PDBe
Protein Data Bank in Europe

2022 CALENDAR

Beauty at a molecular level

JANUARY

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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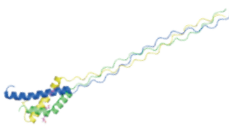
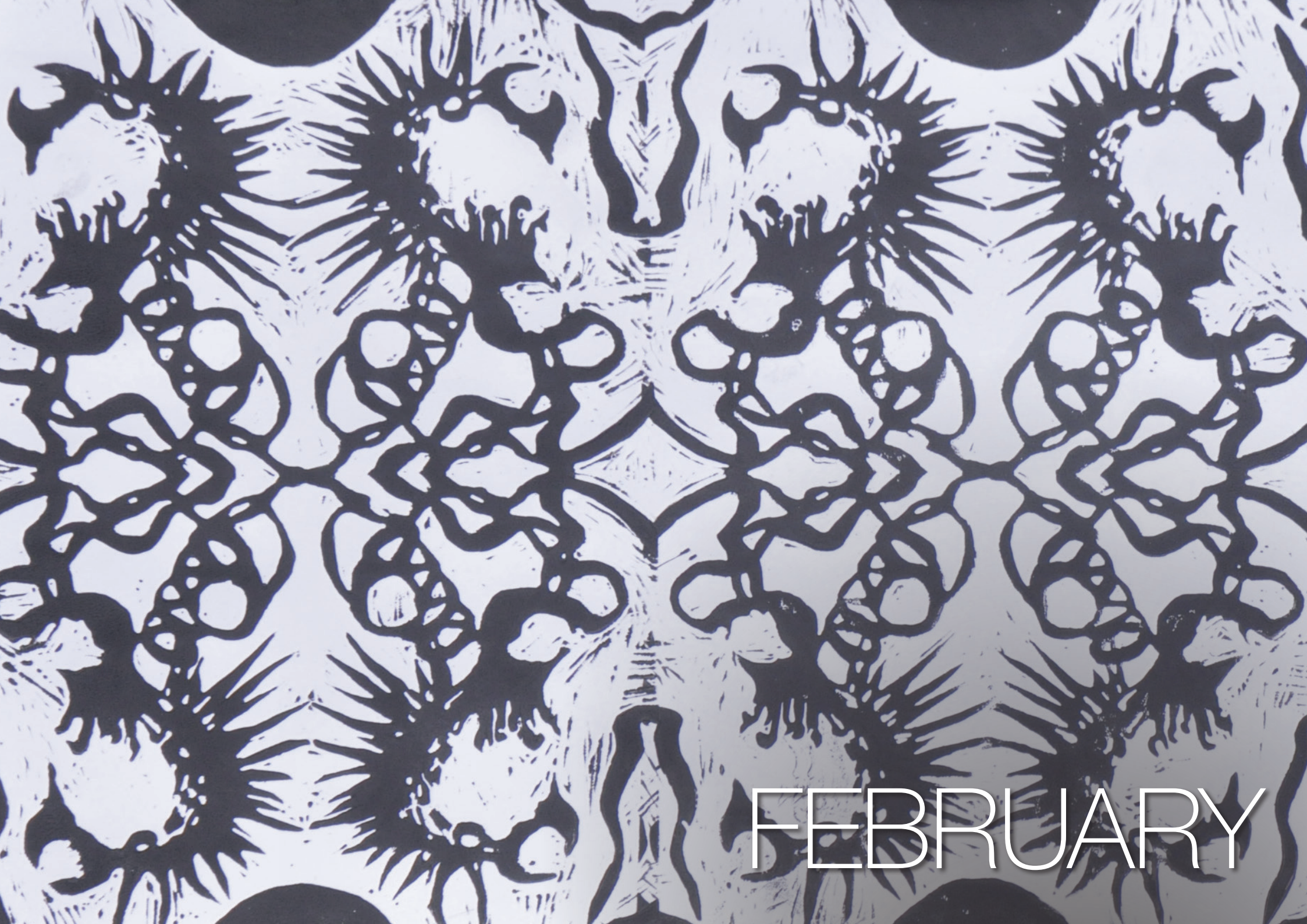
Have we met?

Did you know that creatures alive today still share a strong biological connection with prehistoric dinosaurs? This artwork highlights this fascinating connection through the collagen protein. This structural protein, also known as the body's super glue, holds our bodies together and provides strength. It is the single most abundant protein in the animal kingdom, composed of three protein chains, wound together in a rope-like structure to form a tightly-packed triple helix. Mia used this visual feature to portray the link between the dinosaurs who lived millions of years ago and today's roosters.

Watercolour and burnishing on plywood
Mia Douglas Mueller

PDBe.org/5cti/3d




FEBRUARY

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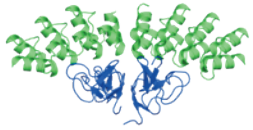
Fighting a battle

Cancer originates when cells divide uncontrollably and unchecked. In most instances, the loss of control begins with faulty instructions from genes that encode proteins regulating normal cell function. A large number of genes have been identified that can cause cancer and are involved in diverse functions within a cell. Among them are tumor suppressor genes which normally act like 'brakes' to inhibit cell growth and division whereas oncogenes act like 'accelerators' to promote cell growth and division. Mutations in these genes can result in defective proteins that often lead to cancers.

This artwork from Joshua, features one such oncogene, HER2, that is highly expressed in 20% of breast cancers. His artwork draws inspiration from his personal experience and finds beauty in something that can be very frightening.

Lino print
Joshua Wenley

PDBe.org/4hrn/3d



MARCH

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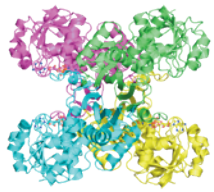
Flex your muscles

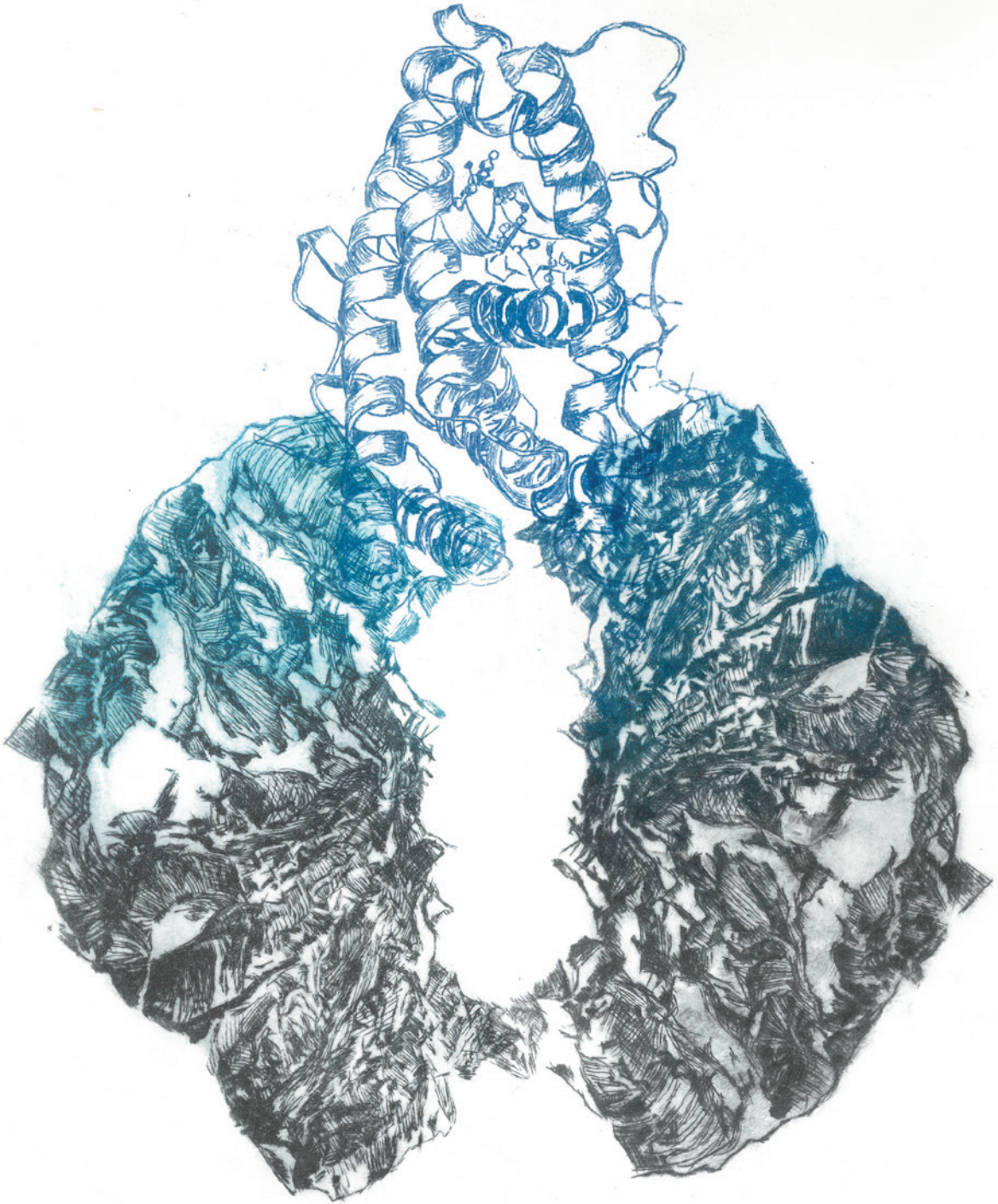
Glyceraldehyde-3-phosphate dehydrogenase (GAPDH), is a 'housekeeping' molecule that plays an essential role in glycolysis. This enzyme is highly conserved in all organisms and it catalyses the breakdown of glucose to release energy. Apart from this, it is also involved in other physiological functions, like apoptosis – or cell death – and DNA repair.

GAPDH is highly expressed in organs with high levels of energy requirement such as muscle, heart, and brain. GAPDH from rabbit muscle tissue is commonly used for studying the protein's structure and function, which was the inspiration for Charlotte's artwork.

Lino printing with mixed media
Charlotte Waite

PDBe.org/1u8f/3d





APRIL

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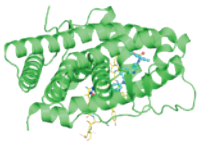
Breathe

Glucocorticoids are essential steroid hormones that play a key role in regulating development, metabolism, inflammation, and stress response. Glucocorticoids help in suppressing inflammation, so they are used for treating several chronic inflammatory and autoimmune diseases, including respiratory diseases – such as asthma, allergic rhinitis, nasal polyposis and chronic obstructive pulmonary disease.

Inhaled glucocorticoids, alone or in combination with bronchodilators, are the mainstay of clinical therapy in the treatment of asthma. They reduce inflammation and mucus in the airways that carry air to the lungs, thereby making it easier to breathe. Wendy's artwork gives an artistic impression of lungs combined with the glucocorticoid receptor protein.

Drypoint etching and monoprint
Wendy Wu

PDBe.org/4csj/3d



MAY

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Astonishing yet deadly

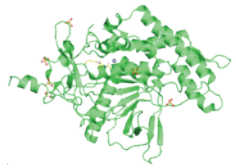
In low-oxygen conditions, the bacterium *Clostridium butyricum* produces the deadliest neurotoxin known to mankind – botulinum. Intoxication can occur naturally as a result of a wound or intestinal infection, or after ingesting food that contains the toxin. This neurotoxin prevents the release of the neurotransmitter acetylcholine from nerve endings, blocking nerve functions and leading to respiratory and muscular paralysis. It causes a serious disease called botulism that can be potentially fatal, but luckily it is relatively rare.

Toxins can function both as a harmful and therapeutic molecule, depending on their concentrations. The botulinum toxin plays a significant role commercially for medical and cosmetic purposes, and is commonly marketed under the brand name Botox.

Elliott describes his inspiration from the artist H.R. Giger, who brings together oil painting, supernatural gothic horror and futuristic sci-fi horror, to make a perfect match for this subject matter.

Painting
Elliot Stannard

PDBe.org/3d3x/3d




JUNE

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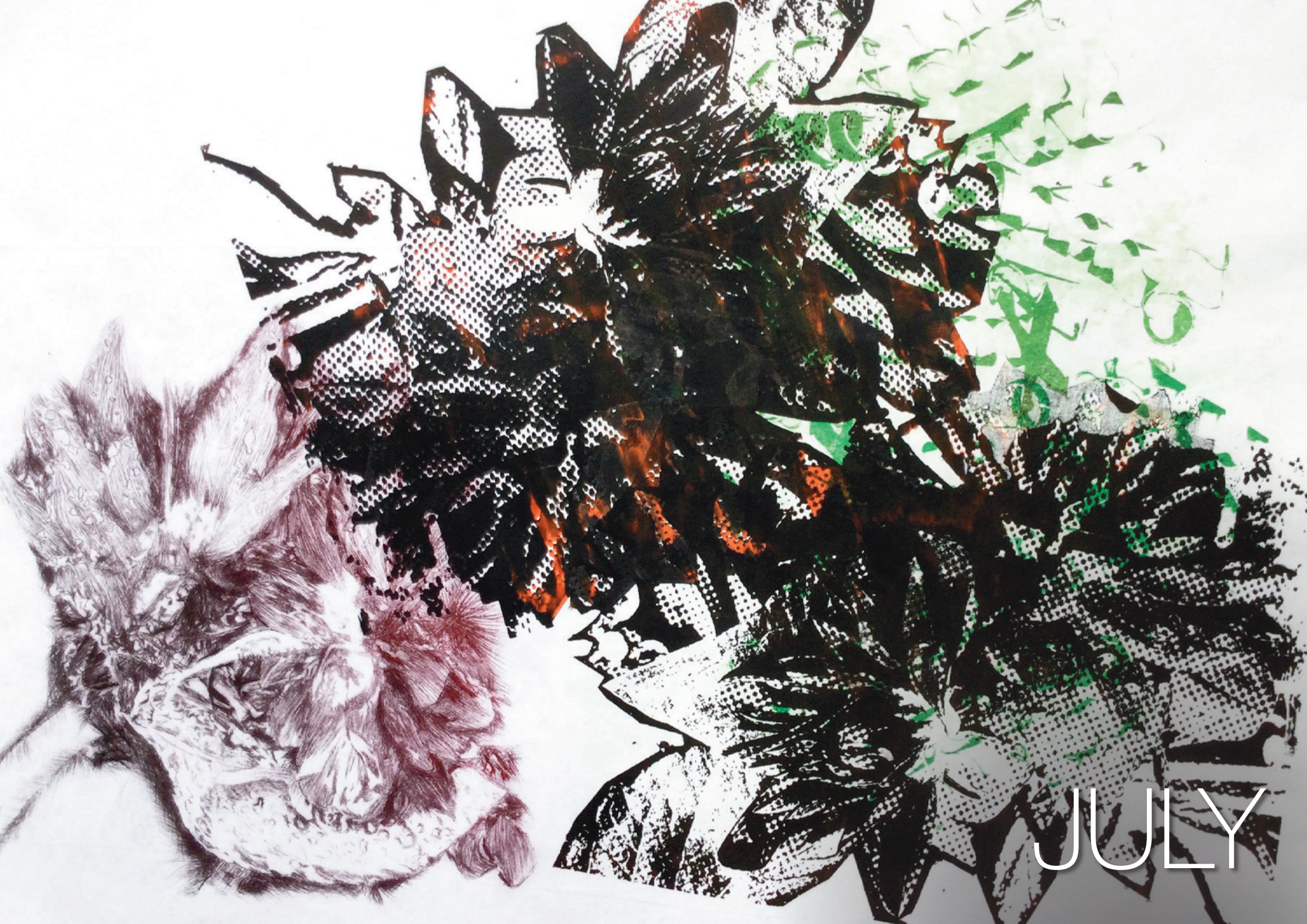
Copper for life

Red blood cells contain the protein hemoglobin, which carries oxygen from the lungs to all parts of the body. They also remove carbon dioxide from the body, bringing it to the lungs to exhale. Each human red blood cell contains approximately 270 million hemoglobin molecules, each carrying four heme groups to which oxygen binds. These heme groups contain iron and give blood its red color.

Octopuses and horseshoe crabs have blue blood because the protein transporting oxygen in their blood, hemocyanin, contains copper, instead of iron, making their blood appear blue rather than red. Hemocyanin is much bigger than hemoglobin and can bind 96 oxygen atoms. Unlike hemoglobin, hemocyanin floats freely in blood. In addition, it is a much more stable molecule that can function at temperatures up to 90°C or even in creatures living in cold climates.

Ceramic
Daisy Wallman

PDBe.org/1lla/3d


JULY

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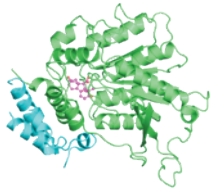
Stimulating growth

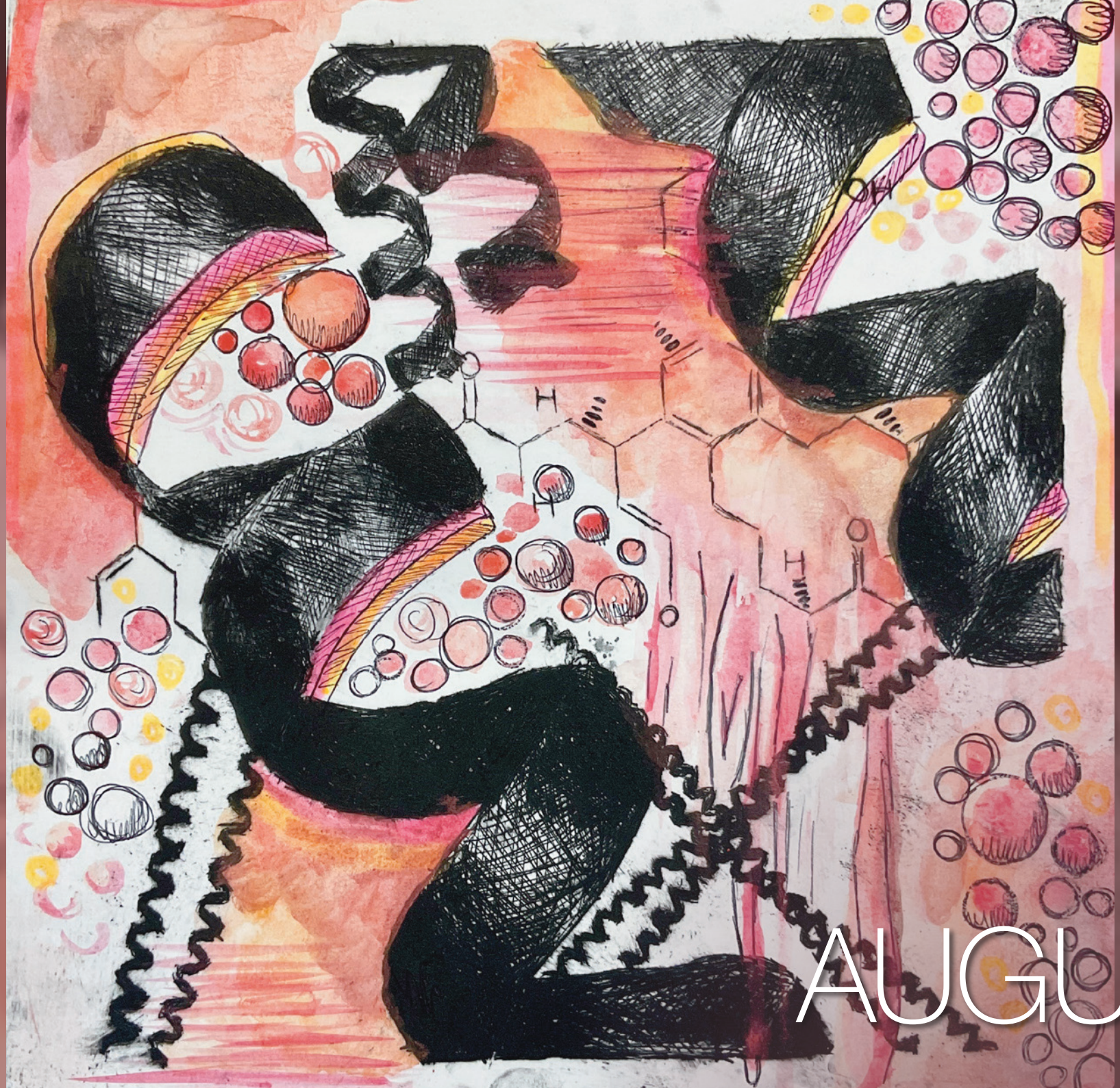
In 1926, a Japanese scientist E. Kurosawa investigated the 'foolish seedling' disease in rice, where the plants grew extremely fast, looked pale, spindly and broke off easily. He discovered this was caused by a substance, later called gibberellin, produced by the fungus *Gibberella fujikuroi*.

Kirsty, who is fascinated by plants, found inspiration in gibberellins – plant hormones that initiate seed germination, promote flowering and increase fruit size. They stimulate cell elongation in seeds, young leaves, and roots and cause rapid stem and root growth. Depending on its concentrations the plants can grow either tall or short. This shoot-to-root ratio is an important parameter to improve agricultural productivity.

Drypoint etching and monoprint
Kirsty Yu

PDBe.org/2zsh/3d




AUGUST

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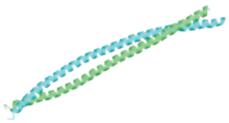
Anti-frizz

Our hair gets its strength from the fibrous protein called keratin. Without it, hair looks frizzy, weak and is easily damaged. There are two types of keratin: the soft form or alpha-keratin that is found in our skin, nails and hair, and beta-keratin, found in hard tissues like bird feathers, horns, claws, and hooves. Keratin is able to self-assemble into bundles of fibers, forming especially strong, insoluble structures that are among the toughest found in nature.

With its exceptional properties of biodegradability, biocompatibility and low toxicity, keratin is widely used in biomedical, cosmetic, and industrial applications. Keratin hydrogel is especially popular in various tissue-engineering applications involving bone engineering, wound healing, nerve regeneration, and skin replacement.

Drypoint etch and printing
Julia Chandy

PDBe.org/3tnu/3d



SEPTEMBER

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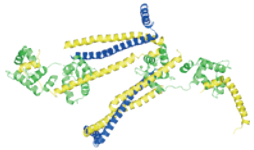
Diagnosing a broken heart

The beating of your heart is a carefully controlled process, powered by the contractions of the cardiac muscle. These contractions are in turn regulated by a protein called troponin, which mediates the motions of muscles through tiny structural changes at a molecular level.

The troponin protein, which inspired Sophia's artwork, is found in muscle 'thin filaments', in complex with actin and myosin. Troponin controls the molecular motion of myosin and actin, which generates muscle contractions. Because the death of cardiac cells releases troponin into the bloodstream, troponin levels in the blood are used as markers for cardiac injury.

Drypoint etching and monotype
Sofia Biggs

PDBe.org/1j1e/3d




OCTOBER

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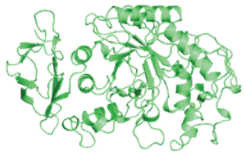
From mouth to stomach

Whatever your diet, the carbohydrates in food provide fuel for your body in the form of glucose. However, finding free glucose is relatively rare in our typical diets, and it is the work of enzymes like amylase to break down more complex carbohydrates, or starch, into smaller, simpler sugars such as glucose.

Salivary amylase is a major component of human saliva that initiates carbohydrate digestion in the mouth. This process continues in the small intestine, where amylase produced by the pancreas performs the final steps of carbohydrate digestion. In addition to amylase, our saliva also contains a large number of other enzymes including lipases, peptidases, and hydrolases, each breaking down different nutrients into smaller units for digestion.

Etching with print
Minty Lumsden

PDBe.org/1smd/3d




NOVEMBER

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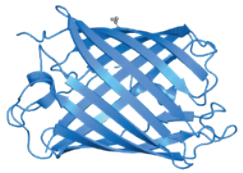
Draining all colour

Coral bleaching caused by rising water temperatures in our oceans is one of the most obvious markers of climate change. Many corals have a symbiotic relationship with algae, which protects them from strong light. But as the temperature of our seas rises, the algae may begin to disappear, exposing the coral to brighter light.

Henrietta channeled her passion for protecting the ocean to create this beautiful artwork inspired by fluorescent proteins, which give coral its striking colours and absorb excess light. There are some promising signs that coral bleaching is reversible if our oceans are protected through urgent climate action.

Print with acrylic paint
Henrietta White

PDBe.org/2ote/3d




DECEMBER

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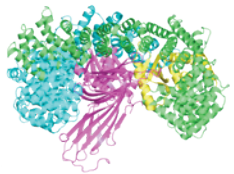
AP2 Clathrin adaptor core

In our cells we have tiny molecular transport systems that take nutrients to where they are needed most. The AP2 adaptor complex is a multimeric protein found in our cell membranes that helps to package up incoming nutrients into tiny, membrane-coated “cargo vessels”. This process helps to bring vital nutrients into the cell, in a process known as endocytosis.

The AP2 adaptor complex works with another protein called clathrin, which acts as a protein scaffold for these membrane containers. Understanding this process also has medical implications, because a number of pathogens hijack this mechanism to gain entry into our cells. Elspeth’s artwork highlights both the protein complex and the process of endocytosis.

Drypoint etch and printing
Elspeth Owen

PDBe.org/2vgl/3d



About the project and the artists

This 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 School, Leventhorpe School and Viewbank College (Australia). School students used 3D structures of molecules in the PDB archive as inspiration for artworks within their school 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 Wellcome Connecting Science Public Engagement team for their help. For more information, visit PDBe.org/art

Cover art: Glowing flowers under the sea

Light-producing organisms are some of nature's awe-inspiring phenomena. Many marine organisms such as jellyfish, sea turtles, eels and the recently discovered Arctic snail fish glow in the dark through a process called biofluorescence. They absorb a low wavelength light and then re-emit a higher wavelength light of a different colour, making them glow.

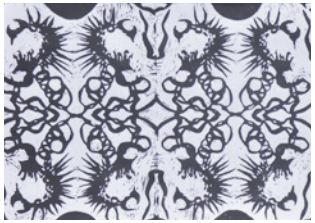
Finding inspiration from sea anemone photoswitchable fluorescent proteins, Sam and Jack created 3D sculptures using plastics, paper, split pins and fishing rods, and combined it with photography elements. The photoswitchable fluorescent proteins are capable of turning the sea anemone's fluorescent lights on or off in response to light. This ability to modulate fluorescence has been harnessed by scientists as a simple, yet powerful way to investigate proteins in situ.

Sam Baker and Jack Bentley

Sam and Jack, aged 12, are students at Thomas Gainsborough School, Sudbury. Sam's favourite hobby is gaming and he enjoys information and communication technology, physical education, geography, maths and english subjects. Jack loves science and enjoys physical education, maths and media subjects.

Mia Douglas Mueller

Mia, aged 16, is a student at the Viewbank College, Melbourne, Australia. She is a passionate arts and science student who wants to pursue a career related to the protection of Australian wildlife. Her all-time favourite movie is Jurassic World and has a strong interest in palaeontology. She also loves music and learnt guitar during lockdown.

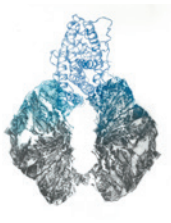


Joshua Wenley

Joshua, aged 16, is a student at Saffron Walden County High School, who is currently working at a local building company. He enjoys constructing from timber and intends to do a carpentry apprenticeship. He is a keen fisherman and likes to play field sports in his free time.

Charlotte Waite

Charlotte, aged 16, is a student at the Saffron Walden County High School. She is currently studying criminology and aims to become a private investigator. Her favourite genre is horror and has interest in special effects, makeup and prosthetics. She is a social person and loves being in good company with her friends and family.



Wendy Wu

Wendy, aged 16, is a student at The Leys School, Cambridge. She enjoys creating artworks about things that inspire her. In her spare time, she plays piano and does Chinese calligraphy.

Elliot Stannard

Elliot, aged 16, is a student at the Saffron Walden County High School who enjoys all forms of art, especially visual art and classical music. He enjoys works of fiction and horror, and aspires to become a film director and an opera singer like his mother.

Daisy Wallman

Daisy, aged 13, is a student at The Perse School in Cambridge. She is currently studying art and enjoys drawing as she finds it very peaceful and calming. She also likes climbing and playing hockey.

Kirsty Yu

Kirtsy, aged 16, is a student at The Leys School, Cambridge. She enjoys studying maths and arts at school. Her hobbies include dancing, drawing and martial arts.

Julia Chandy

Julia, aged 13, is a student at The Perse School in Cambridge. She is interested in coding, computer science, biology and chemistry. Her favourite hobbies include playing the guitar as well as drawing and painting.

Sofia Biggs

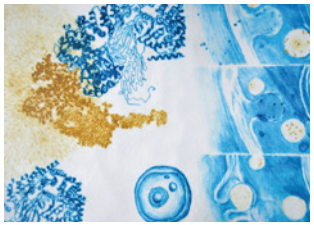
Sofia, aged 16, is a student at The Leys School in Cambridge. She enjoys printing and creating art based on the human body. In her spare time, she loves to listen to music and socialise with friends and family.

Minty Lumsden

Minty, aged 14, is a student at The Perse School in Cambridge. Art is one of her favourite hobbies and she enjoys experimenting with different media including digital art.

Henrietta White

Henrietta, aged 16, is a student at the Saffron Walden County High School. Her hobbies include drawing and art. She also has an interest in caring for the environment, and intends to study property and real estate development at university to develop environment-friendly buildings.



Elspeth Owen

Elspeth, aged 14, is a student at The Perse School in Cambridge. She loves to doodle cartoons for her science notes. She is inspired by the myriad ways that proteins are represented to explain science, and plans to use ideas drawn from these depictions in future artworks and doodles.

THE ARTS SOCIETY GRANTA

CANTAB + wellcome connecting science

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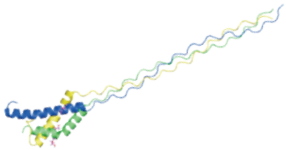
EMBL-EBI

About the proteins

Cover

PDBe.org/2a54/3d

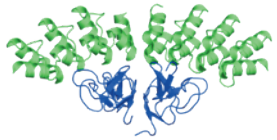
Structure and mechanism of the reversible photoswitch of a fluorescent protein. Andresen *et al*. Proc. Natl. Acad. Sci. (2005)



January

PDBe.org/5cti/3d

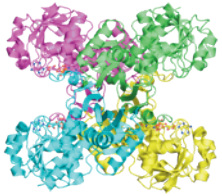
Structural insight for chain selection and stagger control in collagen. Boudko *et al*. Sci Rep (2016)



February

PDBe.org/4hrn/3d

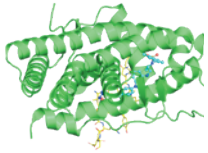
Structural Basis for Eliciting a Cytotoxic Effect in HER2-Overexpressing Cancer Cells via Binding to the Extracellular Domain of HER2. Jost *et al*. Structure (2013)



March

PDBe.org/1u8f/3d

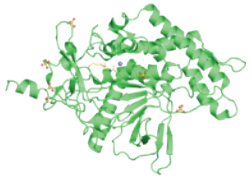
High-resolution structure of human D-glyceraldehyde-3-phosphate dehydrogenase. Jenkins *et al*. Acta Crystallogr. D Biol. Crystallogr. (2006)



April

PDBe.org/4csj/3d

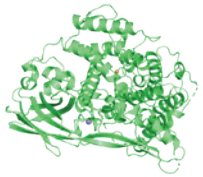
The discovery of potent and selective non-steroidal glucocorticoid receptor modulators, suitable for inhalation. Edman *et al*. Bioorg. Med. Chem. Lett. (2014)



May

PDBe.org/3d3x/3d

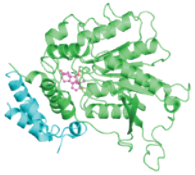
SNAP-25 substrate peptide (residues 180-183) binds to but bypasses cleavage by atalytically active Clostridium botulinum neurotoxin E. Agarwal *et al*. J. Biol. Chem. (2008)



June

PDBe.org/1lla/3d

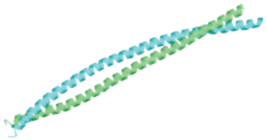
Crystal structure of deoxygenated Limulus polyphemus subunit II hemocyanin at 2.18 A resolution: clues for a mechanism for allosteric regulation. Hazes *et al*. Protein Sci. (1993)



July

PDBe.org/2zsh/3d

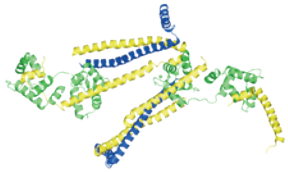
Gibberellin-induced DELLA recognition by the gibberellin receptor GID1. Murase *et al.* Nature (2008)



August

PDBe.org/3tnu/3d

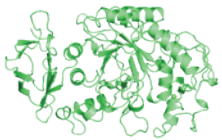
Structural basis for heteromeric assembly and perinuclear organization of keratin filaments. Lee *et al.* Nat. Struct. Mol. Biol. (2012)



September

PDBe.org/1j1e/3d

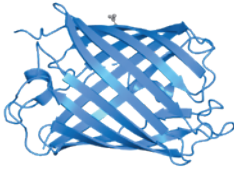
Structure of the core domain of human cardiac troponin in the Ca(2+)-saturated form. Takeda *et al.* Nature (2003)



October

PDBe.org/1smd/3d

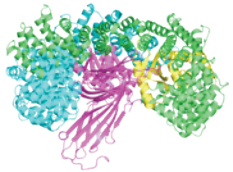
Structure of human salivary alpha-amylase at 1.6 A resolution: implications for its role in the oral cavity. Ramasubbu *et al*. Acta Crystallogr. D Biol. Crystallogr. (1996)



November

PDBe.org/2ote/3d

Structural basis for reversible photobleaching of a green fluorescent protein homologue. Henderson *et al.* Proc. Natl. Acad. Sci. (2007)



December

PDBe.org/2vgl/3d

Molecular architecture and functional model of the endocytic AP2 complex. Collins *et al*. Cell (2002)

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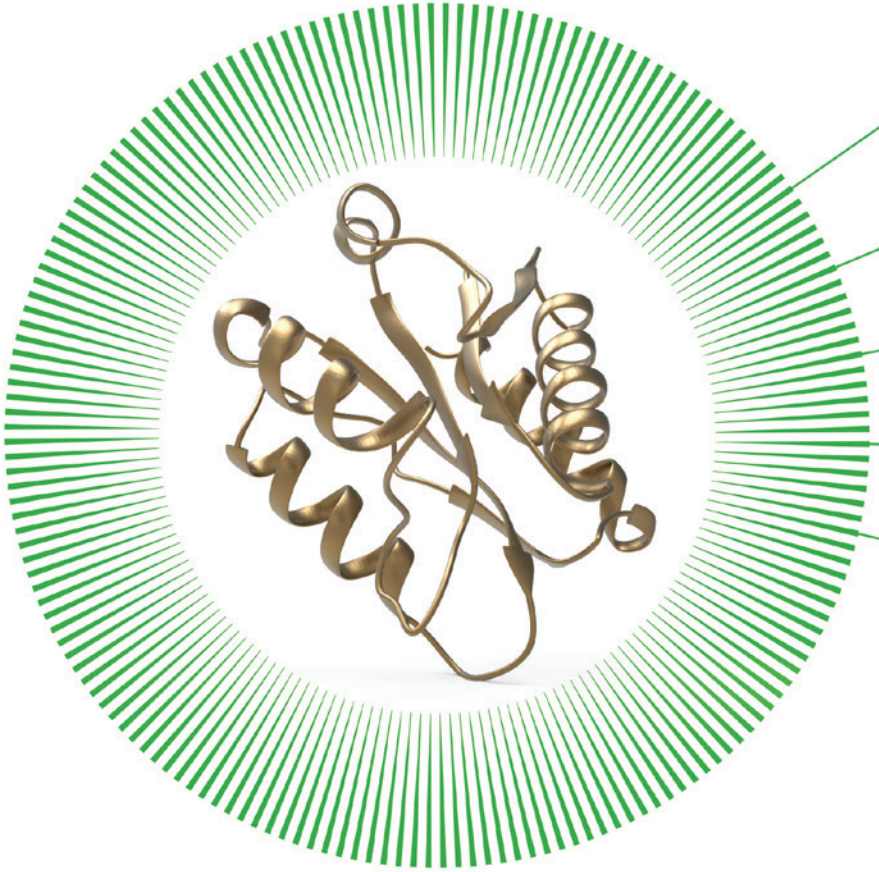

- Functional annotations
- Publications
- Interactions
- Structures
- Ligands

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