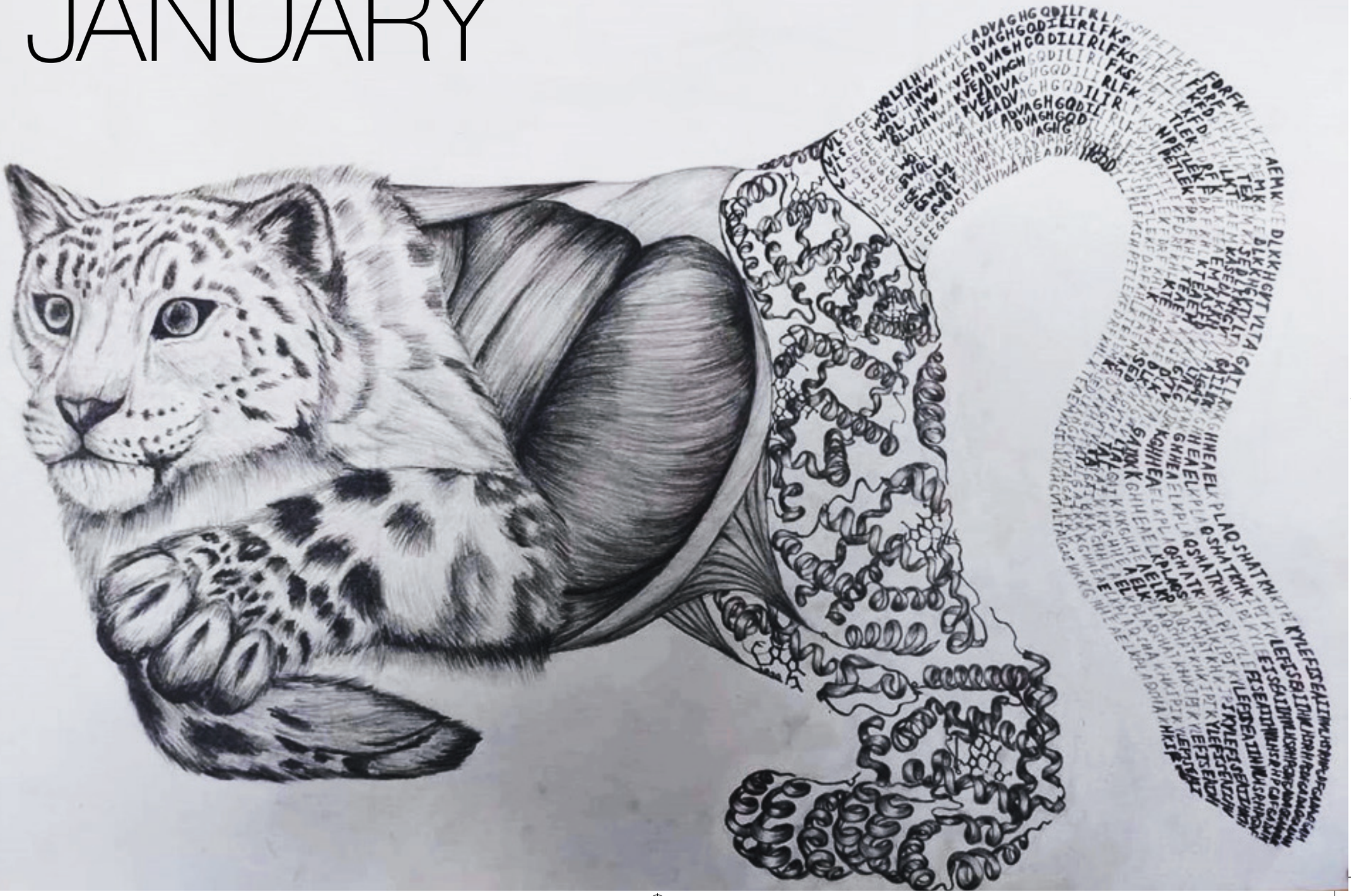
2024 CALENDAR

The Beauty of Biomolecules

JANUARY



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PDBe
Protein Data Bank in Europe

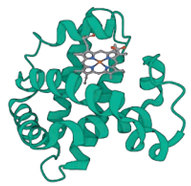
Myoglobin: The mighty oxygen carrier

Myoglobin is a vital protein in muscle tissues, and plays a crucial role in storing and transporting oxygen. It facilitates oxygen supply during muscle contraction and its unique structure enables efficient oxygen diffusion, which is essential for physical activity.

This artwork by Sabina showcases the cultural connection to myoglobin, drawing inspiration from Kazakhstan's diverse landscapes. The snow leopard, known for strength and agility, symbolises the enduring runs enabled by myoglobin's role as an oxygen reservoir. Through skilled use of pencils, pens, and calligraphy, the artist captures the groundbreaking contributions of John Kendrew and his colleagues in determining myoglobin's atomic structure, which earned them the prestigious Nobel Prize in Chemistry in 1962.

Drawing with pencils, pen, and calligraphy
Sabina Seisenbay

PDBe.org/1mbn/3d



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PDBe
Protein Data Bank in Europe

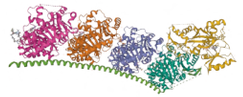
Nature's anti-tumor warriors

Maytansinoids are natural compounds extracted from plants and possess remarkable anti-tumor properties. They inhibit cancer cell growth by disrupting microtubule assembly, cell division, and inducing programmed cell death (apoptosis). Effective against different types of cancer, including breast, lung, and ovarian, they are vital in targeted anti-cancer therapies, where they are linked to antibodies or other molecules for precise drug delivery to cancer cells. Maytansinoids show great potential for developing innovative anti-cancer treatments.

The artist, Bella, found the structure of this complex very interesting and aesthetically appealing. She wanted to create a visually striking composition embedding the PDB ID 7e4q in the artwork. To bring her vision to life, she used paint dyes and employed layering techniques, allowing her to achieve the desired effect and depth in her artwork.

Painting with layering
Bella Frewin

PDBe.org/7e4q/3d

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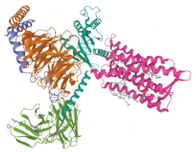
Wings of emotion

Glucocorticoids, such as cortisol, play a significant role in linking external stress with our emotional response. When butterflies encounter predators or unfavourable conditions, their bodies release stress hormones, including glucocorticoids. This enables them to mobilise energy stores to enhance flight response and deal with these external stress factors. Moreover, glucocorticoids can influence the butterfly's behaviour and emotional state, potentially affecting mating behaviours, foraging patterns, and interactions with others. This interplay sheds light on the intricate mechanisms governing the physiological and behavioural responses of butterflies to challenging situations.

Ellie found inspiration in this protein receptor that binds to glucocorticoids and is involved in the related stress response. Drawing inspiration from the deceptive nature of butterflies' wings, which provide camouflage against predators, Ellie incorporated the structure of the receptor in the butterfly wing to create a captivating and intriguing visual, merging the worlds of art and science.

Mixed media
Ellie Statham

PDBe.org/7d77/3d




APRIL

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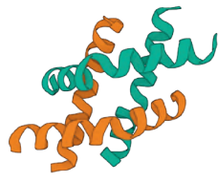
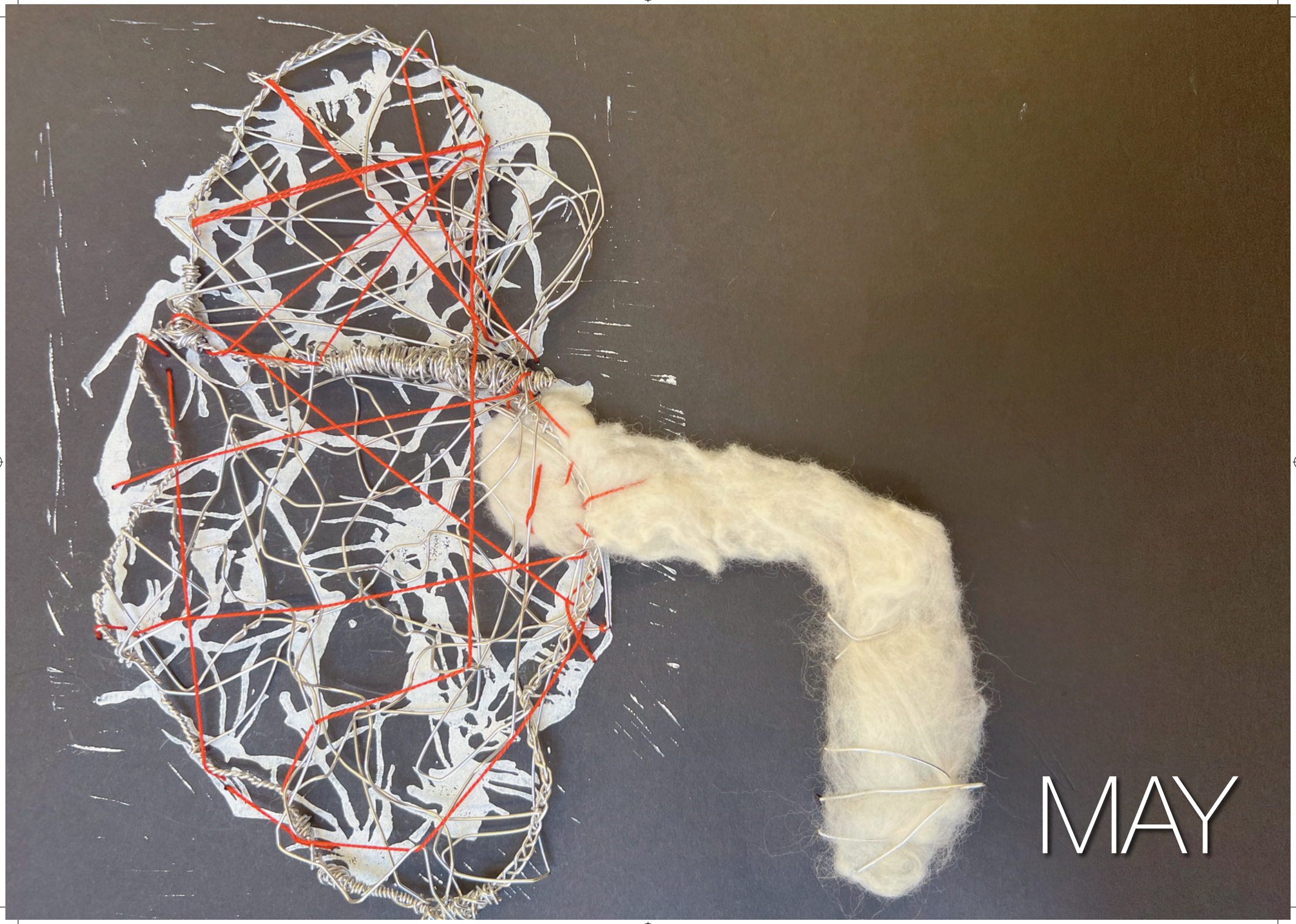
Unleashing the buzzing biochemical warrior

This artwork by Faith Okeke delves into the world of natural symmetry, taking inspiration from melittin, the primary toxin found in bee venom. Melittin is renowned for its powerful antimicrobial and hemolytic activities. It disrupts cell membranes by forming pores in lipid bilayers, leading to cell lysis. Melittin not only induces pain sensations, inflammation, and calcium signaling but also shows promise as a potential cancer chemotherapy candidate due to its ability to damage tumor cell membranes. Despite facing challenges such as rapid degradation and non-specific lytic activity, where it disrupts and destroys cell membranes in various cell types indiscriminately, melittin and its conjugates exhibit potential for targeted therapies. These therapies include hormone receptors, gene therapy, and nanoparticle-based treatments designed for specific types of cancer.

Print making and sewing
on canvas
Faith Okeke

PDBe.org/6o4m/3d




MAY

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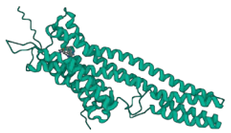
A journey into psychedelic perception

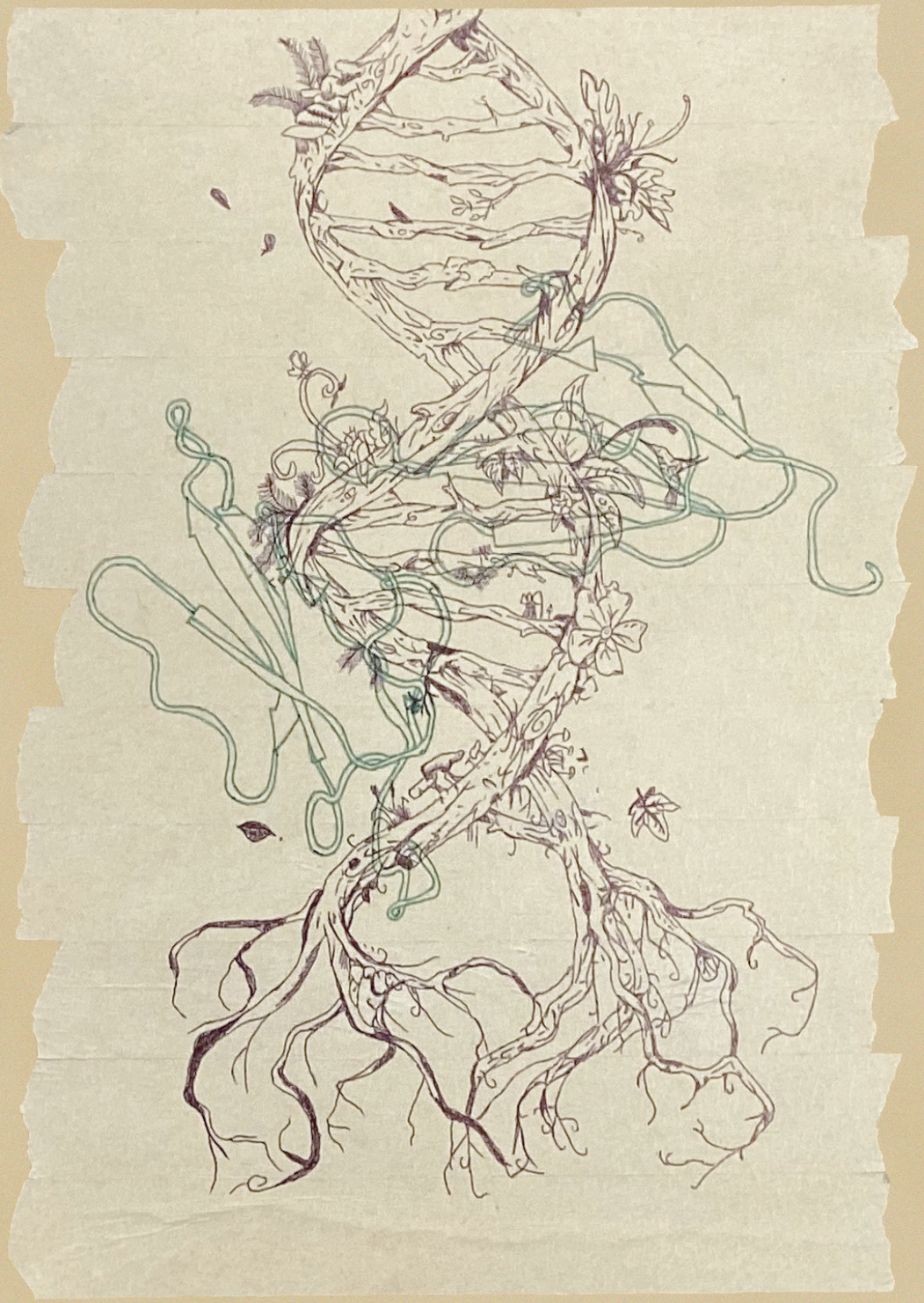
Hallucinogens, such as LSD (lysergic acid diethylamide), have a profound impact on a person's perception of their surroundings, causing significant changes in their thoughts and emotions. They can alter one's awareness, thoughts, and feelings by disrupting communication between chemical networks in the brain. By engaging with 5-HT2A serotonin receptors and modifying serotonin signalling, LSD triggers powerful psychedelic effects. Gaining a deeper comprehension of the intricate interplay between serotonin and LSD offers valuable insights into the mechanisms behind hallucinogenic experiences and potentially opens doors for therapeutic advancements.

Through the exploration of tufting, string shaping, and lino printing techniques, Jennifer explores the fusion of visual art elements while offering an imaginative representation of neural networks.

Mixed media
Jennifer Gong

PDBe.org/5tvn/3d





JUNE

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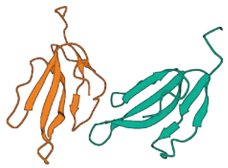
Unveiling serpent secrets

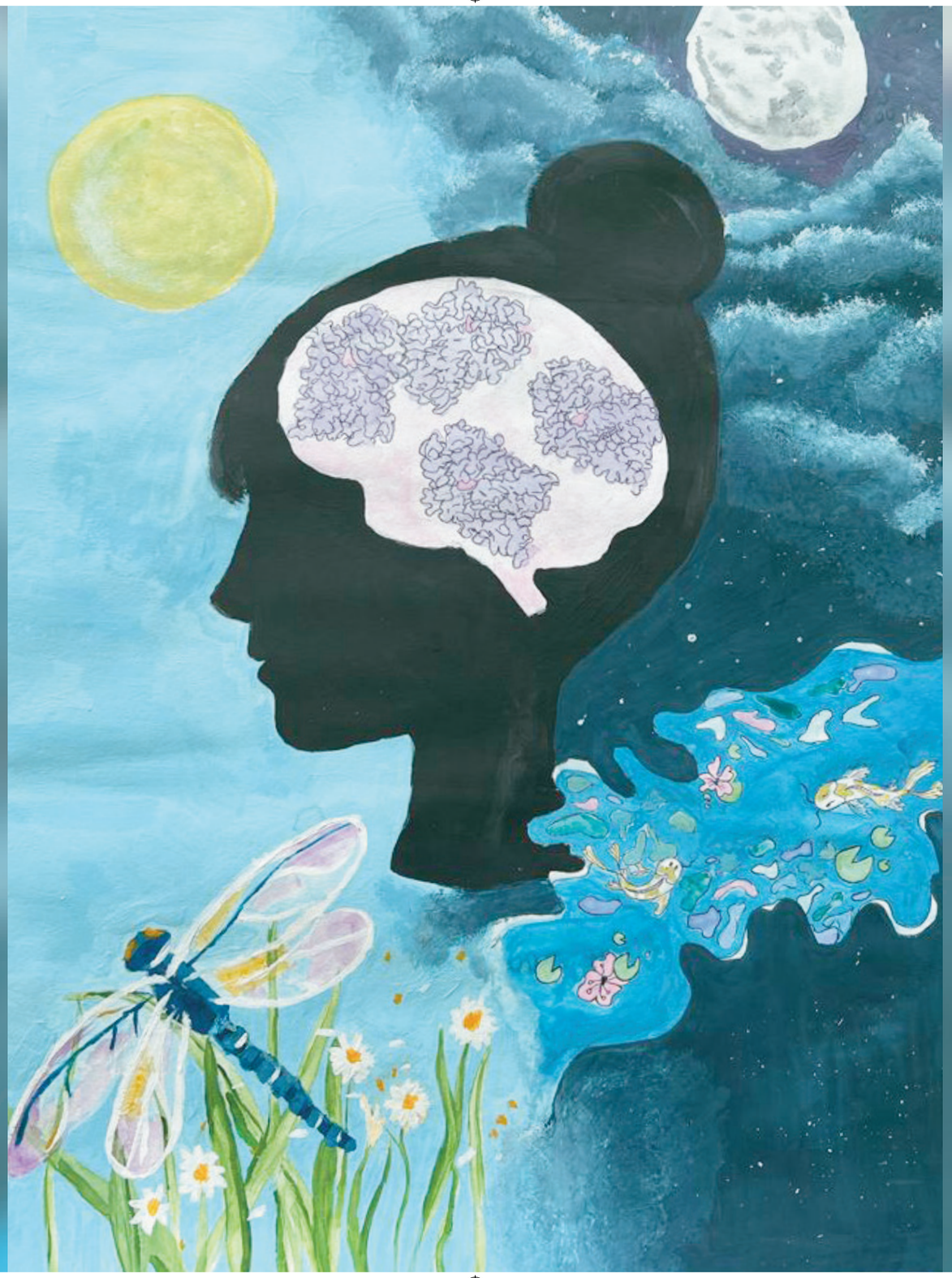
Cat-eyed snakes, belonging to the genus Boiga, are mildly venomous snakes found in Southeast Asia, India, and Australia. Boiga irregularis, known as the Brown tree snake, has infamously invaded Guam, impacting local bird populations. It produces a neurotoxin called irditoxin, a dimeric protein comprising two lobes connected by a flexible region that can wrap around the DNA strand. Although irditoxin is highly toxic to its prey, including birds and reptiles, its potency against mammals is around 1000 times lower.

Grace's fascination with the brown tree snake resulted in the inclusion of tree roots in the DNA structure depicted on the masking tape. Merging the snake protein with the tree motif aligned with her theme and reflected some of the captivating things she learned about lethal and non-lethal snakes during the artistic process.

Print and drawing
Grace Arthur

PDBe.org/2h7z/3d





JULY

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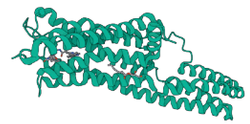
The moody messenger

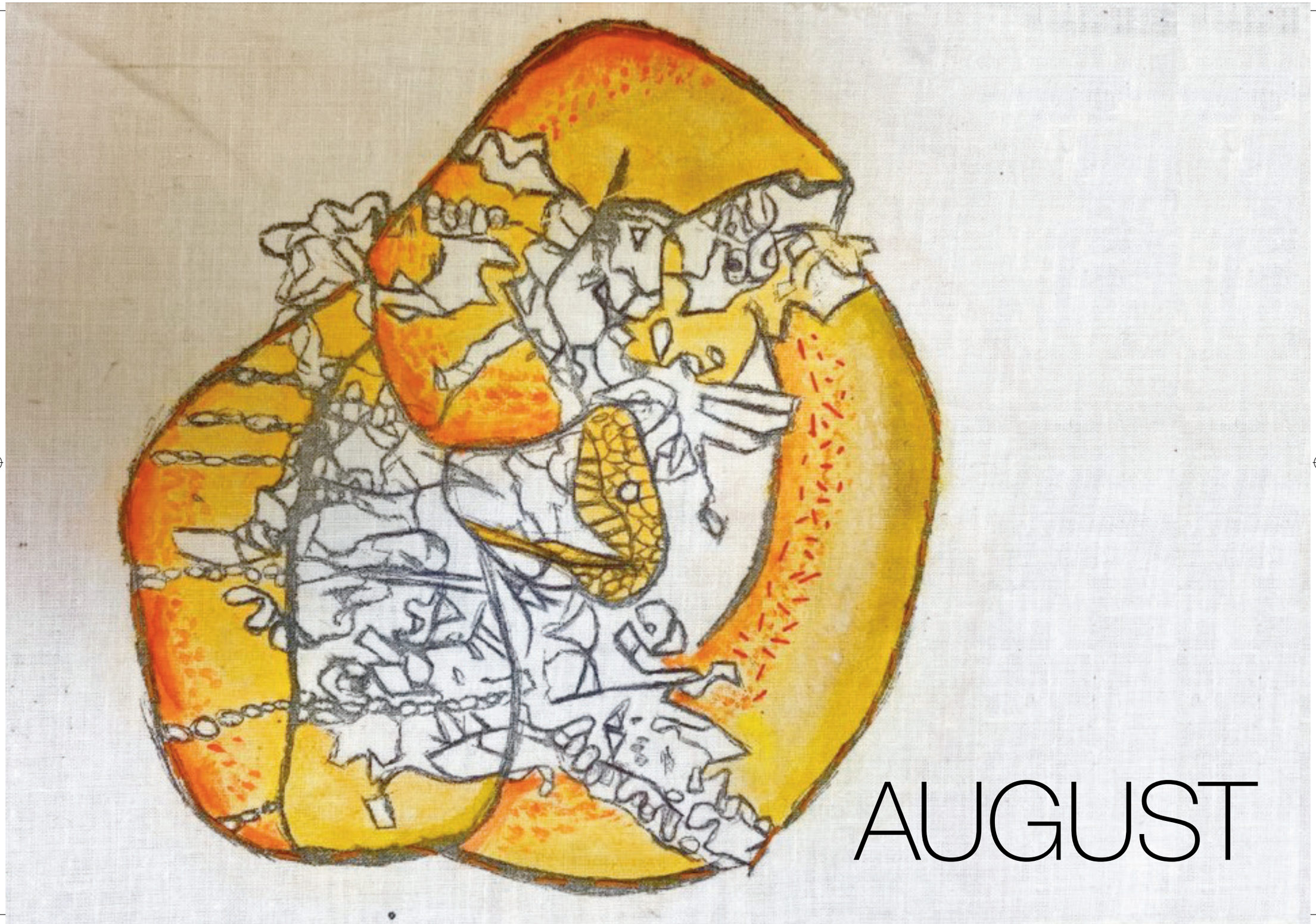
We can spend our lives in the pursuit of happiness, and serotonin, often referred to as the 'feel-good' neurotransmitter, plays a crucial role in achieving it. Serotonin is primarily known for its significant influence on mood, emotions, and overall well-being. It plays an important part in stabilising mood, fostering feelings of happiness and contentment, and regulating sleep patterns. Imbalances in serotonin levels have been associated with mood disorders such as depression and anxiety.

Throughout her study, Amina's exploration of serotonin and its receptors led her to discover numerous other proteins. While crafting this artwork, she deeply appreciated the importance of diverse sketching techniques and refined her impasto, glazing, and sgraffito skills.

Sketching
Amina Myrzagalym

PDBe.org/4iar/3d




AUGUST

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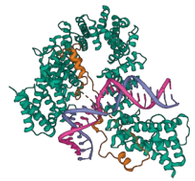
‘Glued’ together

During cell division, condensin and cohesin, two protein complexes found in the nucleus, play crucial roles in the organisation of replicated chromosomes. Sister chromatids, which are identical copies of a single chromosome produced during DNA replication, are held together by cohesin until they separate during cell division. Cohesin acts as the “glue” that keeps sister chromatids attached, while condensin facilitates the compaction and segregation of chromosomes. Together, condensin and cohesin ensure accurate distribution of genetic material and maintain genomic integrity throughout the cell cycle, while also facilitating the organisation, compaction, and untangling of chromosomes during cell division.

Tommy created this beautiful artwork that showcases the coiled and compacted form of the DNA within the nucleus, while the nucleus itself is splitting apart. One particular source of inspiration was the curled form of the condensin and cohesin protein complexes that look similar to ‘coiled snakes’.

Oil painting
Tommy Shotter

PDBe.org/7q2z/3d



SEPTEMBER

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Protein Data Bank in Europe

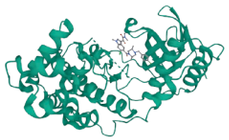
The stress love can cause

Coronary heart disease is the most prevalent form of heart condition. Excessive stress causes the heart to adapt to an uncontrolled workload, ultimately leading to heart failure. One of the signalling pathways responsible for heart failure include MAP kinases, a group of diverse proteins found only in eukaryotes, and involved in regulating cellular functions, such as cell division, proliferation and cellular death. p38 MAP kinases are specifically activated by physical, chemical or physiological stress factors.

Kathryn's artwork intricately weaves together the imagery of a heart, symbolising the emotion of love, with the structural elements of a stress-induced kinase. To capture the intended effect, she employed a drip-like technique by adding an excessive amount of paint thinner. This artistic approach was chosen specifically to evoke the image of a heart shedding tears, symbolising the emotional burden of "stress" associated with love.

Oil painting
Kathryn Elliott

PDBe.org/3hub/3d




OCTOBER

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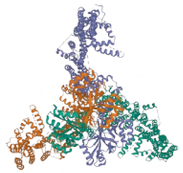
Decoding the language of touch receptors

The 2021 Nobel Prize winners in Medicine, David Julius and Ardem Patapoutian unveiled the long-standing mystery of how our sensory system perceives the physical world through temperature, pressure, and touch sensations. David Julius identified the TRPV1 ion channel, which responds to heat and pain, while Ardem Patapoutian discovered PIEZO1 and PIEZO2 ion channels, involved in mechanical touch perception. Their groundbreaking work shed light on the mechanisms underlying these thermosensation and mechanosensation, offering profound insights into pain and our ability to interact with our surroundings.

This piece symbolises the role of PIEZO1 proteins in tactile perception through the use of sweeping ink strokes. The artist, Hiyori, explores the interplay between physiology discoveries and the emotional response to touch.

Sketching
Hiyori Ikeda

PDBe.org/6bpz/3d




NOVEMBER

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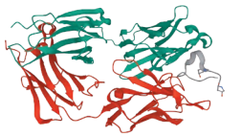
Rheumatoid avengers

Anti-citrullinated protein antibodies (ACPAs) in rheumatoid arthritis target proteins containing citrulline amino acids, modifications of the essential amino acid arginine. These proteins contribute to chronic inflammation and joint damage. ACPAs are detectable in patients' blood and are a hallmark of the disease. They have revolutionised diagnosis, classification, and treatment approaches, with targeted therapies aiming to reduce ACPA production or effects, improving rheumatoid arthritis treatment strategies.

Clara was intrigued by the impact of arthritis on the sense of touch and movement, and aimed to explore this concept through an interlocking pattern of strands. She used felting, sewing, and embroidery techniques to create bold and thought-provoking artwork, abstracting and cross-referencing images for added depth and meaning.

Felting, sewing and embroidery
Clara de Sancha

PDBe.org/5mu2/3d

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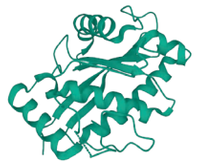
Snaking towards danger

Snake venoms are intricate mixtures of enzymes and non-enzymatic proteins that play a crucial role in immobilising and digesting prey. Within snake venom, there exist snake venom metalloproteinases (SVMPs), a class of enzymes responsible for poisoning snakebite victims. When these enzymes interact with the body, they effectively break down proteins, resulting in a range of effects including tissue damage, bleeding, and inflammation.

Fascinated by the extraordinary and dangerous efficacy of snake venom, Katie explored snake venom metalloproteinases. Through the PDB Art project, she discovered the captivating ability of SVMPs to immobilise or kill with a single drop. She expressed her understanding through her artwork by using various techniques like washes, sketching, and stippling to create depth, tone, and contrast.

Stippling and line technique
Katie Wong

PDBe.org/4j4m/3d



About the PDB Art project and the artists

The project is a collaboration between the Protein Data Bank in Europe (PDBe), The Arts Society Granta, The Arts Society CANTAB, and several UK schools including The Leys, The Perse, The Stephen Perse Foundation, Impington Village College, Saffron Walden County High, Thomas Gainsborough, Leventhorpe, Sybil Andrews Academy, Nazarbayev Intellectual Schools (NIS) in Kazakhstan and Viewbank College in Australia. Students used 3D structures of molecules in the PDB archive as inspiration for their artworks, created within their school's art curriculum. Some of the resulting artworks from the students are featured in this calendar. PDBe is part of EMBL's European Bioinformatics Institute (EMBL-EBI), based on the Wellcome Genome Campus in Cambridgeshire, UK. We thank the campus Connecting Science Public Engagement team for their help.

Cover art: Histamine: A molecular double agent

Histamine, a natural chemical found in our cells, serves a dual role as a defender of our immune system against infections, and a culprit behind allergy symptoms. While it plays a vital protective role, histamine can also trigger allergic reactions, causing sneezing and a runny nose. Ella Buchanan and Scarlett Tran collaborated and found the exploration of histamine's structure and properties very captivating. Their final artwork, created using gouache, brought their artistic vision to life.

Ella Buchanan and Scarlett Tran

Ella and Scarlett, aged 12, are students at the Viewbank College, in Melbourne, Australia. They gained a deeper understanding of protein composition and their vital role in sustaining life through the PDB Art project.

Sabina Seisenbay

Sabina, aged 17, is a student at the NIS school, Taraz, in Kazakhstan. She found a unique way to blend her interests and hobbies through the PDB Art project. Exploring protein structures through art deepened her understanding, igniting a curiosity for science. She also enjoys drawing, piano, and dancing.

Bella Frewin

Bella, aged 12, is a student at the Thomas Gainsborough School in Sudbury, UK. She has a strong passion for art, particularly incorporating Brusho, and an interest in design, technology and gymnastics. This experience has sparked a desire to further immerse herself in the realms of both art and science.

Ellie Statham

Ellie, aged 14, is a student at the Leventhorpe School, Sawbridgeworth, UK. She found great delight in incorporating a wide range of media, skillfully merging them to produce captivating mixed media compositions for her artwork.

Faith Okeke

Faith, aged 16, is a student at The Leys School in Cambridge, UK. She enjoys maths and art at school. She was eager to witness how mixed media could be harnessed to visually depict scientific structures and forms. During her leisure time, she enjoys acting, netball, and reading crime novels.

Jennifer Gong

Jennifer, aged 16, is a student at The Leys School in Cambridge, UK. Finding connections between artwork and protein models brings her immense joy, as she revels in the process of linking the structure of a protein to its function, expanding her imagination in the process. At school, she particularly enjoys maths, while her hobbies encompass animation, singing, and drawing, further fueling her passion for creativity and expression.

Grace Arthur

Grace, aged 16, is studying business, maths, and classical civilisation at The Stephen Perse Foundation in Cambridge, UK. Alongside her studies, she pursues a multitude of hobbies and passions, including drawing, stargazing, boxing and photography. She hopes to study photography at university, transforming her beloved hobby into a fulfilling career path.

Amina Myrzagalym

Amina, aged 16, is a student at the NIS school of Physics and Mathematics, Taraz, in Kazakhstan. She finds joy in maths, art, and physics, as well as basketball. She takes pleasure in listening to podcasts and channelling her creativity into drawing architectural structures.

Tommy Shotter

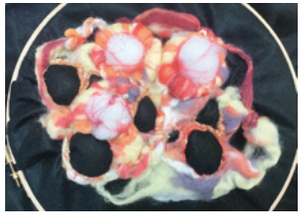
Tommy, aged 14, is a student at Leventhorpe School, Sawbridgeworth, UK. With a passion for art, he found great delight in the ability to customise protein colours, which brought an exciting visual dimension to the research process. The integration of artistic expression with scientific research provided a unique and fulfilling experience, merging his two interests in a remarkable way.

Kathryn Elliott

Kathryn, aged 18, is a student at The Stephen Perse Foundation in Cambridge, UK. Since a young age, she has displayed a profound passion for art, drawing inspiration from the political climate, culture, and religious elements. Due to her Ukrainian heritage, she wholeheartedly endeavours to translate her personal experiences and emotions connected to her country into her artistic creations.

Hiyori Ikeda

Hiyori, aged 12, is a student at the Viewbank College, in Melbourne, Australia. She found the concept of infusing scientific elements into artistic expression fascinating.



Clara de Sancha

Clara, aged 16, is a student at The Leys School in Cambridge, UK, studying biology at A-level. The beauty of art inspired by science is what fascinates her most. She appreciates how the PDB Art project helped her to convey the elegance of molecular biology, making her learning even more enjoyable.

Katie Wong

Katie, aged 15, is a student at The Stephen Perse Foundation in Cambridge, UK. Being passionate about art, music, sports, and mathematics, she found this project incredibly captivating, seeing it as a unique opportunity to develop her skills and explore the intersection of art and science. This project opened her eyes to the possibility of science and art coexisting harmoniously, sparking a newfound curiosity in her.

Explore and view
PDB entries in 3D at PDBe.org

THE ARTS SOCIETY GRANTA

CANTAB

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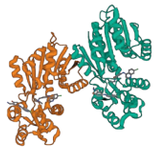
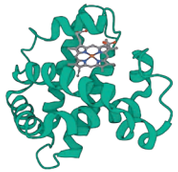
About the proteins



Cover

PDBe.org/2aou/3d

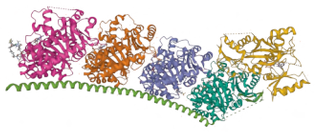
Structural basis for inhibition of histamine N-methyltransferase by diverse drugs. Horton *et al.* J Mol Biol (2005)



January

PDBe.org/1mbn/3d

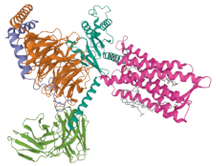
The stereochemistry of the protein myoglobin. Watson H.C. Prog. Stereochem. (1969)



February

PDBe.org/7e4q/3d

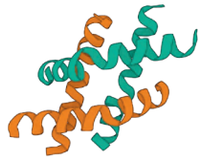
C3 ester side chain plays a pivotal role in the antitumor activity of Maytansinoids. Li *et al.* Biochem Biophys Res Commun (2021)



March

PDBe.org/7d77/3d

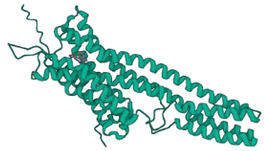
Structures of the glucocorticoid-bound adhesion receptor GPR97-Go complex. Ping *et al.* Nature (2021)



April

PDBe.org/6o4m/3d

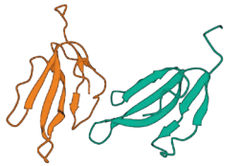
Retention of native quaternary structure in racemic melittin crystals. Kurgan *et al.* J Am Chem Soc (2019)



May

PDBe.org/5tvn/3d

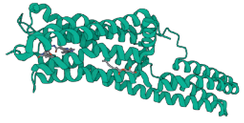
Crystal structure of an LSD-bound human serotonin receptor. Wacker *et al.* Cell (2017)



June

PDBe.org/2h7z/3d

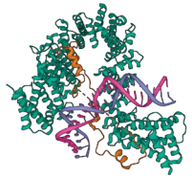
Irditoxin, a novel covalently linked heterodimeric three-finger toxin with high taxon-specific neurotoxicity. Pawlak *et al.* FASEB J (2009)



July

PDBe.org/4iar/3d

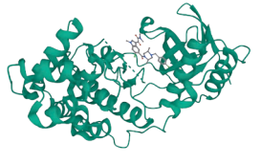
Structural basis for molecular recognition at serotonin receptors. Wang *et al.* Science (2013)



August

PDBe.org/7q2z/3d

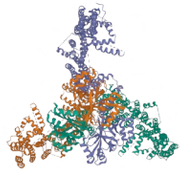
Clamping of DNA shuts the condensin neck gate. Lee *et al.* Proc Natl Acad Sci (2022)



September

PDBe.org/3hub/3d

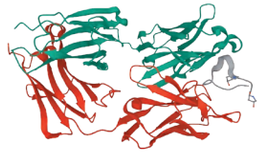
Fluorophore labelling of the glycine-rich loop as a method of identifying inhibitors that bind to active and inactive kinase conformations. Simard *et al.* J Am Chem Soc (2010)



October

PDBe.org/6bpz/3d

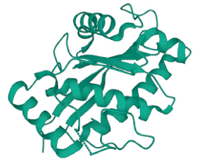
Structure of the mechanically activated ion channel Piezo1. Saotome *et al.* Nature (2018)



November

PDBe.org/5mu2/3d

Anti-citrullinated protein antibodies cause arthritis by cross-reactivity to joint cartilage. Ge *et al.* JCI Insight (2017)

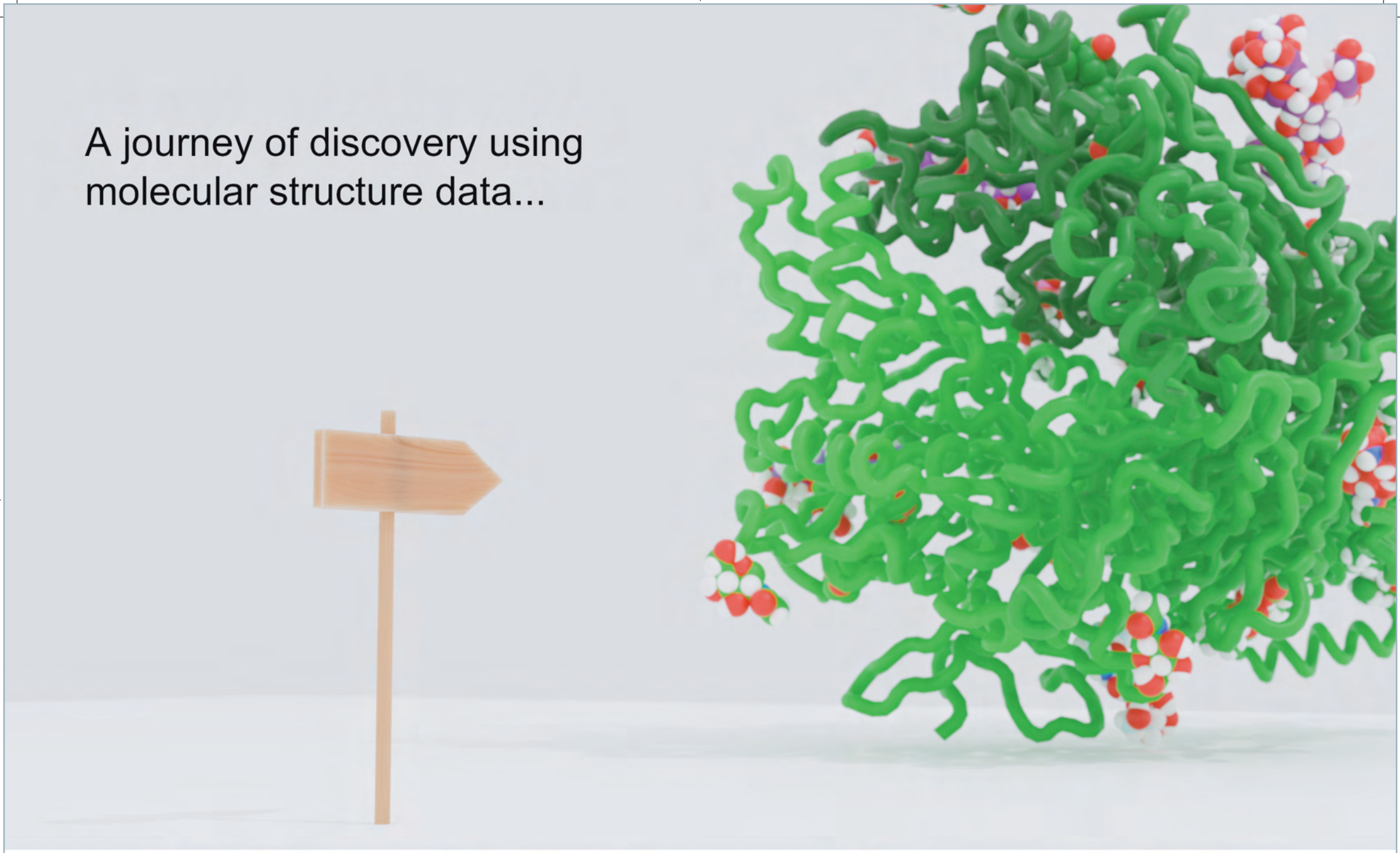


December

PDBe.org/4j4m/3d

Crystal structure of a *Trimeresurus mucrosquamatus* venom metalloproteinase providing new insights into the inhibition by endogenous tripeptide inhibitors. Chou *et al.* Toxicon (2013)

A journey of discovery using molecular structure data...



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