Inspire the next generation of engineers

The Royal Photographic Society’s International Images for Science competition, is supported by Siemens as part of the Curiosity Project; a three year engagement programme to bring science, technology, engineering and mathematics (STEM) to life, and help address the UK’s shortage of engineers.

By supporting those that bring science and art together through the science of photography, we aim to spark curiosity in young people and help them explore and view STEM subjects differently. The project is underpinned by an extensive education portfolio providing free, stimulating and unique resources that bring STEM education to life at home and in the classroom, helping to inspire the next generation of engineers!

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INTERNATIONAL IMAGES FOR SCIENCE 2017
VENUES

25 SEPTEMBER – 9 OCTOBER 2017
Hymers College, Hull

26 SEPTEMBER – 25 OCTOBER 2017
The Crystal, London

19 – 29 OCTOBER 2017
Royal Exchange Theatre, Manchester

31 JANUARY – 22 MARCH 2018
The Hive, Worcester

10 FEBRUARY – 9 MARCH 2018
Millennium Forum, Derry

14 – 17 MARCH 2018
NEC Big Bang Fair, Birmingham

31 MARCH – 15 APRIL 2018
City Arts Centre, Edinburgh

5 – 10 JUNE 2018
Town Hall, Cheltenham

12 JUNE – 10 JULY 2018
Royal Albert Hall, London

ACKNOWLEDGMENTS

The Council of The Royal Photographic Society wishes to express its sincere appreciation to the selection panel for their work in producing the final selection for the exhibition, and to its staff at Fenton House for helping bring this project to fruition.

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SELECTORS

LINDSEY GOFF
Biomedical Picture of the Day

JOHN HALTON
Engineering UK

DAVID MAITLAND FRPS
Photographer

JAMES CUTMORE
BBC Focus

MEDIA PARTNER

INTERNATIONAL IMAGES FOR SCIENCE
2017

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COVER IMAGE

RICHARD BEECH
Soap Bubble Planet
Almost since the very birth of photography, The Royal Photographic Society has been active in promoting both the art and the science behind making images. Many of our past presidents have been eminent scientists as well as accomplished artists.

Today our membership includes some of the people who make modern photography possible, as well as those pushing the boundaries of our art. The Society continues to support science through special interest groups, our world-class Imaging Science Journal and our science qualifications programme.

The application of science to photography is familiar to anyone who owns a digital camera or smart phone. Yet the application of photography to science has been perhaps less well known.

For this reason, we have been very pleased to host the International Images for Science competition for a third year, generously supported by Siemens plc as part of the Curiosity Project. The competition attracted over 3500 entries, 40% more than the previous year, from photographers, scientists and students across 80 countries and a wide range of ages and experience. We are especially pleased with the number of entrants in the 17 years and younger category. The 100 images that made it into the exhibition are all of a remarkable standard. Each is well achieved and has a strong aesthetic quality, yet each also tells an intriguing story.

On behalf of The Royal Photographic Society I would like to express our thanks to our staff and volunteers, the panel of selectors, and everyone who entered the competition for helping to make the International Images for Science a fascinating, entertaining and instructive exhibition.

Siemens is proud to support The Royal Photographic Society’s International Images for Science competition and exhibition for a second year as part of our Curiosity Project.

The project, launched in 2015, aims to help bring science, technology, engineering and mathematics (STEM) to life and inspire young people to be the engineers of the future.

Siemens is a global engineering powerhouse with deep roots in the UK, going back more than 170 years. We have 14,000 employees here and 13 manufacturing sites and we are proud to support the future of engineering in Britain.

With Ingenuity for life, our new brand promise to our customers, colleagues and society, the ‘for life’ focuses and drives all of us to continue to make a positive societal contribution.

We congratulate The Royal Photographic Society on again running a successful International Images for Science competition and mounting an exhibition with beautiful and striking images. We hope that visitors to the exhibition and readers of this book will feel inspired and help us communicate the power and importance of science.

siemens.co.uk/curiosity-project
LINDSEY GOFF
Editor-in-Chief
Biomedical Picture of the Day

Lindsey is Editor-in-Chief of the MRC Clinical Sciences Centre’s Biomedical Picture of the Day (www.bpod.mrc.ac.uk), which showcases the stunning and intriguing images that appear in today’s vast array of biomedical publications, and briefly explains them with the non-scientist in mind. She has worked on BPoD since its inception in January 2012, and loves the diversity of the images amassed in the archive, which acts as a continuous and searchable record of the ‘state of the art’ of science. Before getting involved in scientific publishing and editing, Lindsey was with Cancer Research UK for twenty-five years doing laboratory and clinical research on cancers of the immune system.

JOHN HALTON
Director, Business and Industry Engineering UK

John manages the Business & Industry team at Engineering UK, a not for profit organisation which works in partnership with the engineering community to promote the vital role of engineers and engineering to society. The team encourages companies and organisations from all sectors including Aerospace, Energy, IT, Automotive, Food & Drink, Construction, Transport etc. to provide their support, both ‘in-kind’ and financially for their Corporate Membership, Big Bang Fair and Tomorrow’s Engineers programmes.

John trained as an aeronautical engineer, working on projects such as the Typhoon fighter and the A320 airliner. He subsequently led major international marketing and strategic planning operations for a wide range of engineering consultancies.

DAVID MAITLAND FRPS
Photographer

David is a UK-based professional nature and science photographer specializing in small and microscopic forms, using his images as a tool to lure the viewer towards a greater awareness and understanding of the natural world and science.

He has won numerous international awards, including Sony World Photography Awards, Wildlife Photographer of the Year and Nikon Small World. He was named the European Wildlife photographer of the Year in 2008. In 2015 David won the RPS Gold Medal and overall prize in the first International Images for Science competition.

David’s specialist super-macro skills and artistic eye, have been commissioned for bespoke advertising campaigns and Brian Cox’s BBC series “Wonders of Life” and “Human Universe”, and recently “The Food we Eat”.

David is a regular presenter at international conferences, and competition judge in great demand all over the world.

JAMES CUTMORE
Picture Editor, BBC Focus

James Cutmore studied fine art at the University of the West of England before joining BBC Focus Magazine, a popular science and technology publication, in 2004.

He became picture editor in 2008, and spends most of his time finding new and interesting ways to illustrate various hard science concepts, as well as eye-catching photography for the popular ‘Eye Opener’ section. He has also worked for BBC Sky at Night Magazine, BBC Knowledge Magazine and a variety of special one-off publications with a large variety of subject matter.

He has put his love of photography to good use over the years, working as a judge for the Wellcome Trust Image Awards since 2009, and sometimes dusts his camera off to take the occasional image himself.
SOAP BUBBLE PLANET

Close-up view of a soap bubble. The film of a soap bubble is made from a layer of water sandwiched between two layers of soap. A light ray hitting the film will reflect from the top and bottom soap layers. As the two reflected rays combine, they interfere. The colours that constructively interfere are dependent on the thickness of the water layer and the angle of viewing.

Richard Beech
A Faraday cage being used to isolate a television antenna during a test. A conductive mesh in the walls of the room form the Faraday cage to prevent interference from outside signals. Anechoic blocks on the wall also prevent any interior signal reflections. A Faraday cage operates because an external electrical field causes the electric charges within the cage’s conducting material to be distributed such that they cancel the field’s effect in the cage’s interior.

Luis Davilla
AMOEBA SHELLS

Light micrograph of empty shells of a testate amoeba (*Difflugia* sp.). *Difflugia* builds its shells with particles found in their habitat, this genus uses sand grains. The image covers a field approximately 0.9mm across.

Gerd-A. Günther
The flower of a sacred lotus (*Nelumbo nucifer*) seen in thermal infrared radiation. The lotus is one of only a few flowering plants known to thermoregulate. The flat-topped receptacle in the centre of the flower maintains a temperature of 30-36 Celsius (shown here in red) for 2-4 days, even when the ambient temperature fluctuates between 10-45 Celsius. At dawn, the lotus bud opens emitting a fragrance that attracts beetles to enter the warm shelter, where they forage and find a mate, pollinating the flower in the process.

Heather Angel HonFRPS
LARVA

A coloured scanning electron micrograph (SEM) of a larva of a European spruce bark beetle (*Ips typographus*). This is part of the head capsule, the entire larva is just 5mm in length. The original monochrome image was later coloured digitally, with colours chosen for aesthetic effect.

Viktor Sykora
SURFACE TENSION
A safety pin sitting on the surface of water. The surface tension caused by the intermolecular forces of the water keeps the pin from sinking but the surface is bent by the weight of the pin. At the same time, a light table with an array of small black squares painted on its surface was used to illuminate the pin and the water. The deformed surface acts as a convex mirror around the pin and creates a reduced size virtual image of the light table grid.

Richard Germain
A bead of polymer solution forms on a micropipette tip. Electrostatic forces draw a thin jet of liquid out of the pipette until it reaches terminal velocity and whips into a fast moving spiral, creating a rainbow of colours. The fibre eventually stretches to less than one hundred nanometres (one ten-millionth of a metre), invisible to the naked eye.

Robert Lamberts, Plant & Food Research
LIESEGANG RINGS BLUE

Close-up view of Liesegang rings in a chemical solution. Named after the German chemist Raphael Liesegang, these rings form in many precipitation reactions provided there is no fluid convection. The chemicals form alternating bands of precipitate, then clear regions where no precipitation occurs. Here, potassium dichromate, silver nitrate and cerium sulphate have been added to a gelatin solution. The reddish brown colour is the precipitate of silver dichromate.

Gabriel Kelemen PhD
METAMORPHOSIS
Taken through a window, this photo shows water droplets transforming into intricate patterns on an exterior window on a late winter afternoon.

Ann Parker
MIMICKING THE CANCER ENVIRONMENT

Coloured scanning electron microscope (SEM) image of a pancreatic cancer cell. This cell was cultured on fibres composed of peptide amphiphiles, organic molecules with the ability to self-assemble into fibres. This work aims to mimic the cancer microenvironment in order to be used as a model system for understanding cancer development and for drug testing.

Kseniya Shuturmanska
& Dr Estelle Collin
CAMERA LENS

A close-up shot looking into a zoom lens for a digital SLR camera. A ring-light was attached over the macro lens to light up the various layers and colours and the remaining patterns were created by diffraction. The lens being shown is a Canon 24-105mm f/4 lens, made from 17 lens elements in 12 groups.

Richard Beech
BASS GUITAR STRING

Light micrograph of a longitudinal (lengthwise) section through a 45 bass guitar string. Here you can see the central core around which a helical outer wire has been wound. The image covers a field approximately 2.5mm across.

Gerd-A. Günther
A mixture of ferrofluid and liquid from a glow stick. Ferrofluid is a colloidal liquid containing iron nanoparticles in an organic solvent. Glow sticks typically contain phenyl oxalate, hydrogen peroxide and a fluorescent dye.

When these two fluids were placed together, they formed a complex self-organised pattern. The mathematics behind this were first described by Alan Turing as an explanation for, among other things, stripes on animal skin.

Ella Main
THE CONNECTION
A crane lifting a steel beam to the top of a building. The introduction of steel frame construction was central to the development of high-rise buildings in the early 20th century. Photographed during the construction of “The Exploreum”, an interactive science centre in Pasay City, Philippines.

Emman A Foronda
NEW GENERATION
A young child looking at a piece of construction machinery. This image represents the relationship between engineering and the new generation.

Sujan Sarkar
RED CRESCENT HOSPITAL IN KABUL
A laboratory worker draws blood from a woman for a diagnostic blood test. Photographed in the Central Hospital of the Afghan Red Crescent Society, Kabul, Afghanistan.

Oleksandr Rupeta
Aerial photograph of connected meltwater ponds in the Greenland ice sheet. About 80% of Greenland is covered by ice, the second largest ice sheet on Earth with an area of 1.7 million square kilometres. Climate change is leading to large-scale melting in the Greenland ice cap, each year over 200 cubic kilometres of ice is lost.

Timo Lieber
THE ICE GATEWAY

An iceberg floating in the sea off the coast of Antarctica. A combination of wind and temperature has exploited a weakness in the structure of the ice to erode this bridge-like shape.

Houda Chaloun
CLEANROOM

Cleanroom at an aircraft parts factory.

A cleanroom is an environment in which tiny particles such as dust and aerosols are strictly controlled by filtration. This is critical in a wide range of manufacturing, including microprocessors, pharmaceuticals and aerospace. In the strictest classification, called ISO1, there are fewer than 10 particles of 0.1 micron (one ten-millionth of a metre) or smaller in every cubic metre of air, compared with over 35 million such particles in ‘normal’ air. Photographed in Rayong, Thailand.

Gyuri Szabo
THE FACETS OF AN ANCIENT EYE

All that remains of this Eocene fungus gnat (tribe Orfelliini) is an endocast in Baltic amber from approximately 40 million years ago. A microCT scan revealed the insect’s form, and has allowed the surface of its faceted compound eye to be measured. With this information, it is possible to predict how this gnat viewed the forests of the past and also investigate how the eyes of gnats have evolved. The colours are added for aesthetic effect.

Gavin J Taylor
A red fox (*Vulpes vulpes*) hunts for food under the winter snow. The fox can locate small mammals up to a metre beneath the snow by listening for them. When ready, the fox throws itself upward into a curving path then dives head-first into the snow to grab the prey.

*Angela Jones*
BALANCING ACT

Collision of three water droplets in a bowl of water. First a droplet lands in the bowl of water to create the spike. The second droplet hits top of the spike creating a crown whilst the third and final droplet has just landed on top of the spike. This image was captured in a studio using high speed electronic flash.

Richard Sharrocks
IN THE RAIN
Electricity workers repairing high-tension power transmission lines in the rain.
Photographed in Vietnam.
Tran Hung Dao
MODELING DISSECTION

Four plaster models showing thoracic and abdominal dissection. They were created by sculptor Franz Josef Steger and embryologist Wilhelm His (Germany, c.1900), Photographed at the Harry Brookes Allen Museum of Anatomy and Pathology collection at the University of Melbourne, Australia.

Gavan Mitchell & Ryan Jeffries
Interior of the XENON1T physics experiment at the Gran Sasso Laboratory, Italy. A 1-metre wide top centre container is filled with 3.5 tonnes of ultra-pure liquid xenon. This is held inside this 10-metre wide tank which will be filled with water. The gold-coloured photomultipliers on the walls are part of the detector array. This XENON1T experiment aims to detect particles of dark matter, thought to make up about 27% of the Universe, and to explore some theories such as supersymmetry.

Enrico Sacchetti
HANGING BRIDGE

A farmer carrying sacks of produce across a mist-shrouded suspension bridge. Simple suspension bridges, with no vertical suspenders, have been used in mountainous regions of the world for thousands of years.

Sirsendu Gayen

More modern technology connects the main cables to the deck with vertical suspenders. This enables the deck to hang almost completely level across its whole span. Photographed in Darjeeling, India.
INTENSE SCENTS

Scanning electron microscope (SEM) image showing sensilla hairs on the surface of an insect antenna. These sensory hairs contain receptors responsible for the insect's sense of smell, allowing it to find food and detect pheromones emitted by the opposite sex during the hunt for a mate.

Plant & Food Research
A young female giant prickly stick insect (Extatosoma tiaratum) on the hand of a researcher. Also known as the spiny leaf eater or Macleay’s spectre, this stick insect is found in Australia and is an avid consumer of eucalyptus leaves. The female grows to 8-11cm in length and is covered in thorn-like spikes for camouflage and defence against predators.

Alexandre Lagreou
SOLAR POWER
A villager carries a solar panel which is to be installed on his hut for solar power at Gadkhali, a remote village in Sunderbans, India, where no conventional electricity has been reached.

Sudipto Das
The Anderton Boat Lift was built in 1875 and connects the River Weaver with the Trent and Mersey Canal in Cheshire, UK. A canal boat enters one of two steel caissons, a lock gate closes behind it and the caisson, water and boat are lifted as one a vertical distance of 15 metres. The boat lift was in use until falling into disrepair in 1983, but was fully restored and reopened in 2002. This is one of only two working boat lifts in the UK.

Ian Cook
This compound eye of a tropical orchid bee (*Euglossa imperialis*) is composed of thousands of individual facets. Here, microtomography reveals the lens at the surface of every facet, as well as each underlying light guide and photoreceptor. Orchid bees have evolved large eyes that allow them to use vision to navigate through dim, cluttered tropical forests.

Gavin J Taylor
Gearbox components from a Turbo-Union RB.199 jet engine. The gearbox drives accessories such as fuel, oil and hydraulic pumps and electrical generators. Versions of the RB.199 are used in the Panavia Tornado multi-role fighter.

Mark Parkinson, RAF Photographer
PULEX IRRITANS

Photomicrograph of a female human flea (Pulex irritans). Fleas are small wingless insects, as adults, laterally flattened, blood-sucking and capable of jumping. The mouthparts are adapted for piercing and sucking and consist of three elongated, sharp elements. The legs are rather long and stout, adapted for clinging with large coxae, and long 5-segmented tarsi. This image is a mosaic of several frames, each of which created using focus stacking to give the maximum depth of focus. A total of 132 exposures were used.

David Bryson
SNOWFLAKE
Close-up view of a single snowflake. This clearly shows the six-fold symmetry of the snowflake, caused by the molecular structure of water ice.

Zoltan Toth
OSAKA UMEDA SKY BUILDING

View upward along an escalator at the Umeda Sky Building in Osaka, Japan. The building consists of two 173 metre tall towers connected at the top two floors. This escalator passes from one tower, up through the open atrium space to the Floating Tower Observatory in the roof space. The building was opened in 1993.

Leka Huie
SQUARES AND CIRCLES

Steel tubes in storage racks. The tubes are used in steel frame construction and have either a circular or square ‘box’ cross-section. Photographed in Pengchang near Xiantao, China.

Andrew Wang
THE ONLY WAY IS UP

Scanning electron micrograph (SEM) of a calcite crystal. The surface of the crystal is covered in tiny arrow-shaped decorations. These are caused by a protein that has bound to the crystal as it was grown, the shape of the arrows being specific to the protein.

David C Green
BLUE MORMON BUTTERFLY

Wings of a blue mormon butterfly (*Papilio polymnestor*). This image was captured by the photographer using a tiny amount of electronic flash after night had fallen to accentuate the beautiful blue colour. *P. polymnestor* is a swallow-tail butterfly found in the forests of southern India and Sri Lanka.

Pratik Pradhan
THE MONET
ASTROCYTES

Laser confocal light microscope image of astrocytic cells isolated from mouse brain. Here the astrocytes have been ‘tagged’ with proteins that also contain fluorescent dyes - Vimentin (green), GFAP (red) and DAPI (blue). These help researchers understand the function and connectivity of the cells. Astrocytes make up about 10-20% of the cells of the brain. They are responsible for providing nutrients to nervous tissue and have a role in the repair of the brain after traumatic injury.

Paolo d’Errico
A colony of a giant forest scorpions (Heterometrus swammerdami titanicus) captured during midnight. The black scorpions glow with a blue bluish when illuminated using an ultraviolet torch. H. swammerdami is the largest scorpion species, reaching up to 23cm length and weighing over 50g. Although they do have a mildly toxic sting, they mainly kill by crushing prey in their claws.

Pratik Pradhan
Anterior synechiae in 6-year old cat.
An anterior synechia is created when the iris of the eye adheres to the cornea. This can be due to trauma or to certain infections. Synechiae can lead to glaucoma and a rise in the pressure inside the eye as they can block the drainage of the aqueous humour inside the eyeball. The condition is treatable with drugs.

Pier Luigi Dodi
GOLD-COATED FUNGUS GNAT

Light microscope image of a fungus gnat (family Sciaridae). This specimen has been coated with a very thin layer of gold in preparation for imaging under a scanning electron microscope (SEM). The microscope relies on the electrical conductivity of the surface of specimens, so anything non-conductive is usually coated in gold.

Sergii Dymchenko
Right axillopopliteal graft. This is a bypass technique that uses an artificial blood vessel to link the axillary artery in the armpit to the popliteal artery behind the knee. In this case it was used to create a suitable site for dialysis treatment. Often such a graft is used to bypass a blockage (ischaemia) in the leg, for instance in the femoral artery, to restore blood supply to the lower limb.

Hannah Causer
AMANITA ASCENDS

Multiple exposures on a single sheet of 8x10 inch film show three stages in the fruiting of the fly agaric, *Amanita muscaria*. This illustrates changes to the overall height, size, and shape of the cap as the mushroom fruit develops over a 24-36 hour period. *A. muscaria* is a cosmopolitan species found in a variety of deciduous and conifer forests. In some parts it is known as a hallucinogen as it contains muscimol. However, it is also toxic.

Phred Petersen
SOLAR POWER TECHNOLOGY

Aerial view of solar collectors at the Valle solar power plant. This plant uses parabolic troughs that reflect sunlight onto a central collector tube containing thermal oil. The oil is used to heat water to create steam, which passes through turbines to generate electricity. Each of the two plants at Valle generate 50 MW (megawatts) of electricity, enough to power 40,000 homes. The Valle Solar Plant is near Cádiz, Spain.

Aya Okawa
BREATH OF MANASLU

Peak of Manaslu in the first rays of sunrise, seen between storm clouds. At 8,163 metres above sea level, Manaslu is the eighth-highest mountain in the world. It is located in the Mansiri Himal region of the Himalayas in western Nepal. The peak was first climbed by Toshio Imanishi and sherpa Gyaltsen Norbu on 9th May 1956.

Yevhen Samuchenko
**FEMALE SIMOCEPHALUS**

Light micrograph of a female water flea (*Simocephalus* sp.). The small round objects are the insect’s eggs. *Simocephalus* is typically about 3mm in length and is a filter feeder.

Håken Kvarnström
RETINAL IMPLANT SURGERY

A surgeon inserting a visual prosthesis into the eye of a patient. The Tübingen microphotodiode array (MPDA) has 1500 photodiodes implanted on a chip behind the retina. These collect light and convert it into electrical signals that are sent to retinal ganglion cells. Many patients subsequently have enough sight to locate and identify common objects, even where they were previously completely blind. This photograph shows Professor MacLaren and his colleague at the Oxford Eye Hospital, UK.

Jonathan Brett
FROM LINE TO PARTICLE

The choice of lighting can dramatically alter the way we record phenomena. Here an electrospray apparatus emits a spray of charged liquid droplets. At left, this is seen lit by an extended continuous light source such as an LED bulb. Viewed as a shadow, we see almost no useful information. At centre, we see the spray with the same illumination but in reflected light. At right, the spray is captured with a short duration (125 nanosecond) flash exposure that ‘freezes’ our view of the droplets.

Hamidreza Nasiri
THERMAL IMAGE OF PLANTAR FEET

Thermal infrared image of a patient's feet. The colours indicate skin temperature on a scale from magenta (25 Celsius) through blue, cyan, green, yellow and red to white (36 Celsius). The right foot (left in the image) shows considerable heating. This is an inflammation related to a diabetic ulcer. Foot ulcers are a major complication of diabetes mellitus, occurring in 15% of diabetics.

Dr Ricardo Vardasca ASIS FRPS
WATER LILY LEAF

Coloured scanning electron micrograph (SEM) of a section through a leaf stalk of the water lily Nymphaea album. The water lily has overcome the difficulty of getting air to its submerged roots by having large diameter open tubes within the stalks. These hollow tubes are connected directly to large air spaces in the leaves, which contribute to the plant’s buoyancy. The tubes are lined with epidermal cells and studded with branched hairs. The original image was monochrome with colour added later.

Dr Jeremy Burgess
THE SILENT ASSASSIN

A green vine snake (Ahaetulla nasuta) attacking a common tailorbird (Orthotomus sutorius). Mildly venomous, this snake more commonly hunts frogs and lizards and is found across India and Southeast Asia. It is an ambush predator, using its green colour and slender shape to camouflage itself. The common tailorbird is also found across Asia, more often heard than seen due to their loud call.

Arghya Adhikary
THE BREATER

Close-up view of a breather hole in the window of a passenger aircraft. The breather hole is drilled into the middle of three panels that make up the window. The outer and middle panels are structural and made from glass, the inner panel is mainly cosmetic and made from plastic. The hole allows pressure to equalise between the two glass panels as the aircraft climbs and descends.

Gautam Kamat Bambolkar
The Northern Lights, or Aurora borealis, seen above Jökulsárlón, a large glacial lake on the south leading edge of the vast Vatnajökull Glacier in Iceland. The aurora is caused by charged particles from the Sun being captured by Earth’s magnetic field. As they enter the upper atmosphere these particles collide with oxygen atoms, making them energised. The atoms release energy at a specific wavelength of greenish light.

James Woodend
TAENIA SOLIUM

Laser confocal light micrograph of the head of a pork tapeworm (Taenia solium). The eye-like objects are suckers which, together with the hook-filled rostellum, allow the tapeworm to attach to the lining of the host intestine. The adult worm can infest humans, reaching a length of 2-3 metres.

Teresa A. Zgoda
DIVIDING SEA URCHIN EGGS

Laser confocal light micrograph of eggs of a sea urchin (class Echinoidea). The eggs have been treated with various proteins that attach to specific sites within the structure. Each protein is also attached to a specific colour fluorescent dye. When illuminated with a laser, the dyes fluoresce in their characteristic colours. Here, green shows the egg walls, microtubules in red and the chromosomes in blue.

Teresa A Zgoda
Spore capsule of the many-fruited thyme-moss (*Plagiomnium affine*). This thyme-moss is found in damp forest conditions across North America, Europe and Asia. The spore capsule is about 2mm in length. This image was rendered from a stack of 190 exposures ensuring the image is sharp along the whole length of the capsule.

Henri Koskinen
GREATER CELANDINE

Light micrograph of a seed grain of the greater celandine (Chelidonium majus). The seeds have a white, juicy appendage on the lower part of the brownish seed grain, or elaiosome, which ants like to eat. The seeds are dragged along to new habitats as the ants enjoy their meal. The image covers a field approximately 1.6mm across.

Gerd-A. Günther
Light micrograph of two seed grains of goosegrass (*Galium aparine*). The tiny hooks appear all over the plant. In ancient times the stems of goosegrass were used as a rough sieve for milk, and the plant was used in folk medicine to treat light wounds, burns and stings. The image covers a field approximately 2mm across.

Gerd-A. Günther
Artwork created using almost 600 retinal images showing a wide variety of conditions. The images have been combined to resemble the colour vision test charts created by Dr Shinobu Ishihara.

Jonathan Brett
HORSEHEAD AND FLAME NEBULAE

At the center of the image above is the famous Horsehead Nebula (B33). The Flame Nebula (NGC2024) is at the lower left. Both are in the constellation of Orion. B33 is an opaque dust cloud and is visible against the bright red background of the emission nebula that originates from a hydrogen gas cloud. NGC2024 is energized by high levels of ultraviolet light emanating from the blue supergiant star Alnitak (shown just above it here), the east-most star in the Belt of Orion.

Dave Watson ARPS
32 ANCESTORS
A composite image of 32 human skulls. The skulls were from the ossuary, or bone crypt, of Holy Trinity Church, Rothwell, Northamptonshire. A team at the University of Sheffield has used radiocarbon dating to show that the skulls date from between 1250-1450CE.

Susan Elaine Jones
POISSON’S SPOT

In the centre of the fame is the shadow cast by a tiny steel ball illuminated by a red laser. However, some of the light has diffracted around the ball into the shadow forming a concentric interference pattern. In the very centre is a bright spot, called a Poisson spot or an Arago spot. This is a demonstration of the wave nature of light. Around the shadow, the red laser has saturated both the red and green sensors in the camera CCD, which the camera interprets as yellow light.

Richard Germain
RED BLOOD CELL

Coloured scanning electron micrograph (SEM) of a red blood cell, or erythrocyte, seen in a sinusoid of the liver. Sinusoids are small capillary vessels that receive blood from the intestines through the hepatic portal vein and from the heart through the hepatic artery. These supply the liver cells (hepatocytes) with nutrients and oxygen. The hepatocytes help to regulate fat and sugar levels in the blood. The original monochrome SEM image was later coloured digitally.

A. Menegon
YEAST-LIKE FUNGUS

Light micrograph of a newly-discovered yeast-like fungus, *Fereydounia sp.* strain TAR 509. This specimen was collected on the campus of Chulalongkorn University in Bangkok, Thailand.

Tomás Allen Rush and Phanurut Aiyara
FACIAL PAPER TISSUE

Coloured scanning electron micrograph (SEM) of the cellulose fibres in facial tissue. First marketed in 1924 under the brand name “Kleenex”, the use of squares of very soft paper as a facial cleaner had been known in Japan since the 17th Century. Modern facial tissues use the lowest weight paper (14-18g per square metre), often with a softened surface and with lotions or perfumes added. The original monochrome SEM image was later coloured digitally.

A. Menegon
PLACENTICERAS INTERCALARE

Suture patterns of an ammonite
*Placenticeras intercalare*. The inside of
the shell is divided into a chambered part
and an unchambered part. The body of the
animal occupied the unchambered part,
or living chamber. The chambered portion
of the shell was divided by partitions called
septa. The contact of these septa with the
external shell is called a suture.

Norm Barker ASIS FRPS
CHLOROPLASTS
Coloured scanning electron micrograph (SEM) of a dying euglenoid alga showing the release of its chloroplasts (green). The specimen came from a polluted lake in Vietnam. The original monochrome image has been digitally coloured.

Stephen Gschmeissner
CROSS-SECTION OF A POPPY BUD

Light micrograph of a section through a bud of the poppy, *Papaver rhoeas*. The original monochrome light micrograph was later coloured digitally. In the central region (olive green) are the carpels and ovaries – the female reproductive elements. Surrounding these are a zone of stamens and anthers (purple) – the male reproductive elements. Further out are petals (red) and the outer calyx (green).

*Steve Lowry*
MOSQUITO FOOT

Coloured scanning electron micrograph (SEM) of the mosquito tarsus. Shown here is the mosquito leg tarsus, that includes a claw, pulvillar pad with tentent setae (adhesive hairs), and surrounding scales. Scales cover various parts of the body of most mosquitoes, they are especially dense on the mosquito leg. They are thought to provide protection and water-supporting force. The original monochrome image has been digitally coloured.

Stephen Gschmeissner
UKRAINE PROSTHETIC PROJECT

A Ukrainian soldier testing his future hand during the Ukraine Prosthetic Assistance Project. While under attack, the soldier saved the lives of six colleagues by throwing a grenade out of their armoured vehicle, but in the process lost his hand at the wrist. This project is organised by Ukrainian and Canadian medical workers to share specialist knowledge of prosthetics.

Oleksandr Rupeta
HEALING
35 WEEKS LATER
Self-portrait of a photographer at home 8 months after a heart-lung transplant. Combined transplants of the heart and lungs together are rarely performed. Here the linear scar on the chest is seen where the sternum is separated during surgery, as well as several smaller scars from incisions through which a heart-lung machine was connected.

Kathleen Sheffer
THE GREAT MONARCH’S
MIGRATION
A gathering of great monarch butterflies 
(Danaus plexippus) seen during their 
migration. Monarch butterflies are famous 
for their annual migrations in North America, 
flyong from as far north as Canada to areas 
of Florida and Mexico to spend the winter 
in roost colonies.

Alexandre Lagreou
A glory seen from a hill top. A glory is an optical phenomenon when seen the viewer is looking at mist or cloud lit by the Sun coming from over their shoulder. The physics behind glory formation is still a matter of debate, as it is not caused by the same simple refractive process as a rainbow.

Yevhen Samuchenko
STORM ON TAKE-OFF

A row of Sukhoi Su-30SM “Flanker-C” fighter aircraft at an airbase of the Russian Air Force. In the background numerous rain storms obscure the bright horizon. The Su-30 is an all-purpose, all-weather fighter bomber that has been in service since 1996. Over 540 have been built, serving also in countries including China, India and Algeria.

Artem Markin
A lone tornado tracks through the Nebraska Sand Hills near Whitman, USA. A tornado is a rapidly rotating column of air that forms under a cumulonimbus storm cloud. They are made visible by condensing water vapour in the spout, and by dust and debris picked up from the ground. Most tornadoes are less than 100 metres across and travel only a few kilometres before dissipating, although the most extreme can be over 3km across that travel for 100km with central winds of over 480 km/h.

Martin Lisius
HOLD ON – IT’S GOING TO BE A BUMPY RIDE

A baby southern plains grey langur (Semnopithecus dussumieri) holding tight to its mother as she runs. Grey langurs are found across the Indian subcontinent. They adapt to a wide range of habitats, even human cities.

Anup Deodhar
There is a tuft of black fur on the back of the legs of impala. These are metatarsal glands used in scent marking. Although more developed in males than females, the glands do not undergo seasonal variation so are most likely used to provide cohesion to the herd.

Morgan Trimble
Microbe print grown in a petri dish after a leaf from a bagged salad was pressed on to it. The outline of the leaf is clearly visible from the growth of Salmonella bacteria. Consumers have been advised to wash bagged salad before eating it, and to eat it within a day of purchase.

Carl Vivian
FROZEN BUBBLE

Frozen soap bubble. The wall of the bubble is composed of three layers – layer of water sandwiched between two layers of soap. As the water layer freezes it produces these large dendritic crystals. Eventually cracks form in the ice layer and the frozen bubble collapses.

Daniela Rapavá,
Observatory Rimavská Sobota
ACCORD
Trains sitting with remarkable symmetry at platforms in the main railway station in Tomsk, Russia.

Roman Permyakov
ARECIBO RADIO TELESCOPE

Beam-steering mechanism of the William E Gordon radio telescope at Arecibo, Puerto Rico. The mechanism sits at the focus of a 305-metre (1000 foot) wide spherical radio reflector built in a sinkhole in the local rock. As the telescope dish doesn’t move, the beam-steering mechanism moves above it to allow some tracking facility. Built in 1963, this was the largest single-aperture telescope in the world until 2016.

Enrico Sacchetti
DANCING SHAMPOO

The Kaye effect in shampoo. This was first described by Alan Kaye in 1963 and is a property of “sheer-thinning” liquids, those which lose viscosity when a sheer force is applied. At first, the stream of liquid forms a pile where it hits a surface. However, soon a slender sheer-thinned layer develops in a dimple in the pile. The liquid stream hitting the dimple slides over it and shoots off.

Jungwook Kim
LIGHT REFRACTION

Water drops on the surface of a tablet computer. Several coloured lines had been drawn on the screen. The water droplets create a range of refraction effects.

Matouš Pikous
NORTH RIM

The Milky Way seen over the North Rim of the Grand Canyon in Arizona, USA. The Milky Way is our own galaxy. It appears as a broad band where we look through the flattened disk of billions of stars that makes up its spiral structure. The Grand Canyon is over 400km long, up to 29km wide and up to 1.8km deep, carved by the action of the Colorado River over 5 million years.

John Vermette
SECRET JEWEL

A swarm of crane flies (family Tipulidae) hanging on a spider web thread. This aggregation of males is known as lekking. This occurs in many species and is thought to help improve reproductive success, although quite how this works and how it evolved is not known. Photographed in India.

Breech Asher Harani
The Milky Way seen over Monument Valley in Arizona, USA. The Milky Way is our own galaxy. It appears as a broad band where we look through the flattened disk of billions of stars that makes up its spiral structure. This image was formed from six images put together as a panorama.

John Vermette
FLAMINGOES IN FLIGHT

Aerial view of a flock of greater flamingoes (Phoenicopterus roseus) flying over the Andalucian wild lands in Huelva, Spain. Aerial photography is being used to measure and track the migration of several bird species.

Aya Okawa
CAR LIGHT TRAILS

Light trails from road traffic at dusk. The mixture of headlamps and tail lights, blended with the orange glow of the street lighting, makes the scene resemble a lava flow. Photographed in the Hada Mountains near Taif, Saudi Arabia.

Islam Shaheen
ERTA’ALE

Lava lake in the crater or Erta Ale volcano, Danakil, Ethiopia. Erta Ale is a shield volcano some 613 metres high. It is one of just six volcanoes in the world with lava lakes. The lake was first reported in 1906. It occasionally rises to overflow the crater rim and there have been numerous eruptions from its flanks. The name Erta Ale means “smoking mountain” in the local Afar language.

Mark Levitin
WIND FOR THE FUTURE

A father and young daughter walking along a beach, with a backdrop of wind turbines. These are part of the Bangui Wind Farm, a collection of 20 wind turbines generating a combined 33MW (megawatts) of electricity. The wind farm is on the coast of Ilocos Norte, Philippines.

Emman A Foronda
LONELY

The Milky Way seen rising over a lonely tree in Kaza Valley in India. The Milky Way is our own galaxy. It appears as a broad band where we look through the flattened disk of billions of stars that makes up its spiral structure.

Nimit Nigam
UV FLUORESCENCE OF EGGS

Eggs in visible light (left) and ultraviolet radiation, demonstrating fluorescence. The eggs used are (top to bottom) chicken, duck and quail. The different colours of fluorescence show how the egg shells include different minerals. For hen’s eggs the brown pigment has a strongly red fluorescence which is derived from protoporphyrin. The more blue colour of duck egg is likely to be due to calcite crystals. The quail egg shows a mixture of the two.

Adrian Davies
Newton's rings are the result of reflection of light between two surfaces - normally one flat and one very slightly curved. Light reflecting form one surface interferes with the light reflected by the other. When the difference in path length is an even multiple of a half wavelength of a particular colour, that colour is reinforced. The difference in path lengths shows as a series of concentric rainbow-like rings. Analysis of Newton’s rings gives information about the exact shape of the surfaces.

Richard Germain
BUBBLE COLOURS

Interference colours from soap bubbles.
The film of a soap bubble is made from a layer of water sandwiched between two layers of soap. A light ray hitting the film will reflect from the top and bottom soap layers. As the two reflected rays combine, they interfere. The colours that constructively interfere are dependent on the thickness of the water layer and the angle of viewing.

Greg Vivash ARPS
ANGELS IN LOVE

A pair of sea angels (*Clione limacina*). These are small, swimming sea slugs found in cold waters of the North Pacific and North Atlantic Oceans. Sea angels are molluscs, but discard their shell during embryonic growth. They can reach a length of 7-8cm during their two-year life. Sea angels are simultaneous hermaphrodites, having both male and female parts at the same time, and self-fertilise their eggs.

Andrey Narchuk
CORAL ARCHITECTURE

Close-up view of corals of the order Scleractinia. Each polyp making up the coral has a ring of tentacles surrounding a tiny mouth. At its base each polyp excretes calcium carbonate to protect its body – in a large colony this material combines to form a stony reef.

Andrey Narchuk
PIXELS
Close-up view of the screen of a cathode ray tube (CRT) television. A large convex lens has been placed over the screen, enlarging the image at centre but producing distortions toward the edges. CRT screens were made using sets of red, green and blue phosphors. These are illuminated by electron ‘guns’, one carrying the signal for each colour. Viewed at a distance, the colours and brightnesses merge to give a colour image.

Richard Germain
M42
GREAT ORION NEBULA

The Orion Nebula is a diffuse nebula situated south of Orion’s Belt in the constellation of Orion. It is one of the brightest nebulae and is visible to the naked eye in the night sky. M42 is located at a distance of 1,344 light years and is the closest region of massive star formation to Earth. The M42 nebula is estimated to be 24 light years across. To the left of centre is a region known as the Running Man Nebula.

Dave Watson ARPS
SICKLE CELL RETINOPATHY

Fluorescein angiogram of a human retina, showing proliferative sickle cell retinopathy. At right is a ‘sea fan’ where new blood vessels have formed following the blockage of a capillary in the back of the eye. Damage to the eye is a complication of sickle cell disease. The image was made by photographing the back of the eye after the patient has been injected with a fluorescent dye to highlight the blood vessels.

Paul Whitten, New York Eye & Ear Infirmary of Mount Sinai
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arghya Adhikary</td>
<td>The Silent Assassin</td>
<td>57</td>
</tr>
<tr>
<td>Heather Angel HonFRPS</td>
<td>Lotus flower in infrared</td>
<td>9</td>
</tr>
<tr>
<td>Gautam Kamat Bambolkar</td>
<td>The Breather</td>
<td>58</td>
</tr>
<tr>
<td>Norm Barker ASIS FRPS</td>
<td>Placenticeras intercalare</td>
<td>72</td>
</tr>
<tr>
<td>Richard Beech</td>
<td>Camera Lens</td>
<td>16</td>
</tr>
<tr>
<td>Jonathan Brett</td>
<td>Soap Bubble Planet</td>
<td>6</td>
</tr>
<tr>
<td>Dr Jeremy Burgess</td>
<td>Water Lily Leaf</td>
<td>56</td>
</tr>
<tr>
<td>Hannah Causer</td>
<td>Right Axillopopliteal Graft</td>
<td>48</td>
</tr>
<tr>
<td>Houda Chaloun</td>
<td>The Ice Gateway</td>
<td>23</td>
</tr>
<tr>
<td>Ian Cook</td>
<td>Anderton Boat Lift</td>
<td>35</td>
</tr>
<tr>
<td>Paolo d’Errico</td>
<td>The Monet Astrocytes</td>
<td>44</td>
</tr>
<tr>
<td>Tran Hung Dao</td>
<td>In the Rain</td>
<td>28</td>
</tr>
<tr>
<td>Sudipto Das</td>
<td>Solar Power</td>
<td>34</td>
</tr>
<tr>
<td>Adrian Davies</td>
<td>UV Fluorescence of Eggs</td>
<td>98</td>
</tr>
<tr>
<td>Luis Davilla</td>
<td>Faraday Cage</td>
<td>7</td>
</tr>
<tr>
<td>Anup Deodhar</td>
<td>Hold On – It's Going to be a Bumpy Ride</td>
<td>82</td>
</tr>
<tr>
<td>Pier Luigi Dodi</td>
<td>Anterior Synechiae</td>
<td>46</td>
</tr>
<tr>
<td>Sergii Dymchenko</td>
<td>Gold-coated Fungus Gnat</td>
<td>47</td>
</tr>
<tr>
<td>Emman A Foronda</td>
<td>The Connection</td>
<td>19</td>
</tr>
<tr>
<td>Sirsendu Gayen</td>
<td>Wind for the Future</td>
<td>96</td>
</tr>
<tr>
<td>Richard Germain</td>
<td>Hanging Bridge</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Pixels</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>Poisson’s Spot</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Polychromatic Newton’s Rings</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Surface Tension</td>
<td>11</td>
</tr>
<tr>
<td>David C Green</td>
<td>The Only Way is Up</td>
<td>42</td>
</tr>
<tr>
<td>Stephen Gschmeissner</td>
<td>Chloroplasts</td>
<td>73</td>
</tr>
<tr>
<td>Gerd-A. Günther</td>
<td>Mosquito Foot</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Amoeba shells</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Bass Guitar String</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Greater Celandine</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Nature’s Velcro</td>
<td>64</td>
</tr>
<tr>
<td>Breech Asher Harani</td>
<td>Secret Jewel</td>
<td>91</td>
</tr>
<tr>
<td>Leka Huie</td>
<td>Osaka Umeda Sky Building</td>
<td>40</td>
</tr>
<tr>
<td>Susan Elaine Jones</td>
<td>32 ancestors</td>
<td>67</td>
</tr>
<tr>
<td>Angela Jones</td>
<td>Searching</td>
<td>26</td>
</tr>
<tr>
<td>Gabriel Kelemen PhD</td>
<td>Liesegang Rings Blue</td>
<td>13</td>
</tr>
<tr>
<td>Jungwook Kim</td>
<td>Dancing Shampoo</td>
<td>88</td>
</tr>
<tr>
<td>Henri Koskinen</td>
<td>Spore Capsule of a Moss</td>
<td>62</td>
</tr>
<tr>
<td>Häken Kvarnström</td>
<td>Female Simocephalus</td>
<td>52</td>
</tr>
<tr>
<td>Alexandre Lagreou</td>
<td>Hands-on Entomology</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>The Great Monarch’s Migration</td>
<td>78</td>
</tr>
<tr>
<td>Robert Lamberts, Plant &amp; Food Research</td>
<td>Spinning Rainbow</td>
<td>12</td>
</tr>
<tr>
<td>Mark Levitin</td>
<td>Ert’a’ale</td>
<td>95</td>
</tr>
<tr>
<td>Timo Lieber</td>
<td>Thaw #5</td>
<td>22</td>
</tr>
<tr>
<td>Martin Lisius</td>
<td>Nebraska Sandhills Tornado</td>
<td>81</td>
</tr>
<tr>
<td>Steve Lowry</td>
<td>Cross-section of a Poppy Bud</td>
<td>74</td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Ella Main</td>
<td>FerroFluid Glowing Multicolour</td>
<td>18</td>
</tr>
<tr>
<td>Artem Markin</td>
<td>Storm on Take-off</td>
<td>80</td>
</tr>
<tr>
<td>A. Menegon</td>
<td>Facial Paper Tissue</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Red Blood Cell</td>
<td>69</td>
</tr>
<tr>
<td>Gavan Mitchell &amp; Ryan Jeffries</td>
<td>Modelling Dissection</td>
<td>29</td>
</tr>
<tr>
<td>Andrey Narchuk</td>
<td>Angels in Love</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>Coral Architecture</td>
<td>102</td>
</tr>
<tr>
<td>Hamidreza Nasiri</td>
<td>From Line to Particle</td>
<td>54</td>
</tr>
<tr>
<td>Nimit Nigam</td>
<td>Lonely</td>
<td>97</td>
</tr>
<tr>
<td>Aya Okawa</td>
<td>Flamingos in Flight</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Solar Power Technology</td>
<td>50</td>
</tr>
<tr>
<td>Ann Parker</td>
<td>Metamorphosis</td>
<td>14</td>
</tr>
<tr>
<td>Mark Parkinson, RAF Photographer</td>
<td>Tech Reflect</td>
<td>37</td>
</tr>
<tr>
<td>Roman Permyakov</td>
<td>Accord</td>
<td>86</td>
</tr>
<tr>
<td>Phred Petersen</td>
<td>Amanita ascends</td>
<td>49</td>
</tr>
<tr>
<td>Matouš Pikous</td>
<td>Light Refraction</td>
<td>89</td>
</tr>
<tr>
<td>Plant &amp; Food Research</td>
<td>Intense Scents</td>
<td>32</td>
</tr>
<tr>
<td>Pratik Pradhan</td>
<td>A Nightmare of the Small World</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Blue Mormon Butterfly</td>
<td>43</td>
</tr>
<tr>
<td>Daniela Rapavá, Observatory Rimavská Sobota</td>
<td>Frozen Bubble</td>
<td>85</td>
</tr>
<tr>
<td>Oleksandr Rupeta</td>
<td>Red Crescent Hospital in Kabul</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Ukraine Prosthetic Project</td>
<td>76</td>
</tr>
<tr>
<td>Tomás Allen Rush and Phanurut Aiyara</td>
<td>Yeast-like Fungus</td>
<td>70</td>
</tr>
<tr>
<td>Enrico Sacchetti</td>
<td>Arecibo Radio Telescope</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Xenon1T</td>
<td>30</td>
</tr>
<tr>
<td>Yevhen Samuchenko</td>
<td>Breath of Manaslu</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Halo Glory</td>
<td>79</td>
</tr>
<tr>
<td>Sujan Sarkar</td>
<td>New Generation</td>
<td>20</td>
</tr>
<tr>
<td>Islam Shaheen</td>
<td>Car light trails</td>
<td>94</td>
</tr>
<tr>
<td>Richard Sharrocks</td>
<td>Balancing Act</td>
<td>27</td>
</tr>
<tr>
<td>Kathleen Sheffer</td>
<td>Healing – 35 Weeks Later</td>
<td>77</td>
</tr>
<tr>
<td>Kseniya Shuturmanska &amp; Dr Estelle Collin</td>
<td>Mimicking the Cancer Environment</td>
<td>15</td>
</tr>
<tr>
<td>Viktor Sykora</td>
<td>Larva</td>
<td>10</td>
</tr>
<tr>
<td>Gyuri Szabo</td>
<td>Cleanroom</td>
<td>24</td>
</tr>
<tr>
<td>Gavin J Taylor</td>
<td>Outside and inside of a compound eye</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>The Facets of an Ancient Eye</td>
<td>25</td>
</tr>
<tr>
<td>Zoltan Toth</td>
<td>Snowflake</td>
<td>39</td>
</tr>
<tr>
<td>Morgan Trimble</td>
<td>Impala Cutaneous Glands</td>
<td>83</td>
</tr>
<tr>
<td>Dr Ricardo Vardasca ASIS FRPS</td>
<td>Thermal Image of Plantar Feet</td>
<td>55</td>
</tr>
<tr>
<td>John Vermette</td>
<td>Monument Valley</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>North Rim</td>
<td>90</td>
</tr>
<tr>
<td>Greg Vivash ARPS</td>
<td>Bubble Colours</td>
<td>100</td>
</tr>
<tr>
<td>Carl Vivian</td>
<td>Salad Leaf Microbe Print</td>
<td>84</td>
</tr>
<tr>
<td>Andrew Wang</td>
<td>Squares and Circles</td>
<td>41</td>
</tr>
<tr>
<td>Dave Watson ARPS</td>
<td>Horsehead and Flame Nebulae</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>M42 Great Orion Nebula</td>
<td>104</td>
</tr>
<tr>
<td>Paul Whitten, New York Eye &amp; Ear Infirmary of Mount Sinai</td>
<td>Sickle Cell Retinopathy</td>
<td>105</td>
</tr>
<tr>
<td>James Woodend</td>
<td>Aurora over a Glacier Lagoon</td>
<td>59</td>
</tr>
<tr>
<td>Teresa A Zgoda</td>
<td>Dividing Sea Urchin Eggs</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Taenia solium</td>
<td>60</td>
</tr>
</tbody>
</table>
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