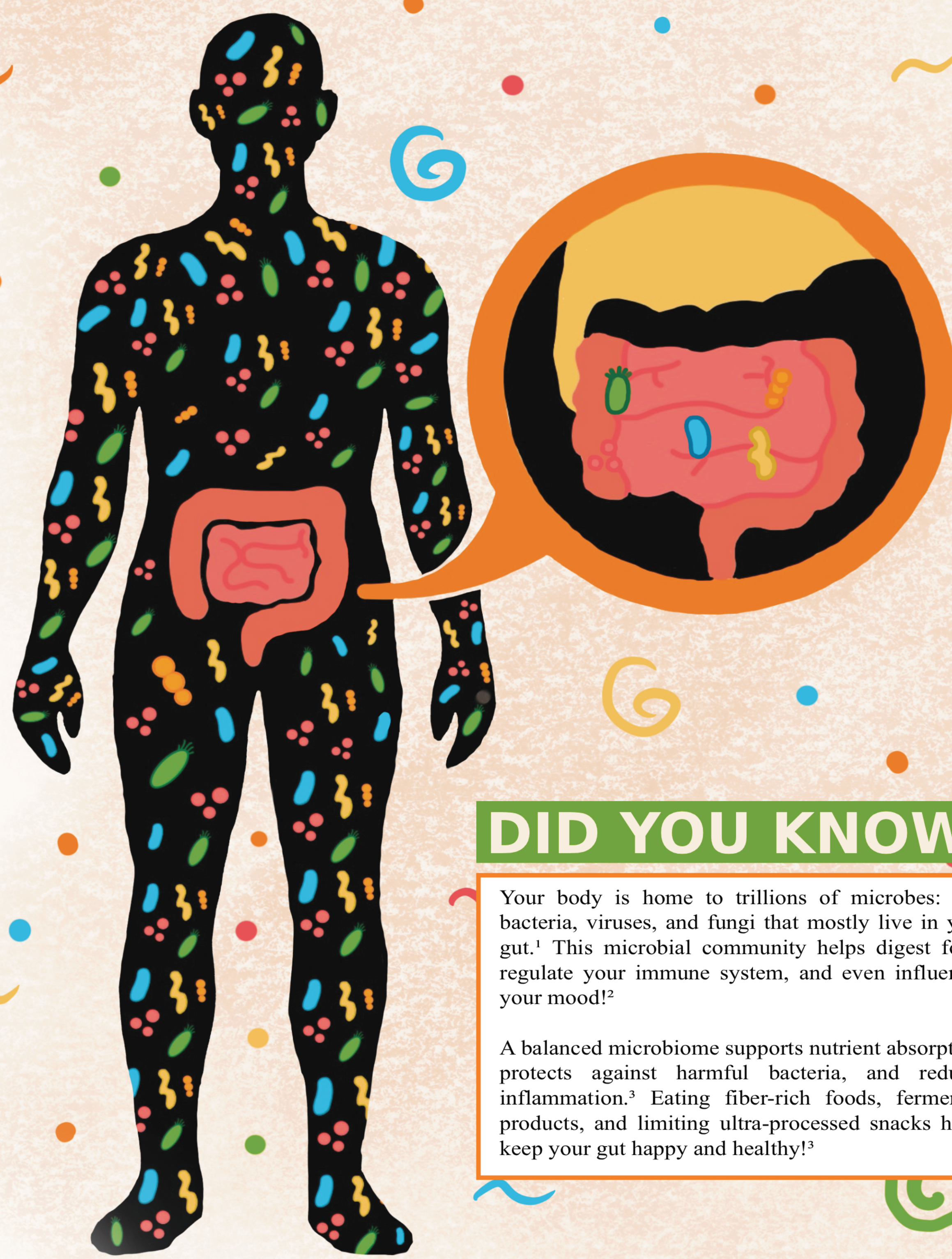
THE MICROBIAL YOU
YOU ARE NOT ALONE



DID YOU KNOW?

Your body is home to trillions of microbes: tiny bacteria, viruses, and fungi that mostly live in your gut.[1] This microbial community helps digest food, regulate your immune system, and even influences your mood![2]

A balanced microbiome supports nutrient absorption, protects against harmful bacteria, and reduces inflammation.[3] Eating fiber-rich foods, fermented products, and limiting ultra-processed snacks helps keep your gut happy and healthy![3]

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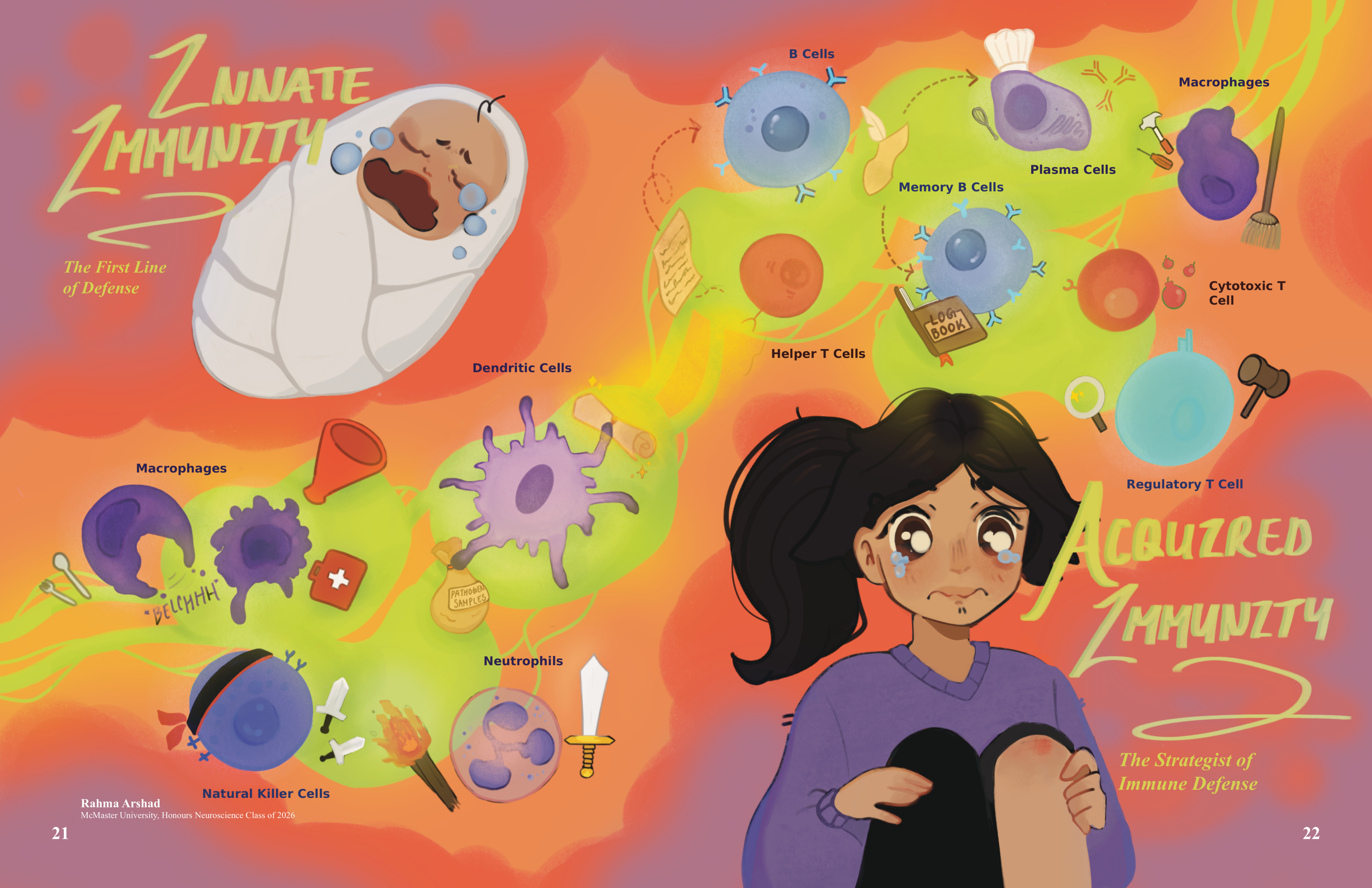

Rahma Arshad
McMaster University, Honours Neuroscience Class of 2026

Visualizing the Nervous System:
A History of Brain Illustration

Hazel Lee
McMaster University, Honours Psychology, Neuroscience and Behaviour Class of 2027

Abstract:
Words often fail to explain complex concepts, creating gaps in understanding which only drawings can bridge. The nervous system is composed of numerous neurons that actively communicate and form a complex network of nerves throughout the body. In just the brain itself, there are approximately 86 billion neurons.[1] Given its delicacy and complexity, the nervous system can be best understood through visual representation. Throughout history, drawings created by neuroscientists worldwide have significantly contributed to the advancement of neuroscience. These exquisite drawings have been valuable across the fields of science, art, and medical education. Understanding how neuroscience has evolved with the aid of drawings can help continue the path of advancement with future illustration technologies.

Neuroscientific Illustrations in Early Civilizations:
When neuroscience first began to emerge, the anatomy of the brain and spinal cord was the main focus of scientists. The first drawings of the nervous system can be traced back to the findings of scientists from 300 BC, Alexandria, a Greek city in Egypt.[2] During this era, dissecting human corpses was allowed, leading to the earliest breakthroughs in scientific understanding of human anatomy.[2] Herophilus was one of the most prominent scientists during that time, conducting dissections and writing books based on his findings. He discovered the structures now known as the lateral ventricles, cerebral aqueduct, and fourth ventricle, and identified the ventricular system of the human brain for the first time. He also discovered and named the choroid plexus on the surface of the ventricles.[2] Referencing Herophilus's findings, a group of drawings called the "five figure series" was produced.[2] The series contains the oldest surviving drawing of the brain, showing two vessels connected to the brain, along with the sulci and gyri on the brain's surface.[3]

Other historical depictions of the nervous system were produced across different parts of the world, including in non-Western cultures. Kitab al-Manazir, translating to 'Book of Optics', was written by Hasan Ibn al-Haytham in Egypt around the 11th century.[4] The book describes how humans sense and process light information with the eyes. It explains the role of the cornea and the lens, predicting that these structures refract the light coming from the outer source to place it onto the fovea. Additional drawings in the book also show the optic nerves and optic chiasm. Tashrih-i badan-i insan or 'Anatomy of the Human Body', written by Ibn Ilyas in the 14th century Iran, is another prominent historical documentation of the nervous system. A drawing in the book shows 30 vertebrae, from which pairs of spinal nerves originate. This correctly depicts that the spinal nerves responsible for the lower limbs originate from the lumbar enlargement, and the spinal nerves responsible for the perineum originate from the end of the spinal cord.[4]

In the 15th-16th century in Europe, Leonardo da Vinci produced numerous drawings exploring human anatomy. He discovered the frontal sinus and meningeal vessels, along with many more brain structures. Moreover, through experimenting with frogs, he developed a neurophysiological theory about how sensory stimuli are processed in the brain.[5]

Despite the distance and time across these works, all of these historical drawings prove that scientists have always been curious about the nervous system. From the drawings in 300 BC in Alexandria, to the drawings of 11th century Egypt, 14th century Iran, and 16th century Europe, all locations played an important role in discovering the nervous system.

Microscopy and the Neuron:
In the late 19th and early 20th centuries, advanced microscopes and staining techniques enabled the drawing of individual neurons. Santiago Ramon y Cajal's drawings of neurons are delicate artworks which have significantly contributed to the scientific advancement of neuroscience. Cajal was able to draw detailed structures of neurons thanks to the invention of the Golgi stain by Camillo Golgi. The Golgi stain method utilizes silver salts impregnating into neurons to stain the cell body, dendrites, and axon of a neuron.[6] Although it only stained 1-5% of all neurons in the human nervous system, it stained all parts of a neuron, which allowed Cajal to observe and draw individual neurons to a high level of detail.[7] His detailed drawings demonstrated the whole structure and various shapes of a neuron. In Cajal's era, drawings, rather than pictures taken from microscopes, better visualized the exact structures of a neuron. This was due to older microscope models having a limited area of focus, consequently being unable to display clear images of every fine neuronal structure.[8]

Cajal's drawings were free of this limit on clarity; when drawing, he continuously obtained clear images of separate parts of a neuron by changing the focus and merging the images in a drawing at the end.[8] Cajal's observations of individual neurons helped him solidify the neuron doctrine, which states that neurons are physically disconnected from each other and have small gaps between them. During that time, other scientists widely believed that a neuron directly goes into a neighbouring neuron, making a physical connection.[9] The neuron doctrine proposed by Cajal was proven correct, and the small gaps between neurons are now known as synapses. Cajal's delicate drawings identified the structures of an individual neuron and how neurons are connected, showcasing the key role of illustrations in advancing neuroscience.

Brain Imaging in Modern Neuroscience:
Visualization is still a crucial tool when studying the nervous system in today's laboratories and clinical institutions. However, this visualization is now done through the use of various brain imaging techniques rather than hand drawings. Moreover, today's visualization illustrates the profound activities of the nervous system, not only the superficial anatomy of the system. Reflecting this fact, there are two broad classifications of brain imaging techniques: structural and functional imaging. Structural focuses on identifying the anatomical properties of the brain structures, while functional imaging focuses on analyzing the underlying activities in specific brain areas.[10] Positron emission tomography (PET) studies the blood flow in the brain using radioactive dye injected into the bloodstream.[11] Functional magnetic resonance imaging (fMRI) detects how blood oxygen level changes when the activity level of certain parts of the brain changes.[12] Magnetoencephalography (MEG) studies the magnetic field created by individual neurons, which have electrochemical properties that allow the charged ions to flow and convey electrical signals.[13] Electroencephalography (EEG) studies the patterns of brain waves that are formed by the electrical activities of the cortical neurons.[14] Each of the different brain imaging techniques has its strengths and weaknesses, and one technique's weakness can be complemented by another's strength. Thus, images from various brain imaging techniques are combined to better understand the activities of the brain and identify the damage to the brain in a patient.

In the modern era, illustrations are used not only to advance the field but also to educate people in more practical situations. The illustrations produced with the brain imaging techniques and computer-based animation drawing techniques aid medical students' learning of course materials, as well as patients' understanding of their diseases.[15,16]

Conclusion:
Illustrations have been contributing to our understanding of the nervous system for thousands of years. Early drawings produced around the globe helped scientists understand neuroanatomy. Cajal's drawings of individual neurons revealed the various types of neurons and neuronal networks. Today's illustrations, utilizing brain imaging techniques and computer animation, help aid both students and patients. Throughout history, medical illustration has played a crucial role in neuroscience. It is a discipline that conveys knowledge words cannot easily capture, and its unique power will continue to reveal the nervous system's hidden secrets for years to come.

The works cited for this piece can be found on pages 25-26.

**We encourage readers to view the pieces discussed here firsthand to fully appreciate their historical significance.*

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Surgical Illustration

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Visualizing The Nervous System

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