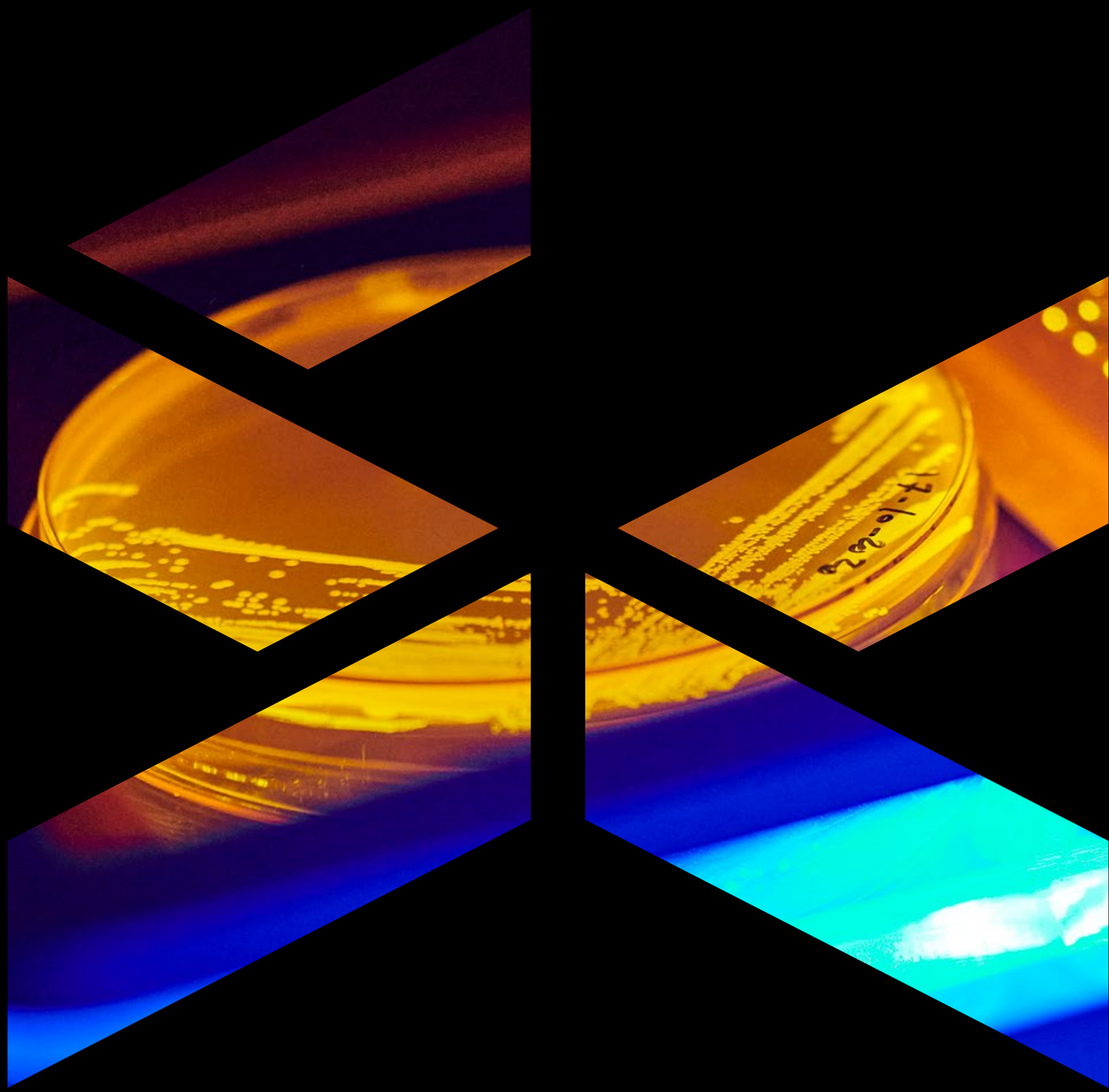


The Story So Far

Science Creates – from Discoveries to Inventions

Progress in today's society is underpinned by scientific breakthroughs. The current global pandemic and climate crisis has highlighted what is missing. Now, more than ever, researchers have a responsibility to play a pivotal role in making sure their discoveries are used to propel us forward.

No matter the quality of the research and the discoveries made, having the right ecosystem is fundamental to success. Studies show that incubators can address the global 90% failure rate of science start-ups[1], transforming that figure into an 88% success rate and as a result creating many more successful ventures.

Breaking the barriers

Five years ago, I was a year into running an unknown biotech company called Ziylo when we hit a major barrier in Bristol. We had outgrown our labs at the University and outside of it there was a complete lack of lab space and support for deep tech companies like us. Bristol had all the other ingredients needed to make us want to stay: decades of world-class research and the talent that comes with that; and a city that is world-renowned for being uniquely diverse, pioneering and rebellious. We decided to stay and do something about these barriers.

Two years later in 2017, we opened the doors at Bristol's first deep tech incubator, Unit DX. Unit DX provided access to facilities and a network of experts, which enabled Ziylo to grow, expand and eventually sell our business. When we opened we had just two members, Ziylo and Nu Nano, now at the time of writing, we have over 37 members.

Creating a community

With so many amazing companies now working in the city, we can truly say that Bristol has its own deep tech community. I am in awe of the raw talent and ambition that I witness on a daily basis. These companies work at the cutting edge, often combining components of biotech, AI, photonics, advanced material, quantum and robotics to develop ground-breaking technology that will propel this world forward. We call this deep tech. Find more about what deep tech is on page 31.

Although Bristol's deep tech ecosystem is flourishing, our mission has only just begun. Over the next five years, I look forward to seeing Bristol become a global leader in deep tech, resulting in some of the most important technologies of the future.

Today we announce the launch of Science Creates, an ecosystem which encompasses everything we do across our incubators, network and investment activities, and paves the way for our collective ambition. In the following pages we will set out our vision for deep tech in Bristol.

1. https://www.future-science.com/doi/full/10.4155/fdd-2019-0010

Harry Destecroix
Founder, Science Creates

Harry was the founder and CEO of Ziylo, which he successfully built and exited within four years of founding for a potential $800m. During this period Harry also founded the Unit DX incubator and associated companies within Science Creates that help support the current Bristol deep tech ecosystem. Within Harry's role at Unit DX he has helped multiple spin outs to emerge, advising them on strategy and helping them build the initial team. Since then, Harry has made a number of angel investments, predominantly into this community. Harry also sits on the University of Bristol Investment Committee.

Contents

Launching Science Creates

The Deep Tech Ecosystem

Science Creates is an ecosystem which encompasses everything we do across our incubators, network and investment activities, and paves the way for our collective ambition. In the following pages we will set out our vision for deep tech in Bristol. It will provide the incubators, network and investment needed to allow the sector to expand on the rapid growth of the last five years through three clear channels:

1. Science Creates Incubators
Home to deep tech

Science Creates Incubators is intended to be used as the trading name of Unit DX Ltd. In partnership with the University of Bristol and Research England, our two central Bristol incubators, Unit DX and Unit DY (currently under construction) offer 45,000 sq. ft of laboratory, office and event space for deep tech start-ups. We designed our Unit DX and Unit DY Incubators for scientists and engineers using input from our own experiences working in laboratories. Our specialist in-house team designed, developed and run our incubators. Patrick Fallon tells us more about the designing and construction of Unit DY on page 13.

2. Science Creates Network
The collective knowledge

The Science Creates Network is made up of our member deep tech companies and our partnerships with local academic institutions, entrepreneurs, investors and strategic service providers. As sector specialists, we know that deep tech businesses need the right equipment, mentors and advisors with specific, relevant experience. The breadth and depth of these circles of expertise continue to grow and flourish, creating a connected community of support that adds value to our member deep tech companies and a sustainable platform for teams that partner with Science Creates in the future. Read more about how our partnership with the University of Bristol forms part of our network from Hugh Brady on page 9, plus further information on our other strategic partnerships from Ashley Brewer on page 11.

3. Science Creates Ventures
Deep tech investment

With the growth of our ecosystem, we identified the need for investment to help companies scale up. This is why we are launching Science Creates Ventures, with the to aim to deliver mould-breaking investment funds. Science Creates Ventures EIS Fund 1, launched in October this year, focuses on deep tech start-ups at pre-seed and seed levels. The fund will aim to provide essential funding to the Bristol region and seek to help ambitious companies in a variety of sectors including therapeutics, diagnostics, advanced materials, hardware and software.

Run exclusively by proven founders who combine deep technical knowledge with extensive commercialisation expertise. Science Creates Ventures will invest in technologies that have the potential to improve healthcare, quality of life, and the environment around us.

You can read more about Science Creates Ventures and our first fund from Sam Olof on page 5.

Science Creates Outreach

We've created a unique learning environment with immersive tours, hands-on workshops and interactive lessons with scientists and engineers. We put you in the heart of our working science incubator, where science entrepreneurs are working to improve healthcare, quality of life and the environment around us. This is a real-world experience. Our lab tours give a 'behind the scenes' look at what our member companies are working on, alongside the chance to run similar experiments yourself in The Learning Lab. See, first-hand, real science in action and understand that it's done by people just like you. Charlie Proctor will discuss our outreach and new learning lab on page 17.

Our Mission:

'To provide an ecosystem of incubators, investment and a network that enables scientific discoveries to have real, global impact.'

Our Vision:

'Better healthcare, a cleaner environment, and an improved quality of life for everyone; achieved by supporting scientists to take discoveries off the shelf and into the real world.'

Launching Science Creates Ventures

Deep Tech Investment

When I finished my PhD in 2013, along with hundreds of other talented scientists, I left Bristol to pursue my next role within an Oxford University life science spin-out. Back then the building that is now Unit DX was a bathroom warehouse and Dr Harry Destecroix was just another PhD student working on a piece of exciting research.

It took a core team, formed around the tenacious Dr Destecroix, to kickstart the process of raising the city's collective ambition. Since the creation of Unit DX and Ziylo, the University of Bristol has experienced unprecedented start-up growth and reflects a growing momentum behind the best and brightest minds choosing to work in exciting, meaningful companies. However, according to the 2019 Biocity Life Science report, although Bristol ranked 6th in the UK for the number of University spinouts in 2019, around 82% of the £2.8bn invested in life-science every year goes to London, the South East and the East of England.

Bristol is a city built on science, technology, and engineering. Isambard Kingdom Brunel left an indelible, physical legacy across the entire UK, but arguably no place more so than Bristol. This legacy is encompassed by his engineering marvels: the Great Western Railway, Clifton Suspension Bridge, and the SS Great Britain. It is a city traditionally known for merchant ventures, not venture capital, and we believe it's time that this changed.

We are excited to present the Science Creates Ventures EIS Fund 1 - a fund that's well positioned to uniquely capitalise on the latent potential that exists within the South West.

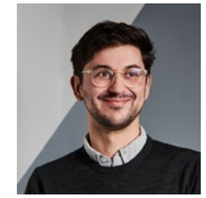
We are not looking exclusively for money. We are looking for experienced founders, mentors and champions prepared to invest money, time, and expertise. Together we plan to invest in and grow this ecosystem of deep tech companies. We seek to champion the under-ventured geography of the South West for deep tech.

Sam is a biotechnologist, Oxford University Fellow and biotech entrepreneur (OxSyBio, Revena). Sam co-founded OxSyBio with Professor Hagan Bayley (founder of Biotech unicorn Oxford Nanopore) and successfully grew the team and raised £11m of venture capital. After this he co-founded his own consultancy, Revena and has held an Entrepreneur in Residence position at Entrepreneur First, the largest seed stage investor in Europe.

'We seek to champion the under-ventured geography of the South West for deep tech.'

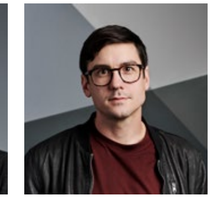
Introducing the Team

Science Creates Ventures is run exclusively by proven founders who combine deep technical knowledge with extensive commercialisation expertise. We will work with our investee companies to raise pre-seed and seed investments, and offer mentoring and support services from ourselves and our investors.



Sam Olof, PhD
General Partner

Both founders and entrepreneurs themselves, Harry and Sam bring their deep technical knowledge and broad commercialisation experience to the management of Science Creates Ventures. You can read more about Sam below to the left, and more about Harry on page 1.



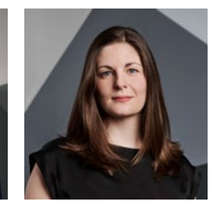
Harry Destecroix, PhD
General Partner

Kay Russel-Smith
Executive Assistant

Having over 10 years' experience within consulting and management firms, Kay supports the team with her meticulous organisation and project management skills.

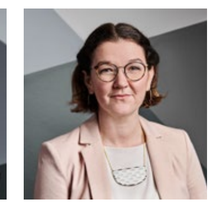
Jon Craton
Chairman

Jon is a seasoned tech entrepreneur and serial angel investor, exiting his first company (Cramer, $425m) in 2006. Jon brings to the team his extensive knowledge of commercialisation along with experience in active mentorship roles.



Emma Tinsley
Advisor

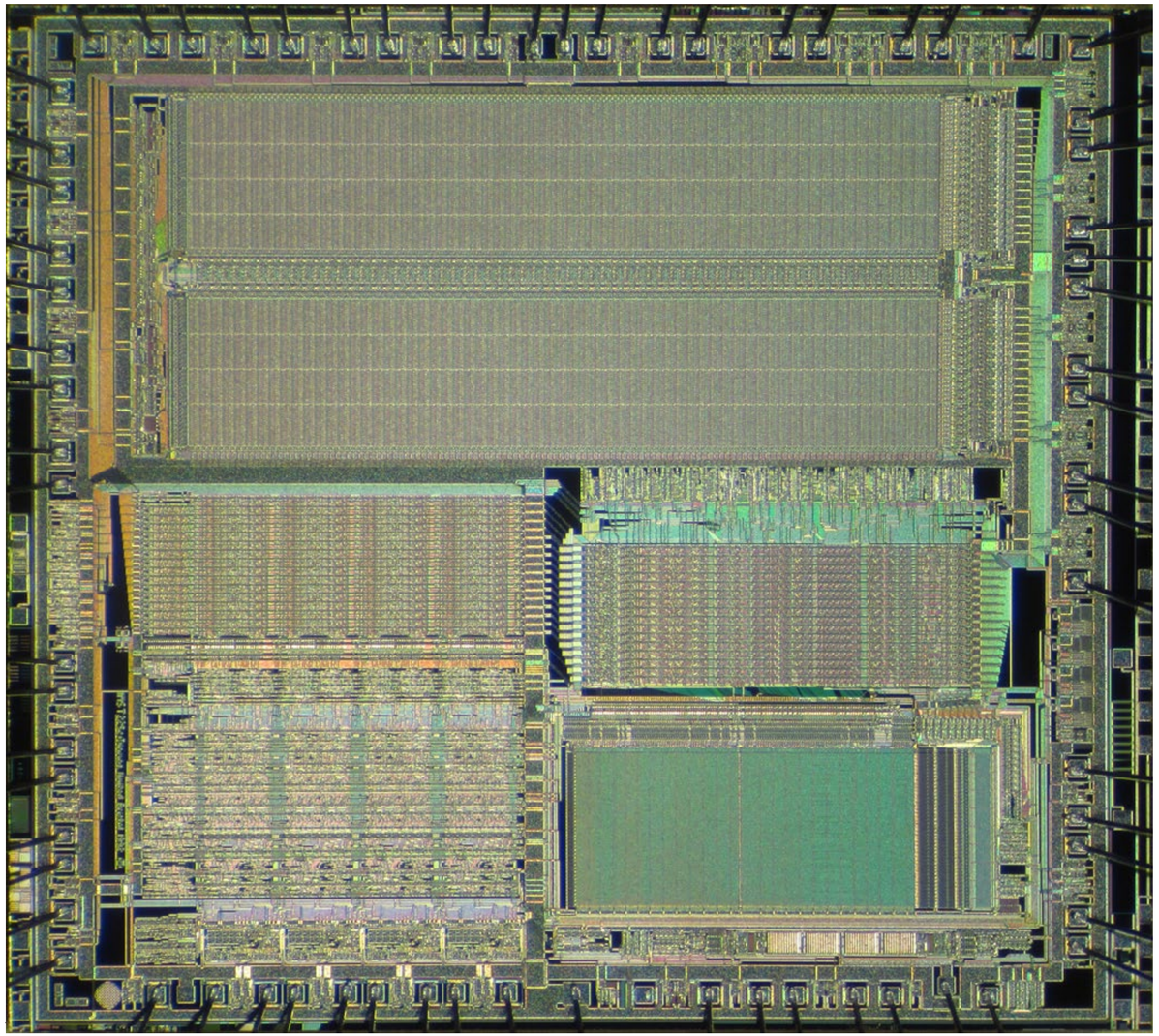
CEO of Weatherden, Emma brings extensive experience in clinical development and biotech company creation along with her knowledge of discretionary fund management gained from working as part of the venture team at SV Health Investors.



Catherine Fletcher, PhD
Associate

Along with her excellent scientific credentials, Catherine brings a wealth of experience from her academic career and a background in operations of early-stage companies.

Below: The INMOS Transputer
Credit: Pauli Rautakorpi CC



Building on a Legacy of Innovation

Professor David May

Professor David May, FREng FRS

The report, Centre for Cities + McKinsey: Industrial revolutions: capturing the growth potential identifies High-tech and ICT South West as one of twelve globally significant and fast growth UK clusters. The cluster generates £4.8billion GVA and employs 69,000 people. 'A diverse combination of electronics manufacturers, animation and computer graphics firms, digital start-ups, and university spin-outs sustains this well-established but not well-known cluster.' Three organisations played a major role in the formation of the cluster: the microelectronics start-up Inmos, the information technology company Hewlett Packard and the BBC.

The Inmos office opened in Bristol on December 4th, 1978. This was the starting point for Bristol's microelectronics industry, leading to the development of the Inmos Transputer, the first microcomputer designed for parallel computing. It was used by thousands of researchers and students around the world. It was used both in high-performance computers and consumer products; over 1 billion products incorporating the Inmos technology were shipped. The many highly skilled technologists who joined Inmos went on to attract investment to form new companies and enabled the region to attract global technology companies such as Infineon, Broadcom and Cray.

Hewlett Packard opened its centre in Bristol in 1983, initially manufacturing computer peripherals and subsequently expanding into software development and research. Like Inmos, Hewlett Packard attracted many highly skilled technologists who went on to form new companies such as IMDb and enabled the region to attract investment from global technology companies such as Oracle.

The BBC established its Natural History Unit in 1957 and resulted in Bristol becoming the global capital of natural history filmmaking with a rich cluster of independent production companies. Aardman are in Bristol because their first professional commission in 1976 was for the Take Hart series which put Morph and friends on screen for six years. As specialist areas grew, the opening of hubs like Watershed in 1982 created a space for interchange and profile raising. Digital innovation accelerated cluster development through the 00's as arts and technology fused, giving rise to a diverse range of SME, micro and freelance creative enterprises, interconnecting networks of talent, ideas and disciplines with international reach and recognition.

Towards 2000, there was increasing engagement between the cluster and the region's universities, leading to collaborative projects including technologists, artists, researchers and students; obvious examples were the Bristol Creative Technology Network and Mobile Bristol project. Government funds including the Science Enterprise Challenge and University Challenge Funds provided support for university entrepreneurship and led directly to the SETsquared incubator (now part of Engine Shed) which has enabled and assisted many new ventures. More recent support for innovators and entrepreneurs includes the Pervasive Media Studio, the Bristol Robotics Lab, the Bristol Games Hub and the Quantum Technology Enterprise Centre. This has provided the launchpad for startups such as XMOS (and spin-out Graphcore), OpenBionics, Ultraleap and Plimsoll Productions.

Science Creates brings a new component to the Cluster: Science. No longer do science start-ups have to look elsewhere. The deep science IP of the universities and their graduates can take root here in Bristol. And as the activities grow they will combine with existing strengths in technology and arts and enable new areas of innovation and entrepreneurship.

Science Creates and its journey towards deep tech will change Bristol as much as Inmos, Hewlett-Packard and the BBC. The brightest entrepreneurial scientists are being attracted here, and once here they will stay.

'Science Creates and its journey towards deep tech will change Bristol as much as Inmos, Hewlett-Packard and the BBC. The brightest entrepreneurial scientists are being attracted here, and once here they will stay.'

A Vision for Bristol

Bristol's Global Ambition

Professor Hugh Brady, Vice-Chancellor and President at the University of Bristol

The University of Bristol is ranked among the world's leading research-intensive universities. Our research has global academic impact, and our researchers are amongst the most cited in the world. But we want our research to have economic and social impact too.

As an institution, we strive to embed entrepreneurial thinking in our staff and students – to be a beacon of good practice in innovation and enterprise, and a sector leader in terms of our ability to establish and maintain productive collaborations that benefit us all.

This ambition is personified by the strength of our partnership with Unit DX. It has been tremendously exciting to be part of Unit DX's success story. I distinctly remember walking around Unit DX with Harry Destecroix, its CEO and Co-Founder, as the finishing touches were being put to the new facility – itself striking for its innovative design. The ambition was palpable and infectious!

Over the ensuing three years, Unit DX has had a profound impact on Bristol's innovation ecosystem, helping to foster an environment that supports scientists, engineers and entrepreneurs to transform cutting-edge research into next generation technologies and applications.

One of the first companies to move to Unit DX was Ziylo – a University of Bristol spin-out whose struggle to find lab space inspired the creation of Unit DX. In 2018, Ziylo was acquired by Novo Nordisk in a staged deal worth a potential $800 million. The sale has put Bristol on the map and attracted substantial additional investment to the sector.

This was a huge success for the Ziylo team, and it was by no means the only such success to emerge from Unit DX. Today, 60 percent of the companies it hosts are University of Bristol spinouts. Their future success is also a success for our city, and for the University's drive to maximise the impact of our research.

It also supports the University's commitment to delivering public good for the people of Bristol, including contributing towards our city's economic health and prosperity.

Looking to the future, if our city is to compete successfully on the global stage, it needs a step-up in investment and innovation capacity. This means building on the success of initiatives like Unit DX to bring scientists, engineers, entrepreneurs and investors together, harnessing our city's wonderful diversity, stimulating more enterprise activity and supporting new business creation.

The challenge now is to continue nurturing a supportive environment that attracts the best talent, facilitates new forms of partnership between industry and academia, sparks new conversations and ideas, and joins up our region's existing strengths and innovation capabilities so that, collectively, they achieve global significance.

The University's new Temple Quarter Enterprise Campus, sitting at the heart of the Temple Quarter regeneration area, will be geared towards helping the city achieve these objectives, and helping us to reimagine our future as one of the world's great civic universities.

Together with Science Creates, we will enable new ideas to flourish, support innovation at scale and help our city realise its potential as a global leader in science, research, innovation and enterprise development.

It's been an exciting five years and much has been achieved. As we start the next phase of our partnership, I have no doubt it will continue to go from strength to strength.

Creating Science with Impact

About Our Home for Innovative Science and Engineering Companies

Since Unit DX opened its doors in 2017, our members have been responsible for a portion of deep tech capital raised at seed level in the South West of England. Our members contribute to tackling global challenges by, for example, developing next-generation battery technologies, targeted therapeutics, and alternatives to broad spectrum antibiotics. Together, we support around 145 scientific sector jobs in the West of England.

In the last three years Unit DX has supported 57 different member companies, 89% of which are still active.

The past year I've been delighted to see some of our members take the next step of their business journey and move into premises of their own. In August 2019, Inductosense expanded into their own R&D and manufacturing space a mile down the road after nearly two years of calling Unit DX their home. After a 16 month residency, the GM Scientific Team secured a unit just outside Bristol where they've created their own lab to scale up production. It's great for us to see our member companies grow and it showed us we needed to develop more space to house growing companies.

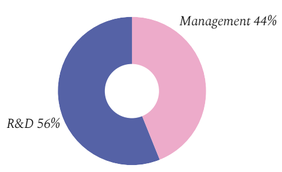
Recently our network has expanded further with more commercial partners joining our community to support our members. We're very thankful to GreenJay for providing regular one-on-one HR sessions and group-focused team management sessions. GrantTree have delivered quarterly seminars providing expert advice on how to write successful Innovate UK grant proposals. They join our long-term commercial partners VWV (legal), HGF (IP), Corrigan (Finance) and Hayes Parsons (Insurance) who collectively provide the services our growing companies need.

This year's global health pandemic has shaken every industry and forced companies to reassess the way they work. The collective response to this from our members has meant that Unit DX has been able to remain operational throughout, obviously with a number of changes put in place to ensure the safety of all that work here. The adoption of new ways of working and the push for new technologies, specifically at this point vaccines and treatments for SARS-CoV-2, re-emphasises the critical importance of appropriately funding scientific R&D.

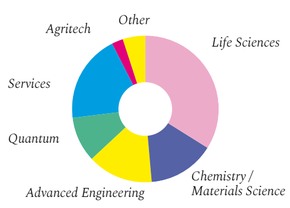
We're proud to provide the facilities and sector specific services that our members need hand in hand with potential investment opportunities as Science Creates. When these three elements combine with our members' big ideas, we create a culture and environment that ensures the big challenges the world faces can be addressed head on.

Ashley Brewer PhD
Centre Director, Science Creates Incubators

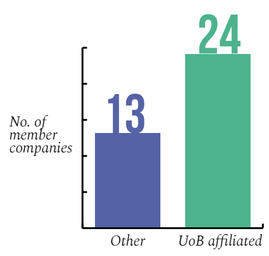
Ashley works with early stage, start-up and University spin-out companies to help them realise their business ambitions. Ashley also oversees Science Creates facilities and health and safety.



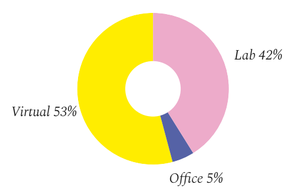
145 Jobs at Unit DX



37 Companies at Unit DX



Unit DX has a strong partnership with University of Bristol.



Membership Breakdown

'Our member companies are tackling big global challenges.'

Launching Unit DY

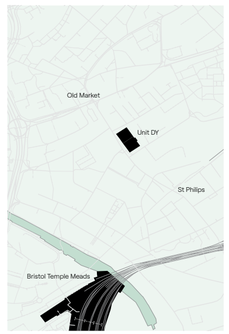
Old Market, New Tricks - Bristol's Scale-up Space for Growing Deep Tech Businesses

Our second facility, Unit DY, which began construction in November 2020, will open in 2021 and provide 30,000 sq ft of R&D, office and events spaces, located in Old Market, east of Bristol City Centre. The new facility will combine purpose-built laboratories, flexible offices, and cutting-edge instrumentation to create a workplace designed to support creative scientific ventures.

This project will allow for the expansion of Bristol's deep tech ecosystem. More and more science companies are forming in Bristol and Unit DX is bursting at the seams. We all know that these companies need lab space to move their businesses forward, and rely on specialist equipment to undertake their important work.

'We consider this to be an exemplary understanding of how the community-based plan can play a constructive role within shaping such a proposal and help meet some of the local aspirations.'

Old Market Community Association



Patrick Fallon, ARB RIBA
Lead Designer, Science Creates Incubators
Architect by day, rapper by night; Pat is driven by the idea of shaping a future for Bristol that involves meaningful buildings and playful spaces that benefit local communities, and add to the cultural history of the city.

'The emergence and growth of central, city centre innovation locations like Unit DY is a trend that is providing exceptional opportunities for a new generation of entrepreneurs.'

Jim Duvall, Non-Executive Director of the UK Science Park Association

The day the Science Minister visited, and we announced the partnership with University of Bristol and Research England to deliver a second building, was the day that Unit DY started to feel real. Since then it has been a slog, but as a team we have been committed and dedicated to get the project over the line.

The new site came up after a long search for suitable commercial property around the city centre. Over a period of two years and seven sites negotiations, we started to wonder if it was not meant to be. Then we learnt that Spicers, a stationary wholesaler based in a 1980s warehouse, were moving out of Old Market. We had often cycled past it and thought that it would be an ideal spot to convert into labs. Fast forward 12 months we have now secured the site, signed a contract and began construction.

Old Market is a part of town rich with history – the site of the city's oldest market, and the world's oldest court, the 'pi poudre'. Formerly outside the city walls and jurisdiction at east gate, the area was inhabited by outlaws and squatters. A lot has changed since then, and today it has a strong community voice, is a conservation area with many architectural gems, and a vibrant community, all of which make it a uniquely vibrant and inclusive part of the city.

From the outset, we wanted to complement the community vision of the area, and took on board the Old Market Community Association's aspirations of opening up the midland road façade; a gigantic 80m windowless brick wall. We've put the front entrance there, facing the city with large windows and a social area to create an active street frontage. OMCA said: 'We consider this to be an exemplary understanding of how the community-based plan can play a constructive role within shaping such a proposal and help meet some of the local aspirations'. We received planning in seven weeks and six days, which must be a world record, and showed that the city supports the idea of 250 scientists who work in synthetic biology, AI and quantum entanglement moving in.

The plan is to subdivide the three-bayed warehouses into 10,000 sq. ft. of bio and engineering labs, 10,000 sq. ft. of office, and 5,000 sq. ft. of meeting space. On top of that, we have indoor and outdoor social areas, an event space and a dedicated outreach lab for schools. The location of table tennis arena is being finalised, but staff wellbeing is important, and I will ensure it is squeezed in!

Unit DY will add to Bristol's abundant appeal and provide more reasons for scientists and innovators to either stay following university or to come to live and work here. The new building will increase the available commercial lab space in the wider Bristol area by 82%, and the city of Bristol by 160%.

Jim Duvall, Non-Executive Director of the UK Science Park association said 'The emergence and growth of central, city centre innovation locations like Unit DY is a trend that is providing exceptional opportunities for a new generation of entrepreneurs'.

Shout out to:

The University of Bristol
Research England
S.A.C Construction
Quartz Project Services
Nash Partnership
Oxford Architects
DW Consulting Engineers
Box Twenty, Ambivent & SEC
Cook Brown
Tenos
Russel Property Consultants
VWV
TRWP
UWE Architecture Department

Charlie Proctor
COO, Science Creates Incubators
Charlie is a teacher, educator, and leads the Science Creates Outreach programme. She is passionate about creating real life learning experiences. Charlie says: 'Everything we do is about creating paths for the scientists of the future.'

Inspiring Science

Bringing the Community into Science Spaces

1. What We've Done

- Hosted over 1,500 local school children at Unit DX
- Worked with 35 local schools and local community groups
- Conducted over 145 hands on experiments with children
- Launched the Unit DX Juniors newsletter for learners in lockdown
- Presented our outreach programme at a Parliamentary event
- Become a 'second home' for science education

2. What We'll Do

- Build a dedicated 'Learning Lab'
- Create an inclusive open space for science
- Remove barriers to people accessing real life science
- Create further links with our local community
- Build on our education relationships and partner with schools

Our new location, Unit DY, will host a dedicated outreach space capable of welcoming a class of learners. This new space will create a unique learning environment with immersive tours, hands-on workshops and interactive lessons with scientists. We will continue to put young learners in the heart of our functioning science incubator, where they can be inspired by science entrepreneurs working to improve healthcare, quality of life and the environment around us.

Children will be able to ask scientists questions, and be propelled into the centre of the global conversations at the heart of science today. We want them to make discoveries, challenge ideas, learn what it's like to be a scientist and view the world with new eyes.

Our outreach work is core to our values and inspiring the next generation of scientists is high on our agenda. With a background in primary education, in my career as a teacher and as an educational consultant, I have worked with many schools across Bristol. When taking classes on trips, I noticed that real life experiences were almost always the most valuable and rewarding. Hands on learning sparks interest in a subject in a special way; you see eyes light up with excitement as learners find their feet and become more aware and confident.

Classes get real life learning experiences when they visit the Science Creates labs. Visitors experience a tour of the labs and meet the companies working there, they put on PPE to try experiments and take part in live discussions with scientists.

From the get-go, I was aware that our Unit DX School Days had a ticking clock attached. When all the labs were filled with member companies, there was no free space available for outreach, so I took the sessions 'on the road', visiting schools with a group of scientists each month, to continue to inspire.

Covid-19 presented the next obstacle for our outreach programme as schools closed and the world adjusted to more remote ways of working. This was a hard time for teachers and parents, juggling remote working and home education. We wanted to continue to provide rich, engaging opportunities for science learning and needed to find a new way to do this. In April 2020 we launched Unit DX Juniors, a weekly science newsletter jam packed with activities for school aged learners. The idea was to help parents and teachers bridge the gap between school and home learning. Our newsletter and national curriculum-linked learning plans bring science into everyone's homes, and fill the gaps that might have appeared with lessons at school on hold.

Going forward, Unit DY will have a dedicated outreach space; nicknamed 'The Learning Lab.' It will be an open inclusive laboratory dedicated to welcoming the community into the building, and will host school visits, outreach activities, courses and will connect us to the outside world. Built and fitted just like the other labs, it will create a unique learning environment.

Openness and inclusivity are key to all that we do at Science Creates and our lab spaces are no different. We look forward to strengthening our links with local schools in the area, including St Philips, Market Gate, Easton, Lawrence Hill and St Pauls, along with community groups in the area.

We can't wait to welcome everyone into our new space.

'Unit DY will have a dedicated learning lab which will be open, inclusive and dedicated to welcoming the community into the building, and will host school visits, outreach activities and courses to connect us with the outside world.'

Cytoseek

Developing the Next Generation of Cell Therapies

We sat down with Carolyn Porter, CEO of Cytoseek to discuss how their technology is aiming to improve therapies for cancer.

What are the challenges that you are looking to overcome or solve with your work?

We are seeking to unlock the potential of cell therapies by applying our innovative technology to overcome their current limitations in treating patients suffering from cancer due to solid tumours. These therapies are currently limited in their effectiveness by the hostile environment in the tumour. Our technology is seeking to enhance the effects of cell therapies when they are at the tumour site and decrease the suppressive effect of the tumour environment both combining to drive development of new therapies for cancer patients.

What's the driving force that gets you out of bed every day to do what you do?

The biotech industry is like no other. You are pushing forward pioneering innovations whose ultimate objective is to save patient lives by developing new therapies. There are few other industries where your success will be ultimately measured by this impact. This is a major motivator for me. I am also motivated by enabling the successful translation of early stage innovations particularly those emerging from the University ecosystem where I have operated on various sides of the table in the most recent part of my career.

How do you think what you do can make the world a better place, improve industries or even lives?

If our technology enables cell therapies to treat patients suffering from cancer due to solid tumors where they have to date been unsuccessful then our impact will be saving patient lives.

What made you want to set up your business in Bristol?

I have operated in the golden triangle for much of my career to date and joined CytoSeek in early 2020 when the business had spun out of Bristol University. The emerging Bristol ecosystem both in terms of companies and wider stakeholders played a role in attracting me to the opportunity. The people, their conviction and the vision behind Science Creates convinced me that Bristol has the potential to rival other technology hubs in the UK and worldwide.

What position were you in before you started working with Cytoseek?

I was previously CBO of an Oxford University spin-out company and prior to that worked in several different roles including in University technology transfer at Oxford, in Business Development in big pharma (Novartis) and biotech (Chiron) and in Corporate finance at Ernst & Young. I have therefore sat on several sides of the table concerning commercialisation of exciting innovations.

Why is Science Creates is the right place for you to be?

Individual companies need a functioning ecosystem to thrive and grow and I believe as part of the ecosystem we all need to play a role in delivering its success. I see Science Creates as the glue that will enable us as individual companies to succeed by providing not only an incubator but also, investment and support and a mechanism to share our experiences for the benefit of the ecosystem stakeholders.

What element of the ecosystem attracted you?

As a young company at the start of its development trajectory we are availing of multiple elements on offer via Science Creates including incubator facilities at Unit DX, its associated business support and investment capability. The combination makes the Science Creates offering more compelling than organisations who focus on providing one element of the package.

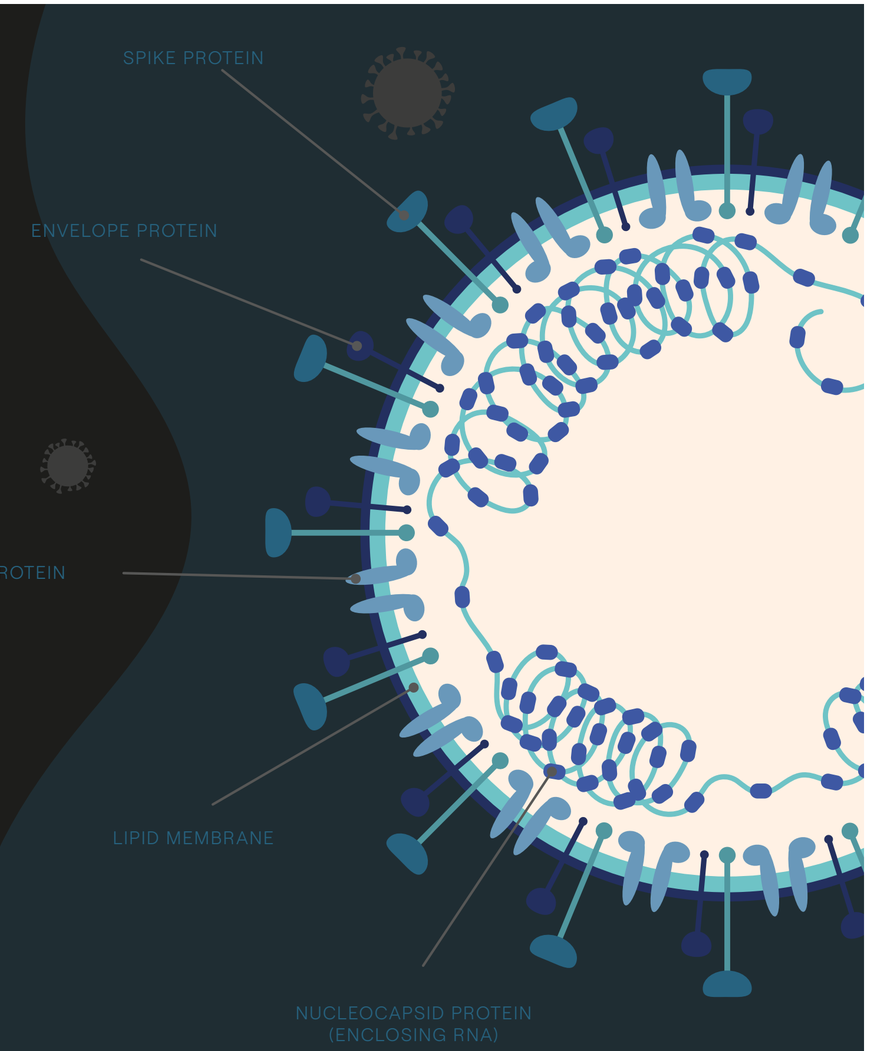
What is the future vision of your business?

We want to get our technology into cancer patients who are currently underserved by existing treatments and also work with partnering organisations to make their therapies better. Along the way we want to create value for our shareholders that can be recycled into the ecosystem both in terms of finance and in fostering talent that can drive future generations of new companies.

What important lessons have your learnt - whether science based or on the entrepreneurial tip?

I have worked in the biotech sector for a significant part of my career to date and this is a high risk, high reward sector where in addition to great science, many other attributes are required to succeed. Two of these I have learnt are particularly required in the current COVID era – tenacity and resilience.

Bristol's Response to COVID-19



Discover More About the Scientists Working to Develop Vaccines, Treatments and a Better Understanding of the Virus

There's a lot that we still don't know about SARS-CoV-2. Researchers in Bristol responded quickly at the start of the pandemic, pooling their collective knowledge, research and equipment to learn more about the virus and look at ways to develop new vaccines and treatments for it. They have made some incredible advances. We spoke to some of the key players about what's been happening behind the lab doors and in hastily-prepared home offices across Bristol.

Bristol UNCOVER

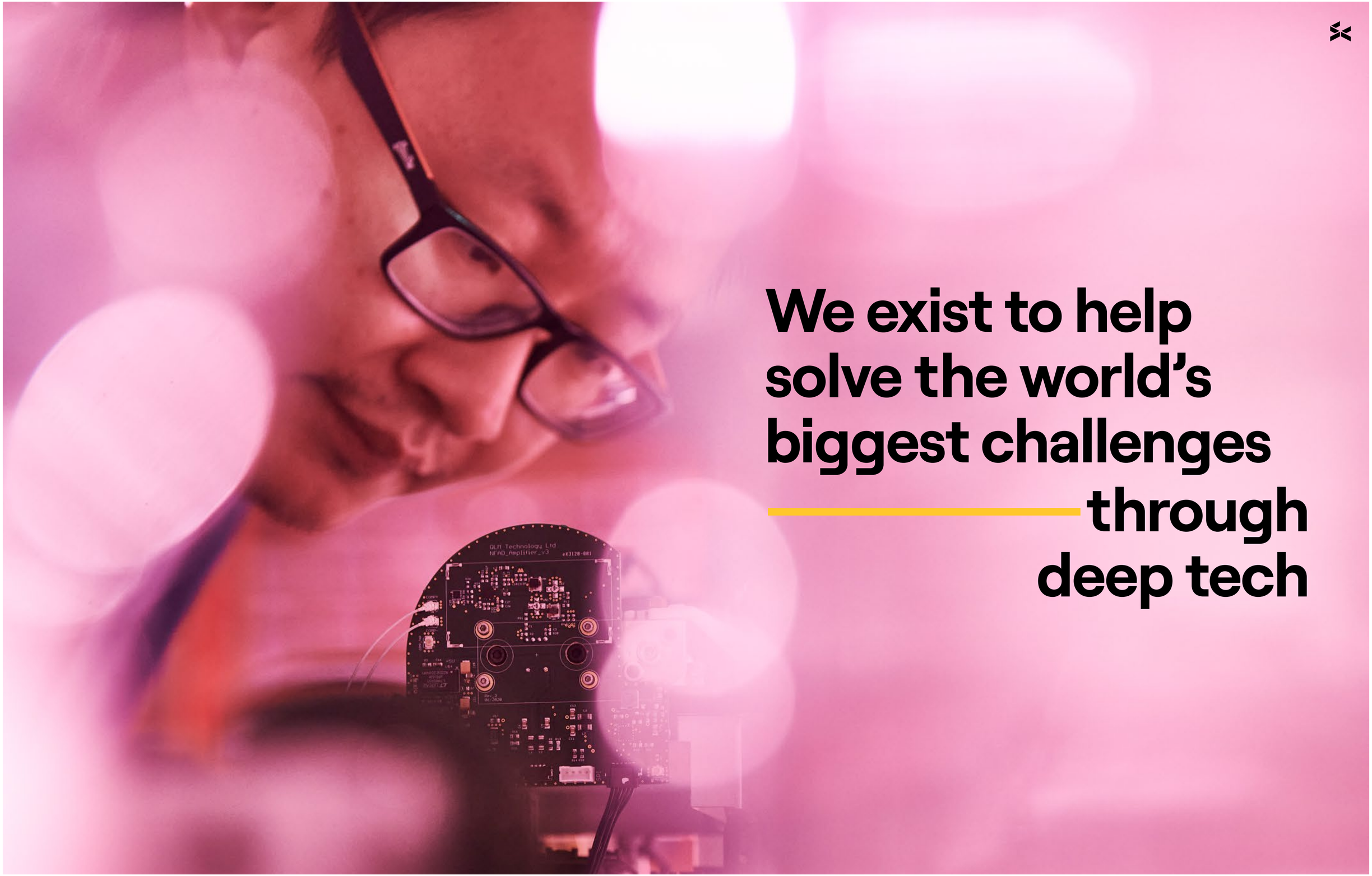
In March, concerned researchers in Bristol came together to form the Bristol University COVID-19 Emergency Research Group (UNCOVER). Initially they held virtual 9am meetings seven days a week to answer each other's questions and identify opportunities to work together. The group is still growing and evolving, and it isn't exclusive: virologists, immunologists, clinicians, aerosol scientists, mathematicians, and more disciplines are represented. UNCOVER is being coordinated by Professor Adam Finn, Director of the Bristol Children's Vaccine Centre, who has worked on vaccine trials for nearly 30 years. He discussed Bristol's response to COVID-19 with us over the phone:

'I've always known that the University of Bristol is a friendly environment: we prefer cooperation over competition, but the response to COVID-19 has surprised me. I thought I'd met everyone I'd want to work with, but the crisis has flushed us all out and brought us together – I've even discovered new collaborators in my own building! I'm proud of how many interdisciplinary projects we've got going, with goals that individual researchers couldn't reach alone. It's only by working together that we'll be able to find solutions.

'Bristol is just one part of the team effort across the world, but we are well-placed to contribute. Andrew Davidson and David Matthews were some of the only people in the world studying coronaviruses before the pandemic, and their experience is critical. The University of Bristol has a powerful synthetic biology capacity, which has allowed us to produce the biological materials required for coronavirus studies around the country. We're strong in both clinical and lab research, and the fluent interface between the two has accelerated our understanding of the virus.

'Bristol also has a wealth of experience in running vaccine trials, and we're one of five centres involved in testing the Oxford vaccine candidate on healthy volunteers. If you'd told me a year ago that we'd be able to test a vaccine candidate in 9,000 people just six months after discovering a virus, I wouldn't have believed you but we're already beginning to understand the body's response to this promising treatment: keep an eye out for details in The Lancet soon.

'I'm an optimist. Our species has been so successful because we're adaptable and resourceful. That we've managed to control the spread of SARS-CoV-2 is a testament to those qualities, and now the best minds on the planet are focused on beating this pandemic. But we can't be complacent. Experts were warning for decades that a crisis like this was coming, but we weren't ready, and precious time was lost. We can't be caught on our heels next time.'



We exist to help solve the world's biggest challenges through deep tech

Cryo EM

SARS-CoV-2 is just one member of a family of coronaviruses, most of which are relatively harmless. Several features of SARS-CoV-2 have combined to make it particularly deadly:

- High infectivity – it easily spreads between people and establishes new infections
- Severe pathology – it produces a disease with serious symptoms, a high mortality rate, and long-term health effects
- Broad tissue tropism – it can infect many different types of cells and tissues in the body

How does the virus do it? A key idea in biology is that the shape of a molecule (its structure) controls what it can do (its function). Scientists especially want to know more about the SARS-CoV-2 spike protein, which allows the virus to invade human cells, so researchers at the University of Bristol decided to study its structure using cryogenic electron microscopy (cryo-EM).

Cryo-EM is a powerful technique that won the Nobel prize in chemistry in 2017. A very pure solution of a particular protein is transferred to a metal mesh and rapidly frozen to -190 °C. A beam of electrons is then fired at the mesh, projecting an image of the proteins onto an electronic detector. Because the wavelength of electrons is much shorter than that of visible light, it produces much higher resolution images than a light microscope, revealing the fine details of molecules.

Professor Christiane Berger-Schaffitzel is the academic lead for the state-of-the-art £3.7 million GW4 cryo-EM facility based at the University of Bristol. As part of UNCOVER, her group produced a new structure of the SARS-CoV-2 spike protein. Some of the greatest advances in science owe a lot to serendipity: microwaves, penicillin, and LSD to name a few. It just so happens that to produce the spike protein [for structural studies] Professor Berger-Schaffitzel uses a media, a kind of salty soup that cells like to grow in, that contains cod liver oil. Cod liver oil contains lots of different fats, but out of this mixture, the spike protein specifically binds linoleic acid. In fact, it manages to hang on to this fatty acid throughout the harsh cryo-EM sample preparation process, which suggests that this interaction is important.

None of the previously published structures of SARS-CoV-2 include linoleic acid, but when the spike protein binds this molecule, its shape changes in significant ways that may affect how the virus binds and infects cells. Disrupting the interaction of the spike protein and linoleic acid could be a good target for drugs that fight SARS-CoV-2.

Professor Berger-Schaffitzel explains: 'Once inside human cells, coronaviruses change the ways that their hosts use fatty acids. This can interfere with communication between cells, leading to inflammation and damage to the body, especially to the lungs. There's evidence that linoleic acid is at the 'crossroads' of the different biochemical pathways that coronaviruses alter, so the ability of SARS-CoV-2 to tightly bind this molecule could be a major reason that this virus is so much more dangerous than its relatives.

Imophoron

Imophoron is a start-up based at Unit DX in Bristol, founded by Frederic Garzoni and Prof Imre Berger using technology developed at an institution in France.

The best way to beat viruses is by vaccination. The World Health Organisation estimates that vaccination saves 2-3 million lives every year. Vaccines rally the body's immune system to prevent viral infections. Importantly, being vaccinated doesn't just protect you – it protects your community. If you can't be infected by a virus, you also can't pass it on, which protects the vulnerable people around you from infection. As more people in a population are vaccinated and become immune, the spread of a virus is slowed, and eventually the disease can be eradicated.

As of the 12th of November, the World Health Organisation reports that 48 COVID-19 vaccine candidates are in clinical trials, and 164 are at preclinical stages. Excitingly, one of these vaccines is being developed by Imophoron at Unit DX. Imophoron was founded by Frédéric Garzoni and Professor Imre Berger in 2017 to develop the ADDomer©, a novel vaccine platform for emerging infectious diseases and unmet medical needs. The ADDomer is based on a single component of the human adenovirus that spontaneously forms a superparticle.

During an infection, the immune system recognises antigens on the invading pathogen and produces antibodies to specifically bind them, neutralising the pathogen. But this process is slow, and some diseases can kill before the immune system is up to speed. That's where vaccination comes in; we expose the immune system to antigens in a controlled and safe way so that it makes effective antibodies that will protect against the real disease in the future.

There are many types of vaccine. Some involve weakening a virus so that it will only cause a mild infection, although there's a risk that the virus may 'reactivate' and cause serious disease. Others present just the viral antigens to the immune system but require additives called 'adjuvants' to activate the immune system; some people refuse vaccination because of concerns about adjuvants. Imophoron's technology is totally synthetic, so it cannot become infectious, and it doesn't require adjuvants. The ADDomer can be easily and rationally engineered to present different viral antigens on its surface, allowing Imophoron to quickly react to new diseases.

Imophoron's CEO Frédéric Garzoni explains: 'As soon as the pandemic hit we knew we had to redirect our research towards a COVID-19 vaccine. We believe that our platform can revolutionise vaccine development, and we couldn't leave it on the shelf while this crisis was unfolding across the world. We've been working around the clock, our first vaccine candidates were ready for preclinical trials just weeks after the SARS-CoV-2 genome sequence was released, which is unprecedented. Now we need to push these trials forwards and prove our candidates are safe and effective. There's no time to lose.'

A key advantage of the ADDomer is its incredible stability. Most vaccines have to be kept between 2-8 °C to remain effective, so a 'cold chain' must be maintained all the way from manufacture to injection. A power outage anywhere along that journey can break the chain and leave a vaccine unusable, but just one-tenth of the poorest countries' health care facilities have reliable power supplies. Imophoron's vaccines can be stored at room temperature as powders, so they don't rely on the cold chain. This may make their vaccine easier to supply to low- and medium-income countries.

Imophoron has designed several vaccine candidates that incorporate specific regions of an important SARS-CoV-2 component called the 'spike protein'. This protein protrudes from the viral surface and binds human cells, allowing the virus to invade. The company's researchers hope that by only presenting the most important parts of the spike protein, their ADDomers will induce a stronger and safer immune response compared to other vaccine candidates.

Imre Berger, Director of Bristol's Max Planck Centre for Minimal Biology and cofounder of Imophoron, said: 'We still have a long road ahead, but COVID-19 research is accelerating at a breathtaking pace. It usually takes a decade to deliver a vaccine, but so many barriers to innovation have fallen recently. Our understanding of this virus is improving every day, and we've been able to leverage this knowledge using our expertise in synthetic biology to develop several promising vaccine candidates. Most vaccine candidates don't make it, but we need as many in the race as possible to be sure that some make it over the line. Science always delivers: we have to keep working and hoping.' Harry Destecroix, founder of Science Creates and an investor in Imophoron, said: 'We're so proud of the incredible effort Fred and the team have put towards fighting this global pandemic. During the peak they were working seven days a week not only accelerating their vaccine platform but also providing key materials for the wider research effort at UNCOVER'

'We have so much more to learn about SARS-CoV-2, but during this crisis we're seeing that when we focus and work together, we can expedite that process. It doesn't hurt to have some good luck too! We're grateful that we can contribute, and excited to find out what surprises the future holds.'

SARS-CoV-2 is a virus: an infectious obligate intracellular parasite. It replicates inside human cells, gaining an advantage at their expense. Viruses rely completely on their hosts – they cannot reproduce on their own – and they infect the body, producing the symptoms of disease.

There's some debate among microbiologists as to whether viruses are technically alive, or what 'alive' even means. Outside of their hosts, viruses exist in a dormant state, waiting until they next encounter a cell to infect. Once they do, viruses use one of the proteins on their surface to specifically recognise and bind to a protein on the cell. The virus then enters the cell and falls apart, releasing its genetic material (DNA or RNA) which encodes all of the information needed to make new viruses and suppress the host's defences. The host cell's machinery is hijacked to read this viral 'code', and it produces many more viruses, which eventually kill the cell and are released from it.

The virus primarily attacks the lungs, and as the immune system tries to fight off the infection, it causes collateral damage: inflammation. Dead cells caught by friendly fire build up and form pus, which interferes with breathing and produces pneumonia. SARS-CoV-2 can also damage the brain, kidneys, heart, and liver, although we don't completely understand how this happens.

The fightback against COVID-19 has taught us many things and just keeping up with the breakneck speed of research being conducted is a challenge in itself. As we look towards a 'new future' it's important to reflect on what's been achieved and acknowledge the people working behind the breakthroughs. The progress that's been made shows the importance of collective endeavour and how a collaborative approach can accelerate our understanding and drive us all towards a brighter future.

	Antigen	Antibody
What is it?	A molecule that triggers an immune response	A large Y-shaped protein that specifically recognises the structure of an antigen and binds it
Where does it come from?	Anything that the immune system recognises can be an antigen: molecules on microbes, pollen, and even your own cells	Antibodies are produced by the white blood cells of the immune system

What is Deep Tech & Why Should You Care?

What is Deep Tech?

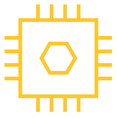
Biotechnology & synthetic biology - engineering biology by redesigning natural systems or building new ones.

Artificial intelligence (AI) - designing computers that can imitate human cognition to learn, recognise patterns, and solve complex problems.

Photonics & electronics - light generation, detection and manipulation, and its integration with electrical systems for sensing and communications.

Drones & robotics - automated and intelligent machines with increasing capabilities in surgery, home maintenance, delivery, and many other sectors.

Advanced materials - the design and discovery of materials with new properties, such as superconductors that power magnetic levitation trains in Japan.



Quantum computing - quantum theory describes the universe at (sub) atomic scales, and its key findings can be applied to the design of faster and more secure computers.

Deep tech is the next big thing. It promises solutions to the biggest problems the world faces today. According to research from Bristol Constulting Group ('The Dawn of the Deep Tech Ecosystem', March 2019) in 2018, nearly $18 billion was privately Invested in deep tech companies around the world, and this interest shows no signs of cooling off. BCG confirmed that investment in deep technology increased by over twenty percent every year to 2018, since 2015. Innovation based on genuine scientific advances, named after the long term research and 'depth' of expertise they're built on. Deep tech companies are disruptive because they have the power to create new markets. The Boston Consulting Group highlights three characteristics of deep tech start-ups: the potential for a big impact, the need for longer timescales, and higher levels of investment.

While the term is 'purposefully vague' because new technologies are emerging all the time, some sectors our outlined above.

But what is it, and why should you care? How will it affect the world you live in? In this article, we'll answer those questions and look at three real-world examples of deep tech companies.

It's important to distinguish between tech and deep tech. Most of the companies that come to mind when you think about Silicon Valley have been successful because they used existing technology to make new business models or move offline activities online. Spotify essentially 'rents' music to listeners so that they can access more music than they could afford to buy. Airbnb links people with spare accommodation to travellers looking for somewhere more interesting than a hotel. Neither of these companies made a technological leap, they found clever ways to reorganise people and resources. 'This is good news because it means that the underlying intellectual property is well-defined and difficult to reproduce, providing a competitive advantage.' By contrast, the foundation of deep tech companies is a scientific discovery. As Deutsche Welle puts it, most tech companies are 'reinventing the wheel', while deep tech 'makes wheels obsolete'. However, deep tech is also riskier because more money is required for R&D, and the road to market is often longer.

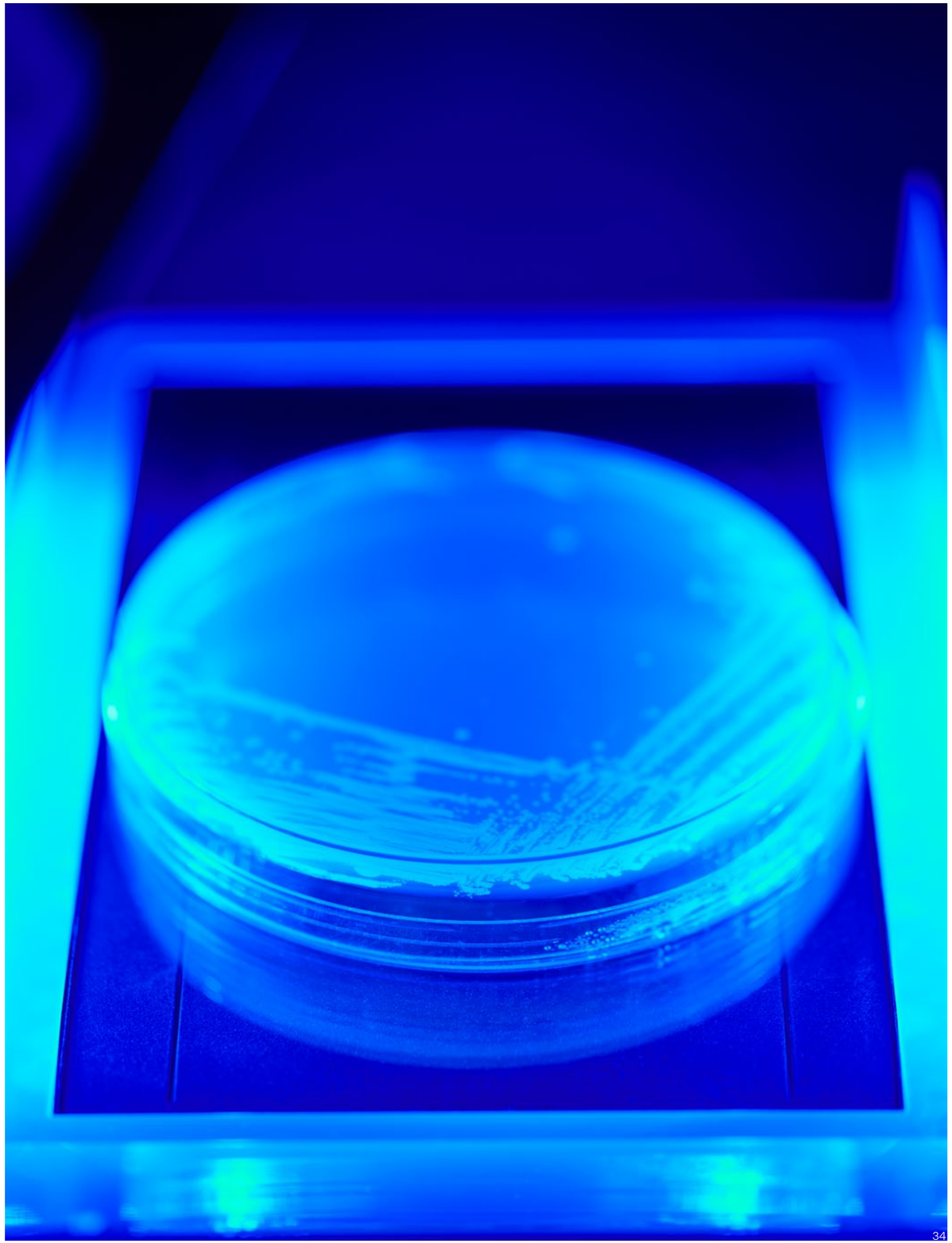
Why is deep tech important?

Analysts predict that a fourth industrial revolution is underway. The World Economic Forum defines it as 'a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres'. Today's deep tech companies are taking aim at global issues: our climate emergency, world hunger, and the future of healthcare for an ageing population. We've lived through three industrial revolutions, each powered by the deep tech of its time:

1760–1840: Steam and water power allowed the transition from hand production to mechanised factories, leading to an explosion in population growth.
1870–1914: Steel replaced iron, allowing for the expansion of railways. Electrification and the petroleum industry enabled mass production. Living standards and public health greatly improved in industrialised countries.
1969–2010: Computers, the internet, and robotics have allowed the digitisation of manufacturing. Far less human labour is required to produce flexible, customisable products economically.

Investors have already started to take notice. The Boston Consulting Group reports that between 2015 and 2018, nearly $60 billion was invested across seven deep tech sectors.

'This is good news because it means that the underlying intellectual property is well-defined and difficult to reproduce, providing a competitive advantage.'



Three Global Examples of Deep Tech Companies

Let's take a look at three start-up examples to illustrate how diverse and disruptive deep tech start-ups can be. In each case, the journey from invention to product took a considerable amount of time, but it's this long term approach that makes these companies so innovative.

1. Boston Dynamics

What do they do?

Boston Dynamics are world leaders in engineering and robotics design. The company captured the public imagination with its series of YouTube videos of its creations, including:Cheetah, which can sprint faster than Usain Bolt's world record pace, Atlas, a humanoid that can perform parkour, and SPOT, which can climb stairs, open doors, and stack dishwashers.

These videos tend to provoke a mixture of awe and terror in viewers. An episode of Black Mirror, the science fiction TV series, was inspired by Boston Dynamics and features murderous robot dogs that hunt down the last surviving humans. In July, a parody of Boston Dynamic's videos imagined a robot fighting back against its testers.

Robots do jobs that are too dirty, dull, or dangerous for human workers. They are 'man's tools for a better and less mechanical life'. However, robots still aren't mobile, perceptive, or intelligent enough for many tasks. These difficult design challenges are what Boston Robotics focus on.

The road to commercialisation has long been unclear for Boston Dynamics. This is often an issue for deep tech companies: because their technology is complex, it can be difficult to understand its value. Boston Dynamics' robots are so advanced that they have the power to create new markets, so they're leasing their first SPOT robots to development partners.

Timeline

1992 - Boston Dynamics spins out of the Massachusetts Institute of Technology
2005 - The company creates BigDog, a four-legged robotic pack mule funded by DARPA. The robot is intended to accompany soldiers on rough terrain, and it can carry 150 kg at 4 mph on inclines of up to 35 degrees.
2013 - Google X acquires Boston Dynamics for an unknown price.
2017 - The company is sold to SoftBank Group for an undisclosed sum.
2019 - Boston Dynamics launch their first commercial product, SPOT.

Time from spin-out to product: 17 years.

2. Folia Water

What do they do?

Folia Water is an advanced materials start-up based in New York. They make paper filters embedded with silver nanoparticles that kill bacteria in dirty water, providing access to clean water for pennies instead of dollars. TIME Magazine selected Folia's technology as one of the 25 best inventions of 2015.

Worldwide, two billion people drink water contaminated by human or animal faeces. More than half of the developing world's population is suffering from one or more diseases associated with unsafe water and poor sanitation. Every day, 6,000 children die of water-related diseases.

In 2013, founder Theresa Dankovich took her filter system around the world to test it against real contaminated water supplies. In South Africa, the team filtered water from a stream where raw sewage was regularly dumped and made it clean enough to drink. Folia spoke to local communities about their needs and refined their product accordingly. In 2014, they produced a book with 25 pages – each of which can be used as a water filter – with sanitation advice in local languages.

Folia's filters have a tremendous potential impact, they could make clean, safe water available to all. Their technology is based on a large body of academic work, and during its development, genuine scientific innovations have been made.

Timeline

2006-12 -During her PhD, Theresa Dankovich, now co-founder and CTO at Folia Water, designs a filter that can remove bacteria from drinking water.
2013-16 - Dr Dankovich continues todevelop her filters and tests them in the field.
2014 - In partnership with WATERisLIFE, The Drinkable Book is launched.
2016 - Folia Water is founded as a for-profit benefit corporation.
2017 - Folia officially launches their product to consumer goods distributors in low- and middle-income countries.

Time from prototype to product: 11 years.

3. Oxford Nanopore

What do they do?

Oxford Nanopore work at the interface of biotech, electronics, and chemistry. The company is one of only 77 tech unicorns (privately owned companies valued at over $1 billion) in the United Kingdom (Tech Nation Report, 2020).

Oxford Nanopore makes devices that can sequence DNA, the molecule carrying the genetic information that makes every living thing what it is. Scientists use DNA sequencing to understand diseases, evolution, agriculture, and crime.

DNA sequencing is slow, expensive, and requires specialist facilities. This makes it difficult for scientists working in dangerous or inaccessible places like jungles, deserts, and mountains. The expense is also a problem for researchers in low-income countries.

Oxford Nanopore's MinION sequencer is the size of a USB stick and weighs just 100 grams; a competitor, the Illumina MiSeq, weighs nearly 600 times as much and is bigger than a microwave. The MinION also costs just $1000, compared to $100,000 for the MiSeq.

Nanopore's mission 'to enable the analysis of any living thing, by anyone, anywhere' is as bold as it is disruptive. The growing 'DIY Biology' movement of amateur scientists wants to 'hack' biology in their own homes and make biotechnology open source to empower the public. Oxford Nanopore's technology is making this possible and raising lots of awkward ethical issues.

Timeline

1990s - Professor Hagan Bayley is studying alpha-haemolysin, the protein that will be engineered into nanopores.
1996 - Collaborators in the USA move single DNA molecules through nanopores. They recognise that 'with further improvements, the method could in principle provide direct, high-speed detection of the sequence of bases in single molecules of DNA.'
2005 - Oxford Nanopore is founded to develop an electronic single-molecule sensing system.
2015 - Their first product, the MinION, is made commercially available.

Time from idea to product: 19 years.

What Do Deep Tech Businesses Need?

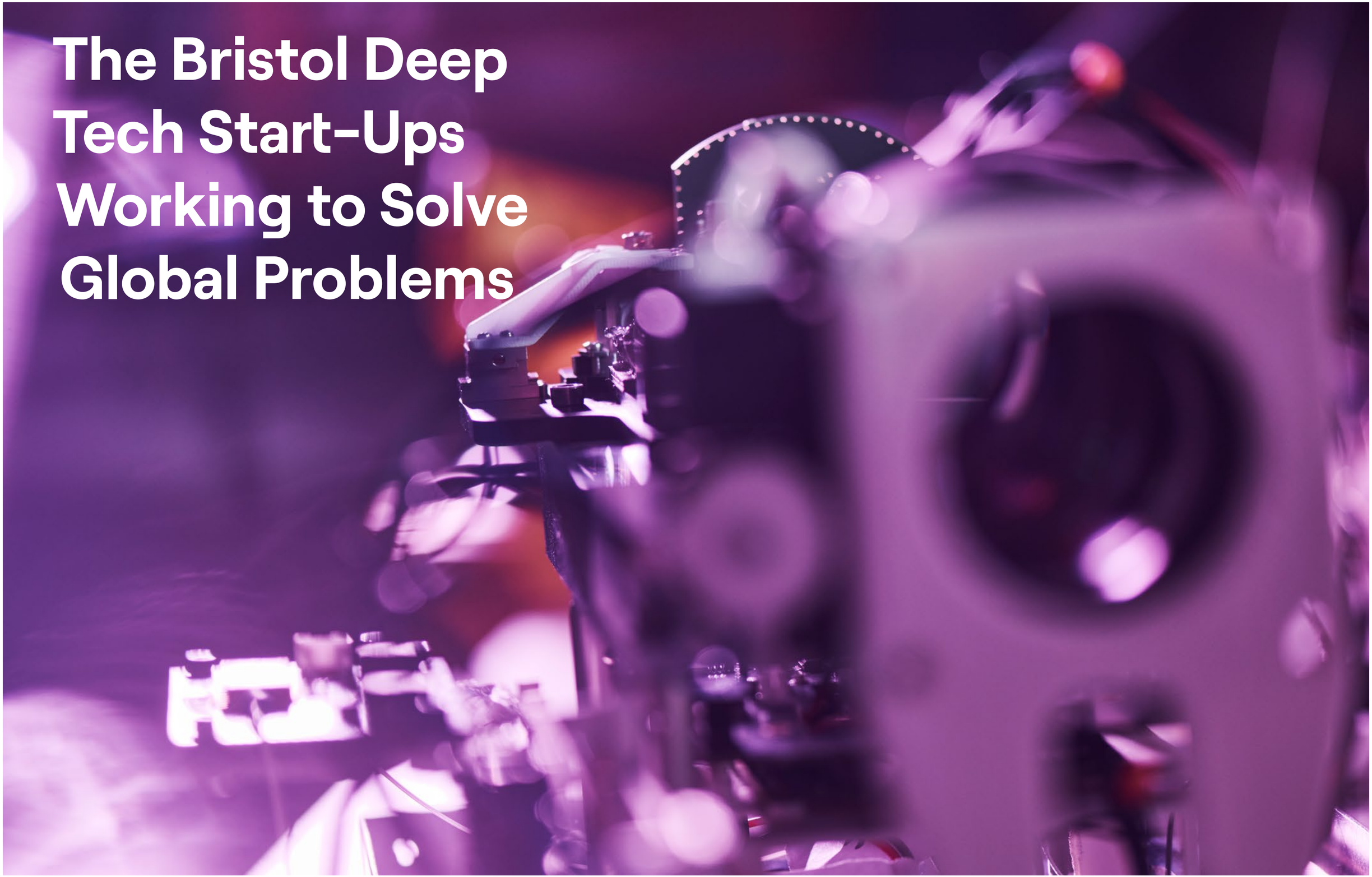
The Boston Consulting Group have identified six key resources that deep tech start-ups need:

- Funding
- Market access
- Technical expertise
- Business expertise
- Access to facilities
- Talent

Funding is the most important of these resources. Because deep tech is complex, it can be difficult for investors to see the value of a start-up and carry out due diligence, which means that deep tech companies are often undervalued. Small businesses can't meet all of their needs. Research from the World Bank has shown that to survive, start-ups need to be embedded within an innovation ecosystem; a network of people from universities, government, professional services, community groups, and investment firms.

Incubators are at the centre of innovation ecosystems, acting as the magnets that draw together the different resources that deep tech start-ups need. A 2019 Nesta report found that 73% of start-ups consider incubators 'vital or significant to their success'.

The Bristol Deep Tech Start-Ups Working to Solve Global Problems



Five Bristol Examples of Deep Tech Start-ups

Deep tech means revolution, not evolution. Where tech companies often use existing methods to solve existing problems, deep technology is based on years of research and development. In this article, we will take a look at the Bristol companies working to overcome the world's biggest problems. Step change, not small change. Deep tech is where seismic shifts in technology will come from such as new drugs, better batteries and quantum computers. Other examples include biotech, artificial intelligence, photonics and electronics, robotics, advanced materials and quantum computers.

We have seen that many venture capital (VC) funds are now making investments in deep tech start-ups, while established firms like Octopus Ventures have dedicated deep tech funds. These funds often focus on big problems like reducing climate change and addressing global healthcare challenges that can't be addressed with software alone.

1. Graphcore

AI on a chip

Graphcore are developing new chips for artificial intelligence (AI) and machine learning (ML). Started in 2016 by CEO Nigel Toon and CTO Simon Knowles, they are developing revolutionary silicon chips that aim to mimic the human brain's ability to process information. They pioneered a new process that reduces the computational power required by the chip by using 'less precise arithmetic', allowing more energy usage to run multiple tasks, simultaneously.

The company's first chip, the C2 IPU or 'Intelligence Processing Unit' was released in 2018, and the company has since become Bristol's first 'Unicorn' (a company valued at over £1bn). In February 2020 they announced that they had raised an additional $150m at a valuation of $1.95bn.

Herman Hauser, Co-founder of ARM Holdings and an investor in Graphcore, told Bloomberg News: 'This has only happened three times in the history of computers [CPUs in the 70s and GPUs in the 90s]… [Graphcore's] chip is one of the great new architectures of the world.'

2. Carbometrics

Glucose sensing

Carbometrics are working with global pharmaceutical partner Novo Nordisk to develop a smart insulin product, using a glucose binding molecule designed in Bristol. The smart insulin, if successfully brought to market, could help people living with diabetes to control their blood sugar levels more effectively, reducing the risk of dangerous hypoglycaemic episodes and long-term damage from high blood sugar.

Carbometrics was set up by the team who created Ziylo, after the Bristol start-up was sold to Novo Nordisk in 2018. The technology is based on research originally conducted by Professor Anthony Davis at the University of Bristol and developed further by the Ziylo (and subsequently Carbometrics) team. They are also looking at developing glucose monitors for people living with diabetes.

3. Rosa Biotech

The synthetic nose

Rosa Biotech are creating a 'synthetic nose' capable of detecting a wide range of compounds, including the faint chemical signatures produced by diseases. Inspired by dogs' ability to sniff out disease, their process combines an array of peptide barrels loaded with dyes, which are dislodged in unique patterns that are interpreted using machine learning. Where existing biosensors may suffer from only being able to seek out one compound at a time, theirs can be trained to recognise almost anything, providing potential benefits from everything from disease prevention to spotting counterfeit food and drinks.

The technology was developed in the lab of Professor Dek Woolfson at the University of Bristol and spun-out in 2019.

'Our mission is to enhance the materials we rely on every day with graphene, to help power the sustainable energy revolution.'

Sam Burrow, Co-founder, Anaphite

4. Anaphite

Graphene-based nanomaterials

Anaphite was founded by Sam Burrow and Alex Hewitt in 2018. The pair started the company after seeing significant commercial interest in a process that Sam had developed for creating graphene composites. Graphene is an incredibly strong and conductive material that received a lot of hype starting from around 2004. The problem with graphene is that it's so difficult to use that it can't replace existing products like silicon just yet. But by combining graphene with other materials, you can harness some of its most important properties. That's where Anaphite's technology can help.

The company can make graphene composites cheaply, quickly and at scale. These composites could help to make better batteries, air purifiers, and heat exchangers.

5. QLM

Quantum-inspired gas leak detection

QLM are developing sensors that can detect and image gas leaks from over 100 metres away from the source. The start-up uses quantum-inspired technology to spot tiny amounts of leaks from a safe distance, allowing them to scan larger areas much faster and at a reduced cost than existing surveys.

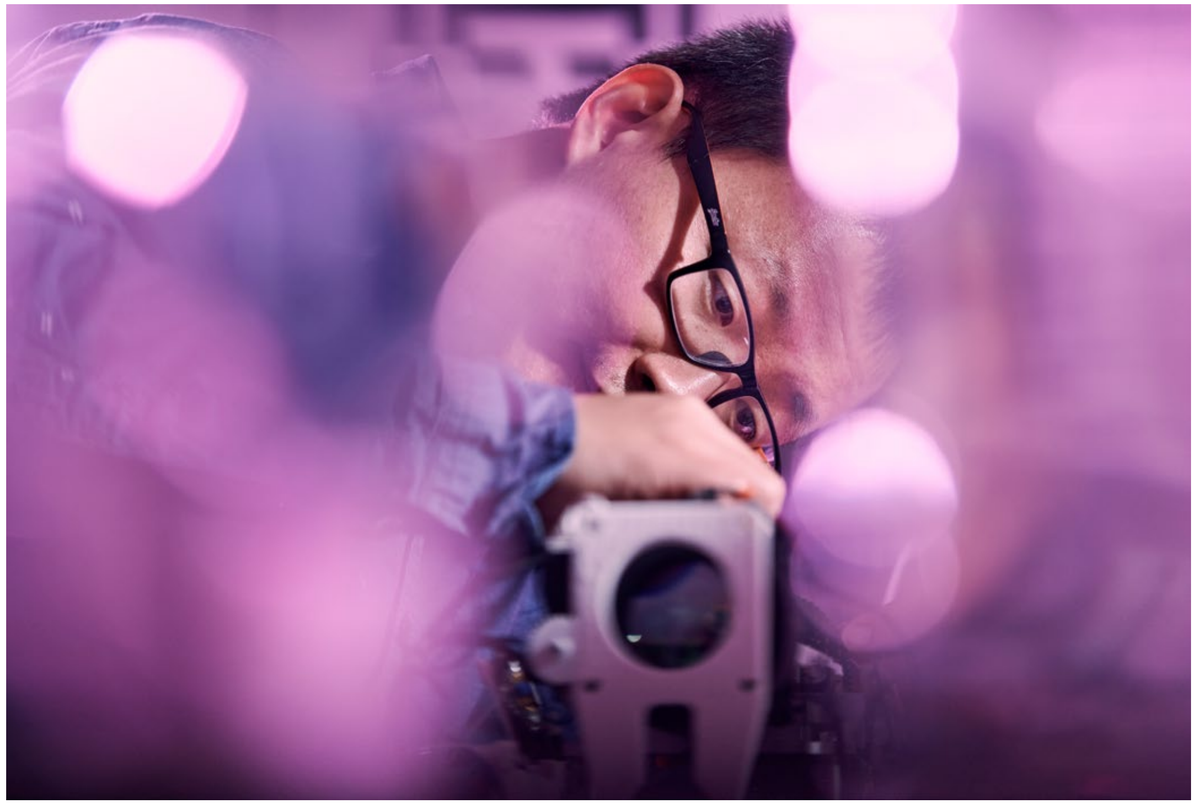
Currently focusing on methane, the company is in the process of miniaturising their prototype, meaning it could be handheld, post-mounted or drone mounted. Methane is one of the most serious contributors to climate change, and leaks from the oil and gas industry are one of the biggest sources of methane release to the atmosphere. QLM's technology could allow them to quickly identify and map the size of a leak, speeding up repairs and reducing the amount of methane leaked. They are also looking to adapt the technology to work for a range of other gases.

Deep Tech is Growing

Bristol has a long history of world-class academic research, but this has not always been well translated into products and services that can make a difference outside of the lab. Deep tech companies need more than just desks and Wi-Fi. They need lab space, more investment and sector-specific business support. This has started to change in the last four years thanks to additional infrastructure (at Unit DX, Future Space and the Bristol and Bath Science Park) increased resources in the University of Bristol's commercialisation team and additional funding in Bristol.

Science companies require the potential for change and large impacts in some new technologies to be recognised. Bristol is seeing an increase in the number of spin-outs in the city and greater investment from angel investors and venture capital. For growth to continue, we need to see more investment in infrastructure (i.e. lab space) and more money channelled into deep tech start-ups. We are working on both.

Growing a deep tech ecosystem is expensive and slow, but the benefits for humanity could be unmeasurable.



The Bristol Companies Fighting Antibiotic Resistance

Three Bristol Innovators Fighting Antibiotic Resistance

'At Folium Science, we've pioneered a platform that can reduce the need to use antibiotics in agriculture. Guided Biotics are selective and precise, will promote animal wellbeing and performance and reduce the risks of resistance. We've proved that our technology works: now it's time to take it to market.'

Antibiotic resistance is as grave a threat as climate change, but it gets nowhere near the amount of media attention (and the conflicting terminology doesn't help). Modern life relies on antibiotics, the drugs used to treat bacterial infections. But bacteria are evolving resistance to antibiotics, making the infections they cause harder to treat and putting global security at risk.

In this article, we'll look at four Bristol innovators working on tech designed to beat the bad bugs. From 'making bacteria self-digest' to 'molecular tyre shredders', we will cover the latest tech being developed in Bristol.

In 2013, the UK Government recommended ten actions to tackle antibiotic resistance on the supply and demand sides. Some involve regulation or raising awareness of the issue, but others clearly require technological innovation. That's where science entrepreneurs are needed.

The economic burden of developing new antibiotics is too great for small companies. Bold start-ups are addressing this crisis head on, by developing technologies to reduce the demand for the antibiotics we do have, making sure that they remain effective.

Bristol is a hub of activity for research into antibiotic resistance. Below, we'll examine four innovators in the region, all hoping to reduce the demand for antibiotics.

1. Folium Science

Making bacteria self-digest

Agriculture is the biggest consumer of antibiotics. In the USA over 70% of antibiotics important for human medicine are given to livestock. Up to 90% of these drugs pass straight through animals unchanged. Farm wastewater is used for irrigation, and manure as fertiliser, which spreads antibiotics throughout the environment, where they drive resistance in bacteria.

The use of sub-therapeutic antibiotics in animal production is becoming increasingly restricted across the world and consumers are rejecting meat produced using antibiotics. This means that the industry is looking for effective alternatives that will prevent the spread of undesirable gut bacteria, promote animal health, and reduce human zoonosis (disease crossover from animals into humans). Currently, the range of options available to producers are not fully effective in removing unwanted bacteria.

Many countries have now banned the use of antibiotics as growth promoters in animals, however in countries where their use is still permitted, this will contribute to an increased risk of antibiotic resistance in bacteria.

By selectively removing unwanted bacteria, Folium's patented 'Guided Biotics'® could reduce the need for antibiotics in agriculture. The technology harnesses the natural CRISPR-Cas9 system.

Some bacteria use a nuclease enzyme (Cas) to cut the DNA of attacking organisms. Guided Biotics redirect this mechanism so that undesirable bacteria cut their own DNA. This causes unwanted bacteria to self-digest, specifically removing them and leaving 'good' bacteria intact. Although CRISPR is more widely known as a gene editing tool, the action of Guided Biotics does not involve any gene editing of the target bacteria.

Folium Science's Guided Biotics technology has many advantages, as shown in the table below. Folium was founded in 2016. They've already proved that their technology works in five independent studies. Ed Fuchs, CEO, says: 'At Folium Science, we've pioneered a platform that can reduce the need to use antibiotics in agriculture. Guided Biotics are selective and precise, will promote animal wellbeing and performance and reduce the risks of resistance. We've proved that our technology works: now it's time to take it to market.'

Because Guided Biotics can be designed to selectively remove many different species of bacteria, Folium Science are applying their technology to bacteria that cause diseases in important animals and plants. Folium's priority targets for poultry are Salmonella, pathogenic E. coli and C. perfringens. They are also developing products for other zoonotic, spoilage and wastage bacteria.

In July, the company won an Innovate UK grant to develop a treatment for Xanthomonas bacteria that devastate staple crops such as cassava, rice, and soy. Folium Science is working in partnership with the John Innes Centre to develop crop protection products for use on fresh fruit and vegetables and broad acre crops. They aim to reduce crop losses and boost overall performance by promoting a productive microbiome. Folium will launch their first product, targeting Salmonella in poultry, in 2021.

Supply	Demand
Set up a global fund for early-stage research to tackle antibiotic resistance.	Reduce unnecessary use of antibiotics in agriculture.
Improve investment into R&D for new antibiotics.	Develop technology to quickly and accurately diagnose infections so doctors know which antibiotics to use.
Fund research into infectious diseases.	Develop and use more vaccines so fewer antibiotics are needed.

	Typical Antibiotics	Guided Biotics
Specificity	Kill 'friendly' bacteria along with those that cause disease. This can damage animal health.	Designed to target only bacteria that cause disease.
Likelihood that bacteria will become resistant	Bacteria have become resistant to every antibiotic.	The chance of resistance developing is very low (10-23) because there are multiple DNA targets.
Ease of redesign if resistance occurs	Very difficult – it took over a decade for chemists to redesign vancomycin.	Trivial – it's much easier to change an RNA sequence than the molecular structure of a drug.
Crossover with human medicine	Many antibiotics used in agriculture are critically important for human health. When resistance develops in animals, it spreads to humans.	None

‘Antibiotic resistance is a complex problem, one that calls for collaboration between scientists, doctors and entrepreneurs. Bristol is a centre of excellence for research in this space, and a real melting pot. We’re a creative city, and you can see that in the range of solutions our scientists are pursuing.’

Bristol is at the centre of the fight against antibiotic resistance.

2. FluoretiQ

Detecting bacteria with fluorescent velcro

Urinary Tract Infections present an unrelenting burden on public health as one of the most common bacterial infections, with an estimated 150 million cases per year reported worldwide. UTI's are the second highest cause of antibiotic prescription and many patients will receive an empirical antibiotic treatment without confirmation of bacterial infection.

FluoretiQ are developing NANOPLEX™ technology for rapid identification of bacterial infections. This technology can reduce bacterial identification from 48-72 hours to under 15 minutes, delivering the sensitivity of the lab at the speed and convenience of the dipstick.

When you have a bacterial infection, bacteria must find a way to attach themselves to their human host. They do so in a very similar way to Velcro, bacterial 'hooks' recognise human 'loops' and adhere to the surface of cells to establish the infection.

FluoretiQ are exploiting this interaction in reverse – by mimicking these 'loops' on the surface of human cells their probes can recognise bacteria 'hooks' allowing for their identification in clinical urine samples.

The technology combines two parts. The first element is a fluorescent nanomaterial probe engineered to recognise one bacterial species over another. The second element is a Quantum-enhanced detection module that allows fluorescent detection without the need for incubation or amplification of the bacterial signal.

The result is a fluorescent readout that confirms if bacteria is present, which kind, and how many, all within 15 minutes.

The approach has three steps:

1. A patient sample is mixed with probes that target specific bacteria.
2. Probe-labelled bacteria are separated from unlabelled species.
3. Bacteria bound to probes are measured by Quantum-enhanced fluorescent detection.

Nanoplex will identify 90% of uropathogenic bacteria in urinary tract infections and is undergoing development with clinical samples at regional pathology laboratories.

Dr Neciah Dorh, CEO, says:

'Even with new drugs under development, the only way to safeguard the future is to develop the right diagnostic tools to allow us to quickly identify bacteria at the point of consultation. Nanoplex can offer this information to the physician at the point of care, reducing the need for empirical antibiotic use.'

The future

FluoretiQ are currently focused on urinary tract infections, but plan to expand their focus to a wider range of infectious disease areas. Product development is well underway and FluoretiQ hope to launch their first product in late 2021.

3. The Su Group

Molecular tyre shredders

Surgeons use titanium implants to replace joints and repair bones because of its strength and because the body doesn't reject it. Unfortunately, bacteria attach themselves to these implants and multiply. These bacteria quickly form a biofilm by producing a sticky goop of proteins and carbohydrates. Bacteria in biofilms start working together to survive, protecting themselves from the immune system and antibiotics. These bacteria cause inflammation around the implant, destroy tissue, and spread throughout the body, causing serious infections.

The only way to treat these infections is to surgically remove the implant and put the patient on a long course of strong antibiotics. This problem increases the demand for antibiotics and the risk of resistance. In the UK, there are nearly 800,000 hip replacements every year. Up to 17.5% get infected and fail, each costing £25,000 on average.

Rather than relying on antibiotics, Professor Su's group at the University of Bristol have taken inspiration from nature. Cicadas have evolved a way to keep their wings clean from bacteria that might infect them. Their wings are covered with tiny spikes which pierce bacterial cells, killing them within three minutes.

Professor Su's group have developed a process for coating the surface of titanium with similar spikes. They designed two patterns:

- Spears – densely packed short spikes similar to the cicada's wing.
- Pockets – longer spikes which twist together into larger pockets.

The researchers tested their designs against polished titanium to see if they could kill bacteria that tried to grow on the surfaces. Bacteria found it more difficult to attach themselves to the spear pattern, and the first wave that did were pierced and killed. But a layer of dead cells built up on which new bacteria could grow and form a biofilm.

However, the pocket pattern was more effective. Bacteria initially adhered to the rims of the pockets, which are blunt. As they divided, they pushed each other into the pockets, where they were either pierced by or squeezed between the longer spikes. The dead cells in the pockets decayed before new cells could grow on them. After six days, five times fewer bacteria were seen on the pocket-patterned surface compared to polished titanium, and half of those cells were dead.

The future

Professor Su's group are continuing to work on a variety of antibacterial surfaces. Their designs need to be refined, but if they reach the clinic, they could make implants much safer, and stop antibiotics from being wasted.

Professor Su says:

'Antibiotic resistance is a complex problem, one that calls for collaboration – between scientists, doctors and entrepreneurs. Bristol is a centre of excellence for research in this space, and a real melting pot. We're a creative city, and you can see that in the range of solutions our scientists are pursuing.'

Fighting Antibiotic Resistance in Bristol

Bristol is at the centre of the fight against antibiotic resistance. The city boasts:

- Internationally-renowned universities producing world-class antibiotic resistance research.
- Innovative spin-out and start-up companies with bold ideas to solve the problem.
- A network of science and technology incubators to help these companies grow and bring their technologies to market.

Science Creates Launch Paper 2020

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Solving the World's Biggest Challenges through Deep Tech

Science Creates Launch Paper 2020

incubators ventures network