

THE JOURNAL

FOR SCIENCE, ENGINEERING AND TECHNOLOGY

advances

WALES

Computer game developed in Wales becomes global success

Developed by graduates from the University of South Wales (USW) the game has captured the imagination of gamers worldwide, making headlines and securing top chart positions across major gaming platforms.



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Welcome to **Advances Wales issue 103**, now available exclusively online. This edition showcases the latest breakthroughs in science and technology from across Wales.

You will find examples of innovation that align with all four of the Welsh Government Innovation Strategy Missions for Innovation: Education; Economy; Health and Wellbeing; and Climate and Nature.

We celebrate the remarkable success of a game developed by graduates from the University of South Wales, which has become a global top seller. This achievement underscores the strength of Welsh innovation in the entertainment industry.

Beyond this success, we feature a range of cutting-edge developments. These include a collaboration between Cardiff University and Airbus, resulting in a novel method for detecting and preventing malicious software - an advancement that could significantly boost cybersecurity across industries. Meanwhile, scientists have surveyed the River Conwy in North Wales, using DNA analysis to reveal freshwater biodiversity, with the potential to revolutionise global river monitoring.

In addition, Welsh researchers are exploring the use of Azithromycin to prevent chronic lung disease in premature babies, while Amotio, a South Wales-based company, is developing precision solutions for orthopaedic revision surgery aimed at reducing complexity and improving patient outcomes.

From tackling bacterial contamination to uncovering climate change indicators, Advances Wales continues to bring you the latest insights. Don't forget to subscribe to our email service for notifications of future issues and stay updated on cutting-edge developments in Wales.

Gwyn Tudor
Editor

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Childhood adversity linked to engagement with healthcare services

Childhood experiences can shape health, well-being, and behaviours throughout life. New research from Bangor University and Public Health Wales has found that adults who suffered from adverse childhood experiences (ACEs), such as child maltreatment or domestic violence, report lower engagement with healthcare services.

This study surveyed 1,696 adults and discovered that individuals who had faced four or more ACEs were over twice as likely to report discomfort when using hospitals, GP surgeries, and dental clinics compared to those with no such experiences. They were also more than three times as likely to perceive that healthcare professionals do not care about their health or understand their problems. Additionally, they were one and a half times more likely to report taking prescription medication but admit they did not always follow the prescribed instructions.

Professor Karen Hughes at Public Health Wales explained, "ACEs can increase people's risk of poor health throughout their lives, which in turn



heightens their need for healthcare services. However, these experiences can also impact how individuals respond to stress and their trust in others, influencing their perceptions of healthcare services and advice. The development of trauma-informed healthcare services could help to improve patients' relationships with healthcare professionals."

"With around half of the population experiencing at least one ACE during childhood, it is crucial that healthcare providers recognise how these early experiences can affect healthcare engagement."

Dr Kat Ford
Bangor University

www.bangor.ac.uk

Nest box project studies climate change impact on bird breeding



Nest boxes have been placed around west Wales, as part of a new study to investigate the effects of climate change on bird breeding and competition between species.

Wales is experiencing rising temperatures due to human activity, with 2022 and 2023 being the warmest years on record. This warming trend is altering bird breeding patterns - great tits, for example, are laying eggs two weeks earlier than they did in the 1960s.

Researchers at Aberystwyth University have installed nest boxes at various altitudes and woodlands to study the breeding patterns of great tits, blue tits, and pied flycatchers. Changes in spring temperatures may increase competition for food and reduce the number of eggs laid. The study will also explore how temperature changes affect the birds' diets.

Forecasting the impact of climate change on biodiversity is crucial. Nest box studies have

"The purpose of the study is to improve our understanding of the effect that climate change has on the relationship between different species, particularly woodland birds. We know that a warmer spring is already leading to birds breeding earlier, and we hope to understand more about how this might affect the competition between different bird species."

Dr Peter Korsten
Aberystwyth University

been key to tracking changes in breeding timing, but how climate change affects competition within ecological communities remains unclear. This project aims to serve as a foundation for future long-term research.

www.aber.ac.uk

Protecting Anglesey as a haven for red squirrels

For over a decade, only native red squirrels have thrived on Anglesey Island, North Wales, following the successful control of invasive grey squirrels. However, grey squirrels are now returning.

Red squirrel numbers in the UK have drastically declined over the past century due to habitat loss and competition from grey squirrels. Grey squirrels also carry squirrelpox, a virus deadly to red squirrels but harmless to themselves.

Red squirrels were once abundant on Anglesey, but by the 1970s, increasing numbers of grey squirrels led to a sharp decline. By 1997, fewer than 40 adult red squirrels remained on the island.

"The greys have discovered several Mission Impossible -style ways of reaching the island," he says, "with one even spotted swimming across the Menai Strait. They can also cross in vehicles and have even been known to board trains."

Dr Shuttleworth

Anglesey Squirrel Population Manager



A conservation project launched in 1997 aimed to reintroduce red squirrels and eliminate the greys. The project succeeded, boosting the red squirrel population from 40 to around 700. In 2013, Anglesey was declared grey squirrel-free, and today, the island hosts Wales' largest red squirrel population, accounting for 60% of the national total.

However, grey squirrels have recently reappeared on Anglesey. Dr Craig Shuttleworth, who has managed the grey squirrel population on the island since 1997, is leading renewed efforts to prevent their spread. Using wildlife cameras and traps, he is determined to protect the red squirrels from the invasive greys.

www.bangor.ac.uk

IN BRIEF

Wales metaverse is European first

Wales has become the first European nation to embrace the metaverse as a tourism tool, creating a virtual experience that allows users to explore the country's famous landmarks from anywhere in the world. Developed by Visit Wales in collaboration with Swansea-based iCreate, this digital world aims to inspire future visits by offering a taste of the nation's culture, history, and landscapes. The virtual island, complete with a castle and a cable car modelled after Llandudno, offers users a fully immersive experience. It includes interactive quests that are designed to engage users while highlighting Wales' unique attractions. The metaverse also features a digital map, helping users plan future visits by creating virtual itineraries based on real-life locations. As the digital space grows in popularity it is hoped that this new platform will inspire millions of virtual explorers to make Wales their next real-world destination.

Robot dragon helps with loneliness

A robotic pet dragon, developed by Aberystwyth University's Smart Home Lab, has been created to help combat loneliness and aid individuals to live independently. Designed to monitor movement, the robotic dragon offers companionship to those who may be unable to care for a real pet, particularly older adults or people with health conditions. It can also prompt users to stay active and provide crucial data to healthcare specialists. The dragon is part of a broader research initiative exploring how robots can support independent living. Other innovative devices include flying drones for communication during natural disasters, robots to monitor changes along the Welsh coastline, and smart wheelchairs. Dr Patricia Shaw, senior lecturer at Aberystwyth University highlighted the significance of the research: "Robots are becoming an increasingly important part of our daily lives, and it's exciting to see the potential benefits they could bring."

Success for ten Welsh companies in King's Awards for Enterprise

The King's Awards for Enterprise, formerly known as the Queen's Awards for Enterprise, is a prestigious programme that recognises British businesses and organisations excelling in international trade, innovation, sustainable development, or promoting opportunity through social mobility. In 2024, ten companies from Wales received awards. There were Innovation Awards for Limb-Art, Ruth Lee, Creo Medical, and Bionema; a Sustainable Development Award for Archwood; and International Trade Awards for Nodor International, Concrete Canvas, Tension Control Bolts, and FRIO UK. North Wales-based Cokbusters was recognised in both the International Trade and Innovation categories, making them one of only five companies out of 252 winners across the UK to receive two awards.

Semiconductor manufacturer establishes base in Cardiff

Semiconductor manufacturer Kubos is set to establish its base in Cardiff University's Sbarc building, positioning itself within Wales' renowned compound semiconductor ecosystem. Kubos is developing a new compound semiconductor material called cubic gallium nitride (GaN). This material is designed to power the next generation of microLEDs, which are critical for small-scale displays such as smartwatches and augmented or virtual reality devices. The company's innovative technology enhances the performance of diodes smaller than the width of a human hair, enabling ultra-high resolution display screens for near-eye applications. By growing cubic GaN on large area silicon carbide on silicon substrates, Kubos is able to lower the cost of high-efficiency green and red LEDs. This breakthrough addresses challenges that have previously hindered the widespread use of LEDs in VR and AR displays, data communications, and lighting solutions.

Partnership delivers innovative data dashboard

A partnership between academia and industry has resulted in the creation of an innovative data dashboard designed to improve operational efficiency for a Welsh-based engineering solutions company. The data dashboard offers real-time data analysis and visualisation, enabling decision-makers to access immediate insights. This fosters better strategic planning, streamlines operations, and enhances transparency in budgets and targets. Team members can easily understand their roles, while supervisors benefit from the real-time updates that help them manage tasks proactively. By integrating advanced data analytics, adaptive design, and robust security measures, this initiative showcases how businesses can harness their data more effectively. The initiative involving Coleg Cambria, Bangor University, and The Open University in Wales, worked with AMRC Cymru to develop the system for LCA Group Ltd in North Wales. The collaboration highlights the potential for future projects in digital transformation, such as data analytics and digital storytelling.

New centre to boost welsh food research

One of humanity's biggest challenges is feeding a growing population without harming the planet. Animal agriculture significantly contributes to greenhouse gas emissions, deforestation, water pollution, and biodiversity loss.

A new initiative, aims to address this challenge by developing alternative proteins that are plant-based,

cultured, or fermented. The Bezos Centre for Sustainable Protein is led by Imperial College London and involves researchers from 10 other institutions, including Aberystwyth University.

Aberystwyth University will focus on using biotechnology and synthetic biology to create novel proteins from microorganisms such as algae, bacteria, and fungi. These proteins could have various applications, such as meat analogues, dairy alternatives, or functional ingredients.

The researchers will also explore the social and economic aspects of adopting these new foods, including consumer acceptance, regulatory frameworks, and market opportunities.

The Centre's hub will be based at Imperial College London, with Aberystwyth University as one of three UK spokes. There will also be three spokes abroad, with more than 65 international partners.



“As the global population expands, the health of both humans and the planet will increasingly depend on the widespread availability of proteins that taste good and are produced in ways that reduce emissions and protect nature. Working with the agri-food industry, we can use this investment to help steer and accelerate the path to net zero.”

Dr David Bryant
Aberystwyth University

 www.aber.ac.uk

Drones reveal link between Icelandic volcano and deaths in Wales

A team of researchers from the University of South Wales is using drones to study volcanic activity in Iceland, offering new insights into the region's history and its potential future impacts. The team conducted a drone survey of Lómagnúpur mountain in southern Iceland, one of the country's most dramatic geological features. Rising to 764 metres, the mountain provides a crucial record of past volcanic events. Using drone software and VR headsets to simulate the operation from over 1,000 miles away, the team have captured detailed 3D imagery of the mountain, which could help geologists better understand volcanic activity. This includes a historical eruption 240 years ago that released a toxic gas plume over Europe, potentially causing deaths as far away as Wales.

Complex life on earth emerged 2.5 billion years ago

A study led by Cardiff University has suggests that complex life on Earth emerged 2.1 billion years ago - 1.5 billion years earlier than previously believed. The research, conducted in the Franceville Basin in Gabon, has uncovered evidence of an ancient ecosystem that predates the widely accepted timeline for the emergence of animals. The study highlights a unique episode of underwater volcanic activity following the collision of two continents. This event created a nutrient-rich marine environment, providing the conditions for early biological evolution. The team linked the availability of phosphorus and oxygen in this environment to the emergence of large, primitive life forms. The findings challenge long-held beliefs and suggest that complex life attempted to evolve in two stages - first 2.1 billion years ago, and later around 635 million years ago, when animals began to diversify globally.

Skin treatment shows promise for treating diabetes

A drug commonly used to treat psoriasis, Ustekinumab, has shown promise in preserving insulin production in adolescents recently diagnosed with type 1 diabetes. Ustekinumab, which has been safely used to treat over 100,000 patients with immune conditions, including arthritis and psoriasis, was tested in 72 adolescents within 100 days of their type 1 diabetes diagnosis. After 12 months, the study found that those treated with Ustekinumab had 49% higher C-peptide levels—a key marker of insulin production—compared to those given a placebo. The research, conducted by Cardiff University, Swansea University, King's College London, and the University of Calgary, revealed that Ustekinumab reduces the troublesome immune cells attacking insulin-producing cells while leaving the majority of the immune system intact. With further trials planned, this could represent a breakthrough in preventing the need for insulin in type 1 diabetes patients.

Using small black holes to find big black holes

An international team of scientists have devised a groundbreaking technique to detect supermassive black hole binaries - pairs of enormous black holes located at the centres of galaxies. This method could reveal these cosmic giants, which are undetectable using current technology. The study, led by Dr Jakob Stegmann from the Max Planck Institute, began during his doctoral research at Cardiff University. Developed with colleagues from the University of Zurich and the Niels Bohr Institute, it uses deci-Hz gravitational-wave detectors, which detect low-frequency ripples in spacetime caused by accelerating massive objects. By analysing the waves from smaller black holes, the team can reveal the presence of supermassive black hole pairs. Dr Fabio Antonini, at Cardiff University's School of Physics and Astronomy, highlights that this approach could uncover black holes with masses between 10 million and 100 million times that of the Sun.

Report highlights impact of climate change on wildfires

The State of Wildfires report, authored by academics from from the University of East Anglia and Swansea University, has revealed the significant influence of climate change on the extreme wildfires that occurred globally during the 2023-24 fire season. The report catalogued major wildfire events in regions such as Canada, Greece, and the western Amazon. The findings point to an increase in the likelihood of extreme fires due to climate change, with Canada alone accounting for one-quarter of global fire carbon emissions. In Europe the report, highlights the devastating Evros fire in Greece, which burned 900 km², claimed 19 lives, and caused mass evacuations. While overall wildfire activity in Europe was moderate, southern Europe has experienced a faster rate of warming, intensifying fire-prone weather. The report calls for urgent mitigation efforts to reduce future fire risks as future forecasts predict high fire danger in several regions.

Unravelling the impact of environmental bacteria

Research from Cardiff University, based on techniques adapted to prevent lung infections among people with cystic fibrosis, is helping to reduce contamination risk in industries worldwide.

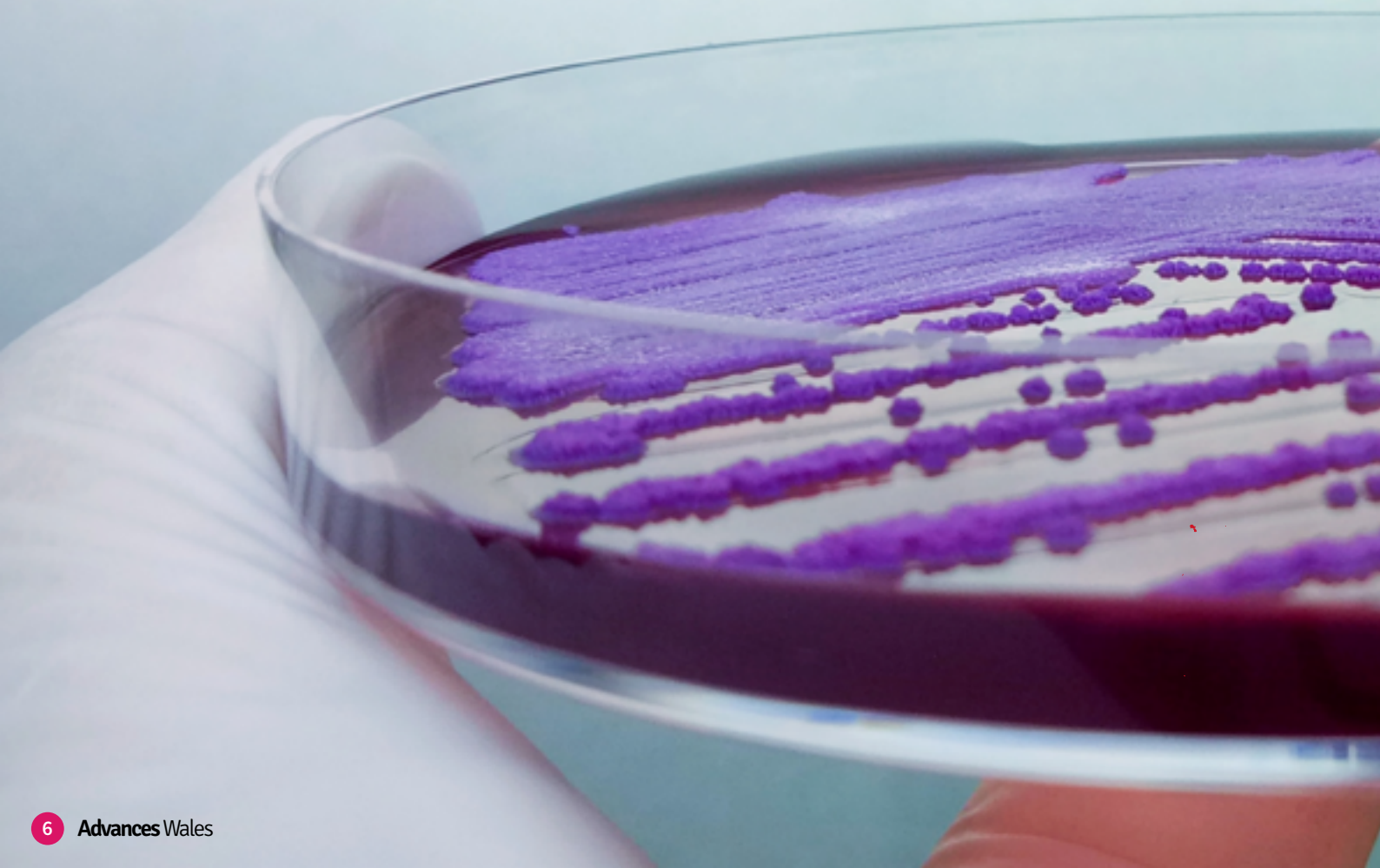
Environmental bacteria, such as Burkholderia, are not only resilient but also versatile. In plants, they can be beneficial, protecting them from attacks by fungi and other pathogens. However, when these bacteria end up in the wrong place, they can be dangerous and even life-threatening. They pose significant challenges due to their ability to survive and thrive in diverse environments, including man-made products and medical settings, where they can cause contamination. Additionally, their high level of antimicrobial resistance makes them a potential threat to vulnerable individuals.

The team at Cardiff University is dedicated to understanding the behaviour and impact of environmental bacteria, particularly when they find themselves in unexpected places. The focus of their research is Burkholderia, which spread rapidly among people with cystic fibrosis in the 1990s. Individuals with cystic fibrosis have weakened lungs due to their condition, making infections by bacterial pathogens like Burkholderia potentially fatal.

This research, now being applied on an industrial scale, has enabled global manufacturer Unilever to reduce incidents of contamination and



The team has adapted techniques originally developed to prevent infections among people with cystic fibrosis to detect bacteria in products such as cosmetics and toiletries, which are often manufactured in environments that are not completely sterile. By utilising DNA sequencing, researchers can detect and identify bacterial contaminants in these products, enabling precise and early detection of harmful bacteria that could pose serious health risks to consumers.





develop improved preservative formulations that effectively prevent product spoilage caused by microorganisms.

Professor Eshwar Mahenthiralingam, Head of the School of Biosciences, said: “We took the genetic tools we used to solve the original CF problem and applied these to tackle an industrial problem.

We can tell manufacturers what types of bacteria to track and help them keep these bacteria out to reduce the risk of contamination.”

The research is particularly significant as the increasing use of natural ingredients, along with milder preservatives and fewer synthetic chemicals, can inadvertently lead to the potential for bacterial contamination. This issue is compounded by the move to using reusable packaging and home refilling, which can potentially create environments conducive to bacterial growth and contamination.

In the future, the researchers hope that the cosmetics and toiletries industry will implement stricter regulations, including identifying the bacteria responsible for contamination, similar to the rigorous restrictions already in place for the food industry.

The team’s current project focuses on examining the evolving use of preservatives in combating a group of emerging industrial contaminants called enteric bacteria. These bacteria also present a significant global health risk due to their growing resistance to antibiotics, making the development of effective preservatives essential to inhibiting their growth in home, beauty, and personal care products.



“We don’t yet know enough about these issues – but what we do know is that the whole landscape is changing, and we need to respond to this. It’s a pretty niche but important area of microbiology that has global reach, and we have a very unique type of expertise to be able to help.”

Professor Eshwar Mahenthiralingam
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CARDIFF

Early consumption of some sugary drinks increases risk of adult obesity



Swansea University research suggests that consumption of some sugar-sweetened beverages during early childhood is linked to less healthy dietary patterns and an increased risk of obesity later in life

In the UK, it is estimated that about one in four adults are living with obesity. This is a growing public health concern worldwide, making it crucial to identify specific dietary factors contributing to this condition.

Previous reports have consistently linked childhood consumption of sugary drinks to a higher risk of obesity, but this latest research shows that what is being eaten very early in life must also be considered, as consuming certain types of food can lead to the formation of dietary patterns, significantly impacting overall health.

Unlike previous studies that often group all sweetened beverages together, this new research examines various types of sugar drinks separately. It distinguishes between fizzy drinks and pure fruit juices, providing nuanced insights into how different beverages may affect weight gain and dietary patterns differently. The study also explores potential gender differences in response to different types of sugary drinks.

Swansea researchers found that children who drank fizzy drinks like cola or sugar-sweetened fruit cordials before the age of two, gained more weight by the

age of 24. Interestingly, girls who drank pure fruit juice gained less weight, while boys' weight remained unchanged.

By age three, toddlers who drank cola consumed more calories, fat, protein, and sugar, but had a lower fibre intake. As fizzy drinks contain neither protein nor fat, this indicates the importance of the rest of the diet. In contrast, those who were given pure apple juice consumed less fat and sugar but higher amounts of fibre.

Professor David Benton, lead researcher, said: "The early diet establishes a food pattern that influences whether weight increases throughout life. The important challenge is to ensure that, in the first few years of life, a child develops a good dietary habit: one that offers less fat and sugar, although pure fruit juice is one of the five a day and does add vitamin C, potassium, folate, and plant polyphenols to the diet."

Dr Hayley Young, Associate Professor of Psychology, added: "Obesity is a serious health concern, one that increases the risk of many other conditions. Our study shows that the dietary causes of adult obesity begin in early childhood and that if we are to control it, more attention needs to be given to our diet in the first years of life."



The research utilised data from the Avon Longitudinal Study of Parents and Children, established to explore how genetic and environmental factors impact health and development from birth to age 24. It tracked the dietary influences of 14,000 British children from birth through to adulthood, making it one of the longest studies of its kind reported to date.

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SWANSEA

Evidence challenges use of antibiotics for premature babies

New evidence from a trial led by Cardiff University indicates that administering the antibiotic azithromycin to premature babies at an early stage does not help prevent the development of chronic lung disease.

Chronic lung disease, often referred to as bronchopulmonary dysplasia, is a serious condition commonly seen in premature babies whose lungs have not fully developed. The disease is associated with high rates of mortality and long-term health problems, including the early onset of chronic obstructive pulmonary disease (COPD).

Despite advances in neonatal care, the incidence of chronic lung disease remains high. This condition is primarily observed in infants born very prematurely, specifically those born before reaching 30 weeks of gestation.

For several decades, there has been conflicting evidence on whether the use of azithromycin, an antibiotic with potent anti-inflammatory properties, can decrease the rates of chronic lung disease in premature babies.

The AZTEC trial, which recruited 796 premature babies born at less than 30 weeks' gestation from 28 neonatal intensive care units across the UK, aimed to determine definitively whether azithromycin can reduce chronic lung disease in premature babies.

The research trial indicates that using only one treatment method, such as administering azithromycin, may not be sufficient to prevent chronic lung disease in these infants. It also highlights the importance of evaluating the long-term effects of azithromycin on both respiratory health and neurodevelopment to ensure its effectiveness and safety over time.

Given that the increased use of antibiotics in preterm infants is associated with higher rates of morbidity, increased mortality, and increased antibiotic microbial resistance, the study urges caution when using azithromycin in this vulnerable population.

The trial presents the first adequately powered study (a study with an adequate sample size) to address this longstanding knowledge gap regarding the



“Our study found that azithromycin did not prevent the development of chronic lung disease in prematurely born babies, and that caution is required when using azithromycin in the neonatal unit as it does not appear to decrease rates of chronic lung disease. This new and definitive information will help narrow down treatment options for chronic lung disease in premature babies and prevent the inappropriate use of antibiotics in clinical settings.”

Professor Sailesh Kotecha
School of Medicine
Cardiff University

effectiveness of this class of medicine in preventing the development of chronic lung disease in preterm infants at high risk of developing the condition.

It underscores the importance of determining the best methods for reducing chronic lung disease in premature babies, while also addressing the global challenge of antibiotic resistance, ensuring antibiotics are used only when appropriate in medical treatments.

The AZTEC trial is a collaborative effort between Cardiff University School of Medicine, Cardiff University Clinical Trials Research Unit, University of Leicester, Imperial College London, University College London, University of Liverpool, and Newcastle University.

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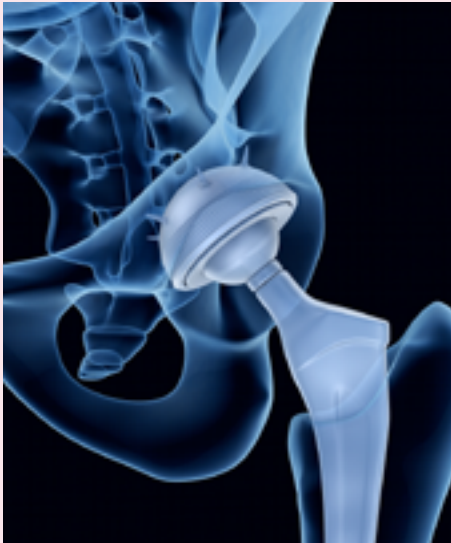


CARDIFF

Innovation in personalised orthopaedic revision surgery

Hip, knee, and shoulder implants have significantly improved the lives of millions worldwide, restoring mobility and enhancing quality of life.

With an ageing global population, the demand for joint replacement surgery is increasing, with projections indicating substantial growth by 2030. In England and Wales alone, over 100,000 primary total hip replacements are performed annually, with a predicted 129% increase by 2030. Similarly, the USA anticipates a rise of over 200%, while Australia projects a 134% increase by 2030. However, 4-10% of these implants will require replacement due to issues such as implant failure, infection, loosening, or bone fractures.



One key approach for securing prosthetic implants is cemented fixation which incorporates the use of a resilient compound comprising polymethyl methacrylate (PMMA) - to ensure implant stability. The durability of bone cement presents significant surgical challenges, as it is difficult to remove.

For some patients, this could mean undergoing the complex and often painful process of revision surgery up to three times in their lifetime. Orthopaedic revision surgery is intricate and challenging for both patients and healthcare providers, often leading to delayed recovery and rehabilitation. These procedures not only affect patients' quality of life but also increase healthcare costs.

Amotio, a new company with research and development facilities in South Wales, is developing patient-specific precision solutions for orthopaedic revision surgery aimed at reducing surgical complexity and enhancing rehabilitation and mobilisation post-surgery.

In collaboration with a team of specialist orthopaedic revision surgeons and international universities, Amotio's research and development team is leading the product development, clinical evaluation, and medical device registration in global markets to revolutionise the surgical approach and outcomes.

This innovative device and surgical procedure are set to transform orthopaedic revision surgeries, improving patient outcomes, reducing surgical burdens, and helping patients regain their mobility and quality of life.

This patented solution integrates musculoskeletal personalised digital joint mapping and templating, 3D additive printing, and the development of specialised precision tools to create a comprehensive, highly

effective, patient-specific solution. The process begins with a patient CT scan, enabling the surgical team to develop a digital template of the patient's joint for pre-surgical planning, leading to the creation of the patient-specific intelligent surgical guide and bone cement removal device.

A digital template of the patient's joint, implant, and bone cement structure is created and approved by the surgical team, marking the first step in the patient-specific surgical planning process, tailored to the individual's unique anatomy. Combining digital joint templating with 3D additive printing technology allows for the creation of an intelligent surgical guide for use by the surgeon during the intervention. Once created, the device is delivered in time for the planned surgery, ensuring precision and accuracy during the procedure.

Working in tandem with the surgical guide, a precision bone cement removal device navigates the confined space within the bone cavity. The two devices work together to enable targeted bone cement removal, improving the outcomes of orthopaedic revision surgeries.



Combining digital joint templating with 3D additive printing technology allows for the creation of an intelligent surgical guide for use by the surgeon during the intervention



"We are very excited to be developing this life-changing solution in South Wales. We also look forward to working with various health boards and universities as we seek to engage all stakeholders as much as possible."

Iestyn Foster
Chief Executive Officer

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CWMBRAN

Revealing freshwater biodiversity through DNA analysis

Scientists have conducted a survey of the River Conwy in North Wales to gather new genetic data that can be used to monitor freshwater rivers around the world.

Human activities, such as climate change and habitat modification, are causing a global decline in freshwater species. To combat this, conservationists and scientists need to establish baseline ecological data to monitor and improve these environments. Traditional freshwater survey methods, however, are often time-consuming and rely heavily on individual expertise.

Collecting water and sediment samples for trace DNA provides a deeper insight into the species present in the environment. Environmental DNA (eDNA) can detect organisms that are too small to be seen by the naked eye, as well as larger species like salmon and dragonfly larvae. These animals leave behind tiny

fragments of DNA as they move through their habitat, which can then be analyzed to determine their presence.

While eDNA analysis is already being employed in lakes and marine environments, one key question remained for its use in rivers: How far does eDNA travel downstream before it can no longer be detected?

To answer this, researchers from Bangor University, Cardiff University, the University of Birmingham, and UKCEH conducted intensive sampling of the River Conwy and compared their findings with data from other rivers, including the Tywi in Wales, the Gwash in England, the Glatt in Switzerland, and the Skaneateles in the USA.

Their work revealed that eDNA does not persist much beyond a kilometer downstream. This finding confirms that species detected through eDNA are

representative of the specific location where the sample was collected, rather than reflecting habitats located several kilometers upstream.

Dr. William Perry of Cardiff University said, “The results of this study allow ecologists and others to use eDNA surveys in rivers worldwide with greater confidence. It shows that obtaining comprehensive data on the organisms inhabiting our rivers is now within reach, offering a valuable tool in our efforts to mitigate the harmful impacts of human activity.”



“To fully understand the travel and persistence of eDNA in natural ecosystems, we needed to conduct this type of study—regular sampling of species from across the tree of life, at multiple spatial scales, and throughout the annual cycle. Our results demonstrate the connection between eDNA traces and the thousands of animals living in river ecosystems globally, validating the use of riverine eDNA analysis to assess biodiversity on an ecosystem-wide scale.”

Prof. Simon Creer
Bangor University

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BANGOR

Climate tipping points preceded by early warning ‘flickers’

A new study by Aberystwyth University has discovered evidence in ancient lake sediments showing periods of alternating extreme drought and heavy rainfall occurring before a major climate tipping point.

The study, led by a team including Professor Henry Lamb, reveals that the sudden shift from humid to arid conditions in northern Africa 6,000 years ago was preceded by climatic ‘flickers’. This is the first time such a pattern has been identified in geological records. Previously, the ‘flickering’ between wet and dry periods in advance of major climate shifts had only been predicted in theory.

These ‘flickers’ consist of periods of extreme wetness followed by droughts, each period lasting between 20 and 80 years and spanning over a thousand years. These rapid environmental changes had a significant impact on humans in northern Africa, leading to the disappearance of crucial ecosystems such as grasslands, open forests, and lakes.

The climate shift, known as the end of the African Humid Period, forced human populations to relocate to areas where conditions were still suitable, such as mountains, oases, and the Nile Valley, where water and resources were more readily available.

The new findings, confirming the existence of this extreme ‘flickering’, provide insights into



We see climate flickers as warning signals of the potentially catastrophic effects that future tipping points would have on the biosphere, including human populations. Clearly, it is important to consider current climate fluctuations as possible warning signs of climate breakdown, not just in Africa, but also in other sensitive climate systems such as the North Atlantic.”

Professor Henry Lamb
Aberystwyth University

possible early warning signals. By showing that there were periods in the past when the climate rapidly switched between wet and dry conditions, scientists can gain valuable knowledge that may help predict and prepare for major climate shifts in the future.

The research analyses several wet-dry transitions in the 620,000-year environmental record from Chew Bahir, a dry lake in southern Ethiopia. The research team collected sediment samples dating back 600,000 years.

Climate modellers have categorised tipping points into two distinct types. The first type involves processes that progressively accelerate, with the climate struggling to recover from disturbances until a transition occurs. The second type is marked by flickering between stable humid and dry climates shortly before a major shift.

Researching and understanding these two types of tipping points is crucial for predicting potential future climate changes, especially those induced by human activities.

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ABERYSTWYTH

Using drone technology to revolutionise lizard conservation

Researchers at the University of South Wales have employed drone technology to map the thermal environments of lizards in the tropics, offering crucial insights that could reshape reptile conservation strategies in the face of climate change.

Led by Dr Emma Higgins, a Lecturer in Ecology, the study focuses on the Bay Islands anole (*Anolis bicaorum*), a critically endangered lizard species found exclusively on the small island of Utila, off the coast of Honduras.



For cold-blooded species like lizards, keeping body temperature within a specific range is essential for survival. Unlike warm-blooded animals, they cannot regulate their internal temperature and so they rely on external heat sources. As human activities such as deforestation and urbanisation increasingly alter natural landscapes, and with the looming threat of climate change, the availability of suitable thermal environments for these creatures is dwindling.

The Bay Islands anole faces these threats firsthand. The island's rapid development is transforming its natural forests into urban areas, stripping away the lizard's preferred habitat. Given the lizard's precarious conservation status, understanding, and preserving, its thermal environment has become more crucial than ever.

Traditionally, measuring the thermal environment of lizards has been complex and costly. Researchers have relied on 3D-printed lizard replicas fitted with thermometers to record temperature data in forested areas. However, these replicas are expensive, and the limited number used

for any one study restricts the breadth of data that can be collected. This limitation can hamper conservation efforts, as it is difficult to assess the thermal suitability of entire landscapes with such sparse data points.

In response to these challenges, the team at the University of South Wales, University of Nottingham, Lakehead University and Kanahau Utila, have turned to drone technology. Recognising the crucial role that forest canopies play in regulating lizard body temperatures, they hypothesised that it might be possible to predict these temperatures using equations based on canopy characteristics.

To test their theory, the researchers used drones to gather detailed data on the canopy structure across their study plots. By hovering a few metres above each plot, the drones captured high-resolution images, from which the team extracted two key metrics: the percentage of greenness (indicative of canopy cover) and texture indices (representing variations in canopy structure).

Combining this data with ground-based air temperature measurements, the team developed machine learning models to predict the body temperature of the lizards at solar noon, when the sun is at its highest point. The results were promising. For anole lizards on Utila, the drone-based method successfully predicted lizard temperatures across the entire study plot, enabling the creation of continuous, high-resolution temperature maps. These maps offer far greater detail than traditional methods, providing data that is directly relevant to the movement patterns and habitat use of individual lizards.

This innovative approach is particularly timely given the dual threats of climate change and habitat loss facing cold-blooded creatures worldwide. These factors are rapidly altering the planet's thermal environments, potentially reducing the availability of suitable habitats for species that rely on specific temperature ranges. The implications are profound, with potential impacts on the fitness and energy expenditure of countless animals.

By using drones to map ecologically significant thermal data across large landscapes, Dr Higgins and her team have developed a tool that exceeds the capabilities of traditional ground-based methods. The next phase of the research will involve testing this method across different species and habitats, as well as incorporating 3D data to map thermal variations throughout the day. This will provide an even more comprehensive understanding of how different species interact with their thermal environment.

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PONTYPRIDD

66 million years of rise and fall in Shark functional diversity

New research by Swansea University and the University of Zurich has found that sharks retained high levels of functional diversity for most of the last 66 million years before steadily declining over the last 10 million years to its lowest value in the present day.

Despite their current endangered status, these ancient predators have adapted to numerous environmental changes and survived multiple extinction events. Today, more than 500 species of sharks play vital roles in marine ecosystems, from apex predators to nutrient transporters. However, this research reveals that their functional diversity—the range of ecological roles they fulfil—has significantly declined over the past 66 million years.

Modern sharks are facing unprecedented threats from anthropogenic pressures (caused or influenced by humans), primarily overfishing, which threatens around 40% of living shark species. Rapid climate change, driven by human activity also poses a severe risk. Critical habitats are shrinking, and the ecological roles of sharks are being eroded.

Functional diversity in sharks can be assessed through dental characteristics, which serve as reliable proxies for body size, prey preference, and feeding mechanisms. Since sharks possess soft cartilaginous skeletons that are unlikely to fossilise, their teeth, which are hard and well-preserved in the fossil record, provide a crucial window into their past ecological roles. The researchers measured more than 9,000 fossil and living shark teeth from around 500 species, gathered from museum collections and literature to

chart changes in shark functional diversity throughout the Cenozoic era (66 million years ago to the present).

Lead author Jack Cooper, a PhD student at Swansea University, explains: “Measurements like tooth size, shape, and types of edges broadly reflect a shark’s functional traits such as body size and diet, allowing us to assess their functional diversity through time.”

The study revealed that extinct shark species contributed disproportionately to functional diversity compared to their extant counterparts. Extinctions of large apex predators, mid-sized suction feeders, and deep-sea predators resulted in significant ecological gaps. By quantifying the ecological contributions of individual species, the researchers determined that the observed decline was driven by the loss of ecologically unique and specialised species. Such losses included the extinction of the megalodon, the largest shark that ever lived, which was an apex super predator, an ecological role not played by any shark living today.





Protecting shark functional diversity requires action. Identifying and safeguarding functionally unique and endangered species is important. Conservation efforts must focus on preserving critical habitats and mitigating overfishing. The study highlights key modern species, such as the bluntnose sixgill shark and the great white shark, which maintain vital parts of the historical functional space.



Senior author Dr Catalina Pimiento, Professor at the University of Zurich and senior lecturer at Swansea University, said: “By identifying the modern species holding some of the Cenozoic functional space, our study could potentially complement conservation priorities for the preservation of shark functional diversity in our changing world.”



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SWANSEA

Floating solar panels could provide much of Africa's energy

New research spearheaded by environmental scientists at Bangor University reveals that several African countries could meet much of their energy needs through innovative solar panel systems floating on lakes. These floating photovoltaic systems, could potentially transform the continent's energy landscape

Floating photovoltaic systems are solar panels mounted on structures that float on water bodies like lakes, reservoirs, and ponds. The panels are kept afloat by pontoons or rafts and are anchored to the edges of the water bodies to ensure stability. Designed to withstand varying water levels and weather conditions, including storms, these systems can provide a robust solution for energy generation.

The study conducted by Doctor Iestyn Woolway and Professor Alona Armstrong analysed the potential energy production from floating solar panels on 10% of the water surface of one million bodies of water globally. The findings showed Ethiopia and Rwanda, for instance, could generate more electric energy than their current national needs from these floating systems. Specifically, Rwanda could produce 237% of its current energy requirements, while Ethiopia could generate 129%. Other countries, such as Chad, Mali, Madagascar, Malawi, Uganda, the Democratic Republic of Congo, and Togo, could also significantly boost their energy supplies with these systems.

Countries with limited land but abundant water bodies, such as Ghana, which recently installed Africa's largest floating solar panel system on one of its reservoirs, are

leading the way in adopting this technology. By gathering data on sunlight, air temperature, and specific details about solar panels, and analysing satellite images, the researchers identified suitable areas for deploying floating solar panels.

To ensure accuracy, the team excluded water bodies that dry up, freeze for more than six months a year, are within protected areas, or are located more than 10km from a population centre. They also considered technical and environmental constraints to limit the size of the floating solar systems.

One of the key advantages of floating solar panels is their ability to reduce water evaporation from lakes and reservoirs, a significant benefit for water-scarce countries in Africa. Additionally, by shading the water, these panels can reduce the occurrence of harmful algae blooms, which degrade water quality and harm aquatic life. This not only improves the health of water bodies but also reduces water treatment costs.

Floating solar systems can bring electricity to rural, remote, or off-grid areas that have never had a reliable supply before. However, to fully harness the potential of this technology, the research team notes that African countries would need to address several challenges. Many regions in sub-Saharan Africa have limited or unreliable grid connections, making it essential to enhance grid infrastructure or develop off-grid solutions such as

mini-grids near water bodies. Governments may need to encourage the development of floating solar projects through incentives, subsidies and streamlined permitting processes, while also establishing environmental and safety regulations. Environmental impact assessments would be needed to avoid negative effects on aquatic ecosystems and water quality. In addition, engaging with local communities to gain their support and ensure equitable benefits from the energy generated is important, as is avoiding "green grabbing" – where local communities are disadvantaged by green energy projects.

Many African countries have large water bodies, abundant sunshine, and issues with water evaporation and algae blooms. Floating solar panel systems offer a potential solution: addressing environmental problems while creating low-carbon energy.

Solar energy generation produces minimal greenhouse gases compared to conventional energy sources like coal and natural gas, helping combat climate change and reduce air pollution. By utilising solar power, countries can decrease their reliance on imported fossil fuels, enhancing energy security and economic stability. As the world strives to achieve Net Zero carbon emissions by 2050, floating solar panel systems could play a crucial role in reaching this goal.



Approximately five million square kilometres of Earth's surface area, or 3.7% of the non-ice-covered surface, is occupied by lakes and reservoirs. Floating solar panel systems could be deployed on many of these water surfaces, converting sunlight into electricity using photovoltaic cells. These floating systems benefit from the cooling effect of water, enabling them to produce more electricity than land-based panels and potentially extending their operational lifespan.

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BANGOR

New method for quantifying 'Invisible' plastics in rivers

Current methods for evaluating the amount of plastic pollution in rivers are insufficient and do not account for the fragments which sink below the surface, scientists have warned.

These 'invisible' plastic pieces can be suspended below the waterline or sink to the riverbed, where they are potentially harmful to the ecology of a river.

The international team, from Cardiff University, Karlsruhe Institute of Technology in Germany, and Deltares in the Netherlands, says these oversights must be addressed to establish baseline pollution levels in rivers and determine the success of ongoing clean-up strategies. Their study describes how these unseen plastics move in rivers and offers a new method for counting them.

The team dropped over 3,000 common plastic pollution items, such as polystyrene cups and other fragments, into large water channels designed to represent real river conditions. Using multiple cameras, they tracked the movements of the samples to millimetre accuracy.

Their analysis shows that sinking plastics with different shapes and sizes can be transported in diverse ways in rivers. In the study, they demonstrate how plastics sink in different orientations, which significantly changes how fast a particle will sink. Previously, it was thought that plastics always find

a stable sinking orientation and therefore sink at a constant speed. This study shows that this is not the case for plastics that are fragmented and fractured. This is important, as the sinking rate of a plastic particle is essential for understanding how it is transported. This finding significantly changes the understanding of how plastics move in rivers.

The research data were used to adapt physics-based equations, previously developed for sediments, which can predict the amount of plastic that travels in rivers within a margin of 10% accuracy. The team says their method could offer more accurate estimates of the total amount of plastic pollution in rivers.

James Lofty, from Cardiff University's School of Engineering, said: "Our study improves our current understanding of how and where plastic pollution is transported in our rivers. The methods used at the moment rely on counting plastics on the river surface and therefore do not accurately capture the plastic travelling underwater or settling on the riverbed. This impacts our ability to quantify exactly how

much plastic our rivers contain, determine hotspots for plastic pollution, and significantly restricts the effectiveness of clean-up strategies."

There are existing methods which can quantify this type of plastic pollution using underwater cameras or sonar, but these cannot practically be deployed in our rivers. This new method can be used in any river because it uses this very well-known equation also used for sediments.

The team is further developing their method in real rivers and on different types of plastic under varying conditions. They plan to collaborate with industry partners to help provide more realistic estimates of plastic pollution in rivers and to implement effective mitigation practices.



"Our research illuminates how much plastic litter is sinking to the riverbed and travelling undetected in rivers. Combined with our existing knowledge of how sediments move in rivers, this new method could provide a more realistic picture of plastic pollution in our rivers and, most importantly, where to focus the resources of plastic clean-up strategies."

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CARDIFF

Detecting the DNA of cyberattacks

A collaboration between Cardiff University and Airbus has led to a new method for detecting and preventing malicious software.

When the WannaCry cyberattack hit the NHS in 2017, it caused widespread disruption. This event showed that cyberattacks were not just a risk to personal devices or data but posed an existential threat to critical infrastructure with potentially devastating consequences. In just eight hours, more than 200,000 computers across 150 countries were attacked, causing damages estimated in the hundreds of millions to billions of dollars. In the UK, up to 70,000 devices across 42 NHS trusts were affected, including MRI scanners, blood-storage refrigerators, and operating theatre equipment, forcing some trusts to turn away non-critical emergencies and divert ambulances.

The team at Cardiff University, led by Professor Pete Burnap, suggests that the attack could have been prevented. Many of the affected organisations were using outdated versions of the Windows operating systems that lacked the up-to-date security patch capable of stopping the attack. The researchers are particularly concerned about these so-called "legacy systems" and their vulnerability to future cyberattacks.

The goal of creating a live, automated defence against cyberattacks has long driven the Cardiff University team. Leveraging the latest advances in artificial intelligence and machine learning, they have moved away from traditional approaches that find malicious software through specific code signatures. Traditional antivirus software looks at the code structure of a piece of malware and says, "that looks familiar". But the problem is malware

authors chop and change the code, so the next day the code looks different and is not detected by the antivirus software.

To address this, the team has developed a method to understand how malware behaves rather than what it looks like. By observing actions such as opening a port, creating a process, or downloading data in a particular order, they can create a "DNA profile" of a cyberattack based on its behaviour. This approach has proven effective, enabling the detection of malicious activity in malware with 98 percent accuracy after just four seconds of execution.

The success of the university's malware detection tool can be attributed to a productive collaboration with the world's largest airline manufacturer. Airbus's interest was piqued following media coverage of Professor Burnap's work detecting malware. They offered him a secondment to lead research focused on protecting their global IT and manufacturing network.



This collaboration led to the development of the malware detection tool and a complete rethink of how large organisations manage cyber threat risks. The team developed a novel risk methodology for Airbus, focusing on what needed to go right rather than what could go wrong. This approach, combined with the malware detection tool, provided a unique system for both detecting potential attacks and assessing their impact on business operations.

This system is now integrated into Airbus’s cybersecurity systems, protecting the confidential data and intellectual property of 134,000 employees, and shielding key European infrastructure, with the potential to save millions in recovery costs from future attacks. The collaboration has continued to thrive, leading to the launch of the Airbus Centre of Excellence in Cyber Security Analytics, directed by the Cardiff team leader.

The hope is that, armed with the tools and methodologies created at the university, businesses can proactively guard against cyberattacks and avoid the overwhelming havoc they can inflict.



"We roll these technologies out because they provide a service to us, but we always then retrospectively try and solve cybersecurity problems. If we keep doing this, the same mistakes will be made over and over again. But if technology such as driverless cars were hacked, the consequences would be devastating and would have even bigger repercussions for things like green infrastructure and Net Zero."

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CARDIFF

Game developed in Wales becomes global success

In an industry often dominated by established giants, a computer game developed by graduates from the University of South Wales (USW) has captured the imagination of gamers worldwide, making headlines and securing top chart positions across major gaming platforms.

"Sker Ritual," a game created by Wales Interactive, is a round-based zombie horror shooter set in 1914, in the eerie and atmospheric Sker Hotel. This fictional setting is inspired by real locations in South Wales, around an area called Sker Point.

The plot revolves around Elisabeth Williams, who seeks domination through the broadcast of the Siren's Song. Players join her daughter, Arianwen, to thwart this broadcast and save the world. The game plunges players into a haunting narrative where they must face waves of grotesque enemies known as the Quiet Ones. These terrifying foes are driven by supernatural forces and a chilling backstory tied to Welsh folklore.

Players can engage in first-person gameplay, teaming up in groups of up to four to fend off increasingly difficult enemy waves. Utilising a variety of weapons and gadgets, players must work together to survive each onslaught. The game's environment is rich with atmospheric details, eerie sounds, and dark, claustrophobic settings. Strategic planning and cooperation are essential in "Sker Ritual," as players must manage limited resources and make tactical decisions to outlast the horrors that await them. The game also offers various objectives and challenges, adding depth to the survival mechanics and keeping players engaged.

The game has achieved global success, ranking in the top three on the Steam digital distribution platform, top five on the Xbox platform, and top ten on the PlayStation platform. Its popularity has cemented its place as one of the best-selling titles for both PC and console.

The creators of the game, Wales Interactive, are a south Wales-based games company set up by Richard Pring, who graduated from USW, and co-founder Dr. David Banner MBE. Reflecting on the game's success, Richard Pring remarked: "We developed a product to address a niche in the market, and I'm delighted that it holds its own among the top contenders in this genre. Our original goal was to create a significant games industry presence in Wales and to tap into the local talent pool."



Now an award-winning video game and interactive movie developer, publisher, and investor, Wales Interactive has grown into a publishing label collaborating with talented game developers and filmmakers across the globe. Their growing portfolio of titles has been played by millions globally, entertaining the world and putting Wales on the video games map.

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PENARTH