Microbiome Ireland

A World Leading SFI Research Centre

Science Foundation Ireland sfi For what's next

20 YEARS OF APC IMPACT

APC MICROBIOME IRELAND A WORLD LEADING SFI RESEARCH CENTRE

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HOST INSTITUTION

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

agasc Agriculture and Food Development Authority

PARTNER INSTITUTION

nibrt

MTU

University of Limerick

20 YEARS OF TRANSFORMATION

In the 20 years since our foundation, APC Microbiome Ireland (APC) has had a profound and pioneering impact on the world of microbiome research. And our focus on such major societal challenges as chronic and infectious disease, anti-microbial resistance and sustainable food development means that our ground breaking scientific research has huge relevance to human and planetary health.

We have published thousands of papers on excellent science – on average a publication per day each year. We have pioneered new directions of research into microbes and the brain, inflammatory bowel disease and early-life and elderly nutrition. We have discovered thousands of new species of microbes that will underpin medical treatments and will protect foods of the future, displacing antibiotics and increasing sustainability. We have spun out companies that are translating these discoveries to the clinic and market.

The depth of our science and our focus on solutions makes APC a household name in microbiome research. Our researchers are recognised as being among the most highly cited and influential in the world. Industry and academics around the world - from Ireland to New Zealand and back - want to work with us, and our science communication and public engagement bring our discoveries into conversations in media, schools and homes.

By understanding the composition and structures of the microbiomes in, on and around us, APC is developing new and sustainable tools and approaches to optimising those malleable microbiome communities to support global sustainability and health from infancy to old age.

And the common denominator underpinning this scientific excellence is our people. At APC we are a family of like-minded and passionate experts working on a world full of microbes. I congratulate our APC family on the last 20 years and look forward to our coming decades of further excellence and impact, mobilising microbes for planet and people health.

Professor Paul Ross, Director, APC Microbiome Ireland, December 2023

20 APC IMPACTS

APC researchers interact with approx.

80,000

members of the public each year through school visits, visits to APC labs, public fora, and science fairs.

APC pioneered a new research field uncovering links between gut microbes, brain function, and behaviour - they also coined the phrase

'Psychobiotics'

to describe live bacteria that might confer a mental health benefit.

13

Of the 33 Irish scientists featured on the 2023 Clarivate Highly Cited Researchers list are from APC.

APC PIs have received

164

significant distinctions and awards.

APC has produced more than

3,000

peer-reviewed publications, which have been cited more than

164,000

times.

In the last 10 years, APC staff and students have been recruited from

59

countries worldwide.

APC has presented science to over

65,000

school students and has almost

17,000

social media followers.

APC researchers have secured more than

€72M

in R&D funding from industry.

APC helps to generate

€1.4m

for the Irish economy each week, including expenditure and taxation impact.

In November 2023, APC researcher Fergus Shanahan and graphic designer Laura Gowers published

'Listen to your Microbes'

a story of the human gut microbiome told from the perspective of the microbes.

APC has won competitive grants from SFI totaling €100m since 2003, and has won an additional

€202M

in research funding from other sources. For every €1 invested by SFI in core funding, APC has added another €2.01 in leveraged investment.

IP based on APC research has been transferred to industry via

47

technology licence, option and assignment (LOA) agreements.

135,000

people have passed through the APC Alimentary Adventures 'inflatable gut' - a 10-metre long inflatable gut that mimics the human digestive system.

APC supports more than

500

jobs in Ireland each year.

In 2022, APC hosted two international conferences with over 900 international delegates, which had an estimated positive impact on the Irish and local economy of

€1.4M

APC has spun out five companies, which together employ more than

100

people.

For every €1 of investment into APC by the State, APC returns

€6.56

to the Irish economy.

719

alumni have been trained at APC of which more than 42% have taken up employment in industry.

APC researchers have secured

6 ERC Awards

in the last five years.

Since 2013 APC has produced over

250 PhD Graduates

to fuel the research and innovation ecosystem.

APC AND ENGAGED RESEARCH

Citizen science, public patient involvement (PPI) and collaborative approaches are integral to APC's research culture.

TACKLING ENDOMETRIOSIS TOGETHER WITH PATIENTS

Around the world 176 million women suffer the pelvic pain of endometriosis – that's around one in every 10 women between the age of puberty and menopause. We don't know exactly what causes endometriosis, which means that research is a priority to help patients today and into the future.

Through an Engaged Research Bursary from APC Microbiome Ireland, Dr Siobhain O' Mahony's team worked with community partners to improve everyone's understanding of the condition.

In 2023, 45 people took part in a Conversation Café on Endometriosis at the River Lee Hotel. Patients, their parents, health care practitioners and researchers met to discuss a range of topics, including the impact of endometriosis on fertility options and on personal and professional relationships.

The event led to the formation of a PPI panel, who are eager to be involved in informing APC research and funding applications in the future.

"This project provided me with a true understanding of Engaged Research and how central patients and stakeholders are to our research. Patients want to be heard, and receive faster and better treatments and have more events like this where they can discuss, share and learn together."

Dr Siobhain O' Mahony, APC Microbiome Ireland

REAL INSIGHTS INTO IBD

"In 2021 I embarked on a new research project at APC together with Naomi Hanrahan. She had gathered IBD patients experiences with various elements of diet since their diagnosis and wanted to disseminate these findings through a PPI collaborative approach. As an IBD warrior myself for 20+ years, and through my work on the Board of Directors with Crohn's & Colitis Ireland (CCI), this felt like a natural pathway for me.

We formed a PPI panel of IBD patients - which we called 'IBD Insights' – to disseminate the information and also to help write the first APC PPI paper (under review) along with each group sessions creating more ideas for future PPI research, and for fundamental science also.

This PPI research approach has given a voice to those that matter the most - the people suffering from IBD and through their lived experience, cultivate ideas and thoughts that may help those affected by IBD, and future research into this invisible and debilitating disease."

Victoria Spillane, APC Microbiome Ireland and Crohn's & Colitis Ireland

THE PATIENT'S VOICE - CRUCIAL TO RESEARCH

"Understanding the role of diet in IBD is complex, a complexity we felt could not be fully addressed without integrating the lived experience. Our PPI project aimed to clarify dietary components consumed and gather perspectives of individuals with IBD to understand their food choices and to identify key aspects for future research. The patient-collaborator panel we assembled was essential in guiding our investigations and grounding them in real-world issues often overlooked - such as in understanding the many factors affecting what someone living with an IBD can and will eat. Incorporating the patient's voice accelerates the discovery of patient-important aspects, reshaping how we approach problems and find solutions. The insights from the PPI panel were invaluable and have transformed my approach to research, in realising the impact it has on people's lives."

Naomi Hanrahan, Final Year APC PhD student in UCC College of Medicine and Health

APC AND LONG COVID

APC's research programme on Long COVID implemented Engaged Research by design and hugely benefitted from the lived experience and knowledge of Long COVID patients incorporated through a variety of methods including a patient survey and focus groups. APC's research on Long COVID implemented Engaged Research by Design and hugely benefitted from the lived experience and knowledge of Ms Tanja Buwalda, Long COVID sufferer and representative of 'Long Covid Advocacy Ireland'.

"Long Covid patients are fighting to get identified, treated, and supported by the Irish health system. In light of this, the partnership between the Long Covid Ireland support group and APC on Long Covid research, and the resulting webinar and survey, has allowed patients to participate directly in the research and should set the standard for future exploration - allowing patients to participate in vital investigations that will have an impact on their health.

The novel patient/researcher webinar provided the first national education event on Long Covid and was wholeheartedly welcomed and supported by patients. We hope to see more collaborations in the future to help us make substantial advances in how we diagnose and treat Long Covid."

Tanya Buwalda / Long COVID Support Ireland

APC AND HEALTH

APC research is changing how we understand the impact of our microbes on health, and how we can best support them for our well-being.

MICROBIOME AND HUMAN PERFORMANCE - A GOOD FIT

Teagasc and APC researcher Dr Orla O'Sullivan is finding that the composition of the human gut microbiome is linked with physical fitness and athletic performance. As part of her research into the gut microbiome in fitness, Orla has worked with athletes from the IRFU, Cricket Ireland, Sports Ireland Institute, Ironman Indiana and a Premiership soccer team. In 2018, she was listed as a Clarivate Highly cited Researcher placing her in the top 1% of researchers globally, and in 2019 she received the prestigious SFI Early Career Researcher of the Year Award.

Credit: Tina Darb

THE MICROBE-MOOD CONNECTION

In the last 20 years, APC research led by Profs John Cryan and Ted Dinan has identified bacteria that could be linked with stress and mood. The findings have informed commercial supplements that look to modulate our moods through our microbes, and the gut-brain axis is now a thriving area of research worldwide. Major neuroscience conferences around the world now routinely feature research into the microbiome, and APC researchers are recognised as leaders in this field.

NEW ANTIMICROBIALS FROM THE MICROBIOME

Antimicrobial resistance is a factor in millions of deaths around the world each year and as a result, there is an urgent need for new antimicrobials to replace or enhance ineffective antibiotics.

This has prompted APC researchers led by Profs Paul Ross and Colin Hill to mine microbiomes for microbes and molecules that kill problematic bacteria in a targeted way. Their discoveries include Thuricin, which was isolated from a strain of bacteria in the human microbiome, and actifensin, which they discovered in a bacterium isolated from the sheep microbiome.

These and other APC discoveries are being explored as antibiotic alternatives, food biopreservatives, animal feed supplements and treatments for disease, including a clinical trial in the USA on a new approach to treat inflammatory bowel disease and to stop the recurrence of a debilitating bowel infection.

Credit: Emma McCarthy

IMPORTANT INFORMATION IN THE IRISH TRAVELLER MICROBIOME

Most Irish Travellers have an ancient, pre-industrialised type of gut microbiome that could hold clues to protecting against inflammatory bowel disease - a condition that affects millions of people worldwide - according to a study by APC led by Prof Fergus Shanahan with the Traveller community, which was published in Nature Medicine.

The Traveller Visibility Group (TVG) and Travellers of North Cork were integral partners on the study. TVG's Director of Advocacy, Breda O'Donoghue says: *"The microbiome research has confirmed what we always knew, we need to preserve the traditional Traveller lifestyle as it is essential for the health and wellness of our community. We can see from the research that once a Traveller adapts to a settled lifestyle their microbiome is negatively affected."*

TVG Development Worker John O'Sullivan says: *"A sequence of legislative changes since 1963 has eroded Traveller culture making it almost impossible for a Traveller to continue the traditional lifestyle they were brought up with, including possession of horses. We hope this research will help us get support to restore some of our heritage and preserve our unique way of life."*

TACKLING ANTIMICROBIAL RESISTANCE THROUGH MICROBIOME RESEARCH

"My interest in the microbiome started in India, when I chose the topic for a research module in my Master's degree. When the time came to do a PhD, I really wanted to continue researching the microbiome, so I came to APC.

My doctoral project was on the effects of antibiotics on the microbiome and the rise of anti-microbial resistance, which is a big and growing problem in human and veterinary medicine. When microbes become resistant to antibiotics, we have fewer and fewer options for treating the infections they cause.

There were many aspects to the research, and one was to look at the effects of antibiotics on the microbiomes of babies. We showed that if a baby is exposed to antibiotics in the first four days after birth, that has immediate and long-lasting effects on their microbiome. We could see that babies exposed to antibiotics had higher levels of microbial resistance genes in their microbiomes for as long as six months afterwards.

I hope that our research prompts further action to use antibiotics more judiciously, and perhaps even in the future we could see where local resistance genes are increasing and tailor the antibiotic use in those geographic regions to address antimicrobial resistance.

For me, there is no better place to learn about the microbiome than APC, and I have the best mentors here, who not only support me but also push me to do the best I can."

Dr Dhrati Patangia, Post-doctoral researcher, APC and Teagasc

IMPROVED HEALTH IN OLD AGE

APC researchers have carried out landmark studies, including ELDERMET, that show too little diversity in the gut microbiome and loss of key microbes is linked with poorer health in older people, and that having an appropriate variety of microbes in the gut is key for good health.

APC IMPACTING CLINICAL PRACTICE

Good evidence leads to good clinical practice and better outcomes - APC research is making a difference.

RESTORING GUT HEALTH

In faecal microbiota transplantation (FMT), microbes are introduced to a person's intestine to restore a healthy balance of gut bacteria. APC researchers led by Fergus Shanahan and Paul O'Toole supported the introduction of FMT in Irish hospitals, particularly Cork University Hospital, for patients suffering from debilitating and life-threatening recurrent infections with Clostridium difficile bacteria. They performed microbiological processing of FMT samples to preserve anaerobic bacteria and this compassionate emergency care given to patients with very poor prognoses genuinely helped save lives.

EARLY-LIFE PROBIOTIC BOOST

APC research led by Prof Catherine Stanton in collaboration with Cork University Maternity Hospital (CUMH) has found that gut microbes in babies are altered by C-sections, antibiotic use, formula feeding and premature birth. Based on the findings, CUMH now gives probiotics to pre-term infants, and published analysis by APC indicates the probiotics are helping to protect these vulnerable babies from severe gut infections such as necrotising enterocolitis (NEC) and mortality.

TRACKING COVID IN REAL TIME

APC played a crucial role in Ireland's response to the COVID-19 pandemic by leading the National Coronavirus Sequencing Consortium. The network used the APC's expertise and equipment to rapidly sequence the genetic material of virus samples and interpret the results to keep track of emerging infection trends in the Irish population. Being able to quickly alert the authorities to new strains coming into Ireland meant that responses could be put in place quickly to help protect people against infection and illness.

APC research led by Prof Liam O'Mahony showed that a person's risk of death when they have severe COVID-19 depends in part on the types of interactions occurring between their microbiota, metabolism and immune system, opening the way for new diagnostics and potential treatments in the future.

LESS RADIATION FOR PATIENTS UNDERGOING CT SCANS

APC researchers led by Prof Michael Maher worked with industry collaborator GE Healthcare to reduce radiation exposure in CT scans. The updated protocols for scanning mean that patients with chronic gastrointestinal conditions are exposed to less radiation during the scan, improving safety, but the scan maintains accuracy. This is particularly impactful for patients with chronic conditions, such as inflammatory bowel disease (IBD), that need repeated CT scans over their lifetime.

APC AND FOOD

APC researchers are pioneering new microbe-related approaches to make food safer and better for us all.

ANCIENT FOODS, MODERN INSIGHTS

Whether it's soy sauce or buttermilk, kimchi, yogurt or pickles, people around the world have eaten fermented foods for thousands of years. APC researchers led by Prof Paul Cotter & Dr John Leech have now shown that fermented foods benefit the bugs in our intestines, and they have discovered genes from bacteria in fermented foods that can promote human health and food flavour. APC is working with academic and industry partners in Ireland and internationally to develop new food supplements and ingredients that harness the benefits of fermented foods.

FEED THE ANIMALS, FEED THE HUMANS

Livestock such as cows, pigs and sheep need to be fed optimally in order to produce nutritious food for humans. APC research has discovered and tested several ways to positively support animal microbiomes through their feeds. They include using bacterial molecules and strains as more targeted alternatives to antibiotics, and probiotics that can reduce the amounts of Salmonella shed by pigs. APC is working with industry partners to bring beneficial animal feed supplements into more general use.

NEW MICROBE GENOME DATABASES FOR FOOD SAFETY

APC researcher Prof Paul Cotter co-ordinated the EU Innovation Action MASTER, a 29-partner project to develop new microbial strains, foods, feeds, processes and databases of relevance to the food chain, all with sustainability in mind. As part of the 4.5-year initiative, APC researchers were involved in the sequencing of DNA from food samples, in order to audit microbes in the food chain in Europe. They identified 2,000 types of microbe in the food chain and created a reference database with 10,000 genomes. This means it is now easier to quickly identify what microbes are in the food chain, and use that information to improve food quality and safety.

NUTRITION FOR LONG LIFE

Through a European programme called LONGLIFE, APC researchers have analysed lactic acid bacteria and the molecules they produce. Their discoveries are being taken forward by industry as functional ingredients to enhance the nutrition and health-promoting qualities of foods.

END-TO-END SOLUTIONS FOR FOOD TRIALS

Cork-based APC spin out Atlantia Food Clinical Trials Ltd delivers end-to-end solutions for clinical trials in functional ingredients in foods, beverages, nutraceuticals, medical foods and dietary supplements. The company continues to work closely with APC and has built a comprehensive client list that includes many of the food industry's biggest names.

DRIVING INTERNATIONAL CONSENSUS

APC is contributing to the global definitions and guidelines for various microbe-related foods. APC researchers have co-authored The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statements on fermented foods, probiotics and postbiotics, and are now evaluating the possibility of including microbes in international dietary guidelines.

APC AND SUSTAINABILITY

The only future is a sustainable one, and sustainability underpins APC research and training.

METHLAB TAKES THE METH OUT OF BREATH FOR COWS

Ruminant livestock, such as cows, belch out methane, an undesirable 'greenhouse' gas. More than 100 countries, including Ireland, have committed to reducing greenhouse gas emissions. Lactic acid bacteria are often given to animals to boost health and production, but APC researchers led by Professor Catherine Stanton have taken it to the next level. The MethLAB project, which saw APC researchers work with partners in, Europe and New Zealand, tested several types of lactic acid bacteria both in the lab and on the farm. They identified two strains that could markedly reduce the amount of methane produced from cows, while at the same time maintaining the animal's health and its ability to produce food.

MICROBES, SDGS AND THE FUTURE OF HUMANITY

In June 2023, APC researcher Professor Paul O'Toole co-authored a paper called 'The human microbiome, global health and the Sustainable Development Goals: opportunities and challenges' in the prestigious journal Nature Reviews Microbiology. The paper outlines how microbes and microbiome research underpin the success of the UN SDGs, and pointed to the need to understand and harness the connections between human activity and microbiomes, climate change, food production and the health of humanity.

GROWING SUSTAINABLE SCIENCE EDUCATION IN DEVELOPING COUNTRIES

Honduras is one of the poorest countries in Latin America and one of the most affected by climate change. A team of APC researchers led by Dr Yensi Flores Bueso and Dr Mark Tangney developed a training programme on synthetic biology and delivered it at the National University of Honduras. At one point, activities were disrupted by Honduran riot police firing tear gas at protesters. The training in biotechnology techniques has resulted in local scientists running similar courses in Honduras and in other Latin American countries. The resulting events in schools and in communities are encouraging widespread engagement with science.

INSPIRING RESEARCH FOR TODAY'S GLOBAL CHALLENGES

APC is recruiting 20 researchers from around the world into the INSPIRE (INnovative Sustainable Development InterdisciPlinary Post-Doctoral Fellowship) Programme, which trains researchers and encourages industry exposure as they focus on major global challenges facing food systems and health, with a focus on sustainable solutions.

APC AND THE ECONOMY

APC delivers a high return to the Irish economy, and from day one APC has cultivated strong links with industry, and has spun out five companies that are generating economic impact in Ireland.

APC SPIN OUTS

4D Pharma Cork Ltd (formerly Tucana Health) investigated how the composition of bacterial communities in the gut can aid the diagnosis and treatment of disease, particularly irritable bowel syndrome (IBS). inflammatory bowel disease or IBD

Cork-based **Atlantia Clinical Trials** specialises in conducting human clinical studies in functional foods, supplements, ingredients and live biotherapeutics. Founded in 2012, the company now employs over 80 people with operations in Ireland and in the US.

Adiso Therapeutics (formerly Artugen Therapeutics) is a clinical-stage biopharmaceutical company dedicated to improving the health of patients suffering from debilitating inflammatory diseases. The company is trialling new treatments for mild to moderate ulcerative colitis and recurrent Clostridium difficile infection.

SeqBiome, which was spun out in 2019, provides high-quality next-generation interactive sequencing and microbiome analysis for academia and industry. The company provides its bioinformatics analysis services to clients across sectors such as Pharmaceuticals, Nutrition, Sport, Healthcare, Agriculture and other Life Sciences.

CaraBia is a new early stage spin-out company from the APC that will develop novel microbiome-tailored food products for healthy aging, building on well over a decade of in-depth analysis of the gut microbiome of aged cohorts in different settings.

Precision Biotics

"PrecisionBiotics Ltd was spun out of UCC in 1999 and has maintained a strong research partnership with the APC since its inception in 2003. This partnership has played a huge part in our journey from small start-up to becoming a global leader, now as part of Novozymes OneHealth, in the discovery, development and commercialisation of unique probiotic cultures that impact human health. Our lead products Alflorex® incorporating the B. longum 35624® strain discovered in Cork and licensed from UCC and more recently Zenflore® were based on collaborative research with the APC. In addition to collaborative research programmes, APC also provided the company with a stream of talented people who came to us and have kept the company at the forefront of this pioneering research. We have ambitious plans and will continue our close partnership with the APC going forward with a focus on the development and commercialisation of precision cultures for human health underpinned by high-quality science."

Barry Kiely, General Manager, PrecisionBiotics, part of the Novozymes OneHealth Group

APC DELIVERS A HIGH RETURN ON STATE INVESTMENT

Taking 2022 as a representative year, the total economic impact of APC is €73.7m per annum, meaning that APC helps generate €1.4m per week for the Irish economy and returns €6.56 to the economy for every €1 invested by the State. Separately, for every €1 invested by the State in APC, APC is responsible for returning €0.75 cent of that back to the government in the form of taxes and social insurance contributions.

APC has won competitive grants from SFI of €99m since 2003, and has added to this by winning another €202m in research funding from Industry, Exchequer, EU and philanthropic sources. For every €1 invested by SFI via core funding, APC has added another €2.01 in matched investment (of which 55% has come from non-Exchequer sources).

APC BRINGING KNOWLEDGE TO INDUSTRY

In the last five years, APC has signed 13 collaborative research agreements with Irish companies, and four license agreements with Irish SMEs. These interactions enhance the R&D portfolios of these Irish companies, and potentially lead to development of new products that will boost sales and secure jobs in Ireland.

APC AND INDUSTRY

For 20 years, APC has collaborated closely with industry, translating excellent science and innovation into impact.

Since 2003, APC has collaborated with **86 companies** from **15 different countries** across a variety of sectors including food & nutrition, healthcare, biotechnology, probiotics, dairy, brewing and sport.

In the last **20 years**, APC has licensed

47

technologies to industry which has generated IP licence revenue for the APC that is being re-invested in the APC Entrepreneurship programme to support early stage researchers and faculty to progress commercial ideas that might one day lead to new spin-out companies.

APC has attracted foreign direct investment from

11

companies that **would not otherwise have a footprint in Ireland** were it not for the APC research.

DANONE
ONE PLANET. ONE HEALTH

"Microbiome research is a crucial part of the Danone-Nutricia research strategy and a cornerstone of this has been the highly rewarding collaboration with APC for over a decade. This partnership has yielded a variety of insights into our understanding of for example bifidobacteria and the role they play in dairy, infant and fermented food products – from their impact on overall health, gut-brain interaction, as well as microbiome restoration following antibiotic use. In short, APC have helped us understand how microbes can shape the qualities of our nutritional products."

Jan Knol, Senior Director Gut Biology & Microbiology, Danone Nutricia

dsm-firmenich

"Working with Profs Douwe van Sinderen and Jennifer Mahony at APC over the years, most recently through the DSM-SFI co-funded BacTrans Spoke project, has empowered dsm-firmenich, Taste, Texture & Health to accelerate its dairy cultures innovation programme. Next to a deepened understanding and increased expertise to identify and create novel cultures, the collaboration accelerates the development of next-generation, high-quality culture solutions that offer taste, texture, nutritional and health benefits of the product to ensure it meets the producer's and consumers' expectations. With 100+ years of industry expertise combined with Douwe and Jennifer's profound scientific knowledge and vision, this strong partnership has led and will lead to extended culture solutions of added-value making use of proprietary technology developed within the programme."

Dr Noël van Peij, Principal Scientist dsm-firmenich | Taste, Texture & Health | Center for Food Innovation

TATE & LYLE

"APC Microbiome Ireland has been a valued research partner of Tate & Lyle's for many years, complementing our global nutrition team's work to extend our understanding of the beneficial effects of our dietary fibres, particularly around metabolic health, while supporting our NPD pipeline through the co-creation of breakthrough new ingredient technologies."

Dr Kavita Karnik, Tate & Lyle's Global Head of Nutrition, Regulation and Scientific Affairs

Fonterra™

Dairy for life

"When I was tasked with developing a new probiotics discovery programme, it was important to me that we worked with the best in class. For me it was a no-brainer, it was APC. Although we've achieved a lot through our collaboration over the past four years, establishing a research centre in Ireland with APC speaks to the longevity of our partnership and is testament to the value in which we hold our relationship with APC."

Dr Shalome Bassett, Programme Leader Scientific Affairs, Fonterra

APC TRAINING LEADS TO SUCCESS WITH INDUSTRY

"When I started my PhD on obesity and the gut microbiome, I became part of the APC family. And just like a family, the people at APC have always supported me, not only when I worked there as a PhD student and then a post-doctoral researcher on the gut-brain axis, but they also created opportunities for me when I chose to move to industry.

I could see the value of the work we were doing at APC on the links between probiotics and behaviour and mood, and I wanted to help bring these innovations to consumers. I worked with DuPont Nutrition and Biosciences (now IFF) in Finland, where I co-developed the strategy and innovation pipeline for probiotics for brain health together with my team. Then I moved back to Cork and joined Novozymes OneHealth, where I work on projects to bring new biological products for brain health to the market.

All through my time in industry to date, I have maintained a close collaboration with APC scientists, and I have continued to be linked-in with APC's network. The scientific training that I got at APC is recognised all over the world in industry, and from the work I did with APC's Education and Public Engagement, I also learned how to communicate about microbiome research clearly, something that has stood to me when connecting with global customers, marketing and commercial teams. Like a nurturing family, APC truly sets you up for success."

Dr Elaine Patterson, Health Science & Technology Lead at Novozymes OneHealth

Credit: Jakub Saluda

Over 30 APC Alumni has found employment in Lilly in the last 10 years

"What really sets the APC apart from the rest are the opportunities for growth. Beyond its scientific excellence it gave me the chance to cultivate interests in Education and Public Engagement and Science Communications. This allowed me to develop desirable skills that gave me the edge on the jobs market. "

Jack Daly, Global Scientific Communications, Eli Lilly, Cork.

APC CONNECTING WITH PEOPLE

APC is driven by people for people – we attract and support the highest calibre researchers and reach wide audiences through engagement.

Credit: Catriona O'Driscoll

APC researchers interact with approx.

80,000

members of the public **each year** through school visits, visits to APC labs, public fora, and science fairs.

APC has co-ordinated more than **350 Transition-Year** student placements and APC researchers have presented science to around

65,000

school students.

"Thank you for having us in APC. We had a great time in the lab and learned a lot We really enjoyed our tour as well."

4th class students of St Catherine's National School, Model Farm Road, Cork

CONNECTING WITH PEOPLE

In 2018, APC launched World Microbiome Day, an annual, public, global event on June 27th to celebrate and explore microbiome science. Since its inception, over 200 events have taken place in almost 30 countries around the world.

Fancy growing your own kefir? APC is a partner in the citizen science project *Kefir4All* that encourages people to grow and 'mind' kefir, a fermented drink based on milk or water. Participants send samples in to APC for testing, and learn more about the microbes behind these health-promoting drinks.

Almost 135,000 children have been 'gobbled up' passing through the APC Alimentary Adventures - a 10-metre long inflatable gut that mimics the human digestive system - at public events such as the Cork Carnival of Science and our annual visit to Fota Wildlife Park.

"The environment within APC is an excellent breeding ground that nurtures your scientific temper. I have had some of the most enthralling discussions on microbiome in specifics and science in general, made some exceptional friends who are now around the globe and are still a phone call away and managed to meet and interact with some of the greatest microbiome researchers of our times."

Dr Tarini Ghosh, Assistant Professor, Department of Computational Biology, Indraprastha Institute of Information Technology, Deli. APC Senior Researcher 2018-2022

"My daughter's class were lucky enough to attend the APC 'Food is Funky Digestive Workshop' and Hiba brought them through the Food is Funky presentation in an accessible communicative manner. The children were so engaged, and she was able to deal with the many questions and included everyone, even the quieter children at the back of the class. Lisa had the experiments organised perfectly and the tour afterwards was the icing on the cake. I just wanted to acknowledge the volunteers and the positive impact these events can have on the wider community"

Hilary - Parent of pupil of St Catherine's National School 4th class.

"We had such a great day out. Everything ran smoothly, the workshop and tour after were brilliant. The girls had such a giggle during the workshop. It was very age appropriate, great fun and also really made them understand how the digestive system works. There were plenty of helpers around too that could circle and help the girls out. Thoroughly enjoyed the day and would love to be invited back again."

Scoil Maria Assumpta 4th class teacher Shirley Burns following the Food is Funky event run by APC.

APC AND THE FUTURE

Credit: Provision

The future is as yet unscripted, but solid scientific evidence will be our guide.

AI AND THE MICROBIOME FOR EARLY COLON CANCER DIAGNOSIS

Colorectal cancer is one of the most common cancers in the world and is rising at alarming rates among young people. If it's diagnosed early, the patient has a better outcome. APC research has discovered changes in the gut microbiome in people at high risk of colon cancer or who already have cancer. APC is now teaming up with BowelScreen, the national screening programme in Ireland, and the equivalent programme in France, to develop Artificial Intelligence that can take the microbiome into account in stool samples and improve the early detection rate for colon cancer. The AI element is being developed with the University of Hamburg.

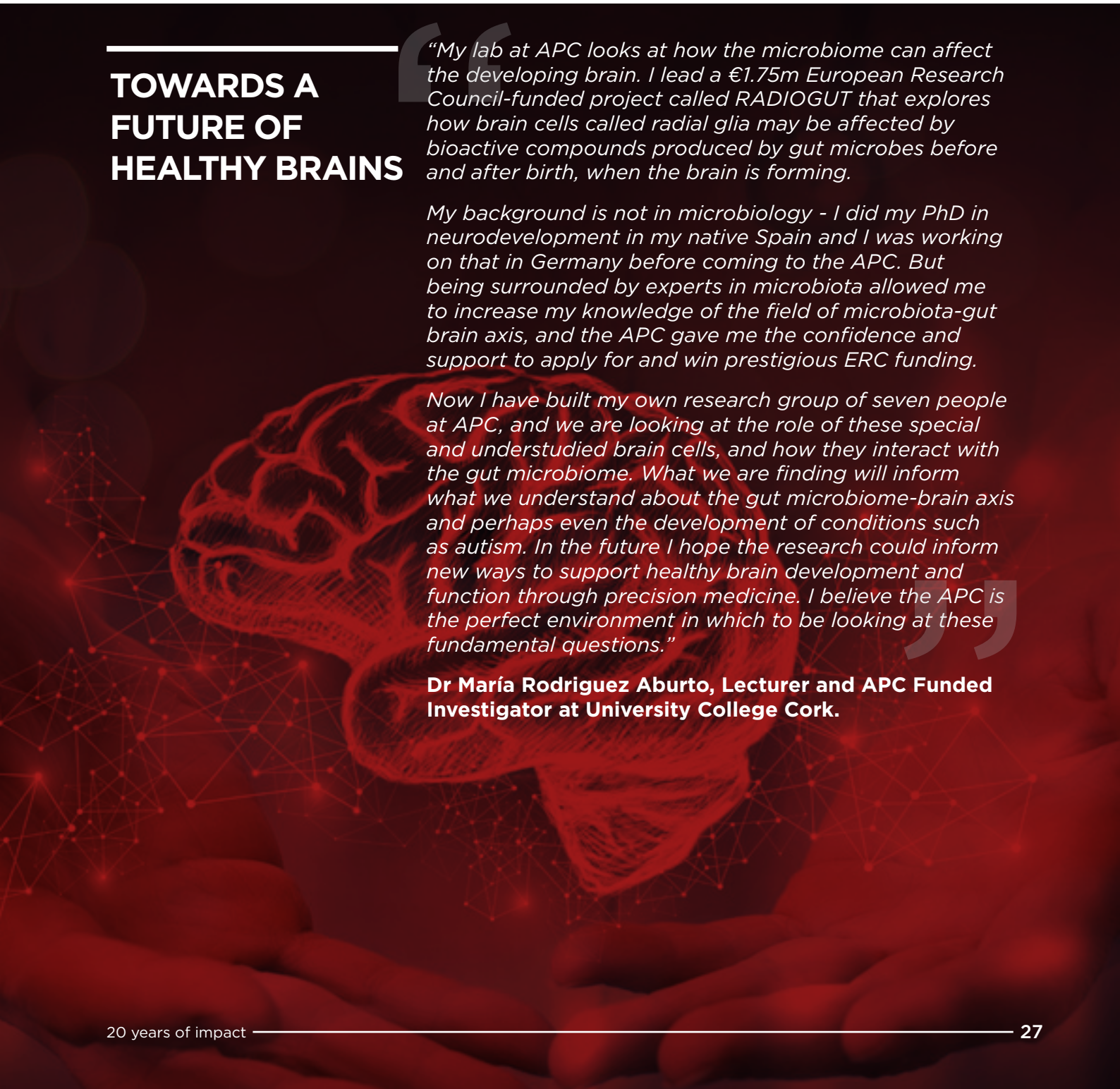
UNDERSTANDING ABUNDANT VIRUSES

When we think about the microbiome, we tend to think of the bacteria, but these are far outnumbered by viruses. Professors Colin Hill and Andrey Shkoporov's research at APC focuses on a type of virus in the gut called bacteriophages, or phages, that can kill bacteria by infecting and exploding them. One of the most abundant is the Crassvirus, but until recently nobody knew what it looked like. In 2023, Professor Hill and colleagues in the UK published the first images of this keystone and beautiful virus in the prestigious journal *Nature*.

SUPPORTING GOOD STARTS IN LIFE

A good start is half the battle, but many babies are born with less-than-optimum microbiomes, potentially leading to health issues in childhood and later life. APC researchers led by Prof Catherine Stanton and Paul Ross are currently involved in projects to redress that balance. The *'Missing Microbes in Infants born by C-section'* (MiMIC) project, a collaboration between APC and IFF (previously DuPont Nutrition & Biosciences, is finding the gut microbes in early life that play an important role in short and long-term health and developing strategies to balance the microbiota following antibiotics or C-sections. Another APC project, *'MicrobeMom'*, a partnership with PrecisionBiotics Group is tracking how microbes are transferred between mothers and infants and identifying ways to optimise mother and infant health.

TOWARDS A FUTURE OF HEALTHY BRAINS



"My lab at APC looks at how the microbiome can affect the developing brain. I lead a €1.75m European Research Council-funded project called RADIOGUT that explores how brain cells called radial glia may be affected by bioactive compounds produced by gut microbes before and after birth, when the brain is forming.

My background is not in microbiology - I did my PhD in neurodevelopment in my native Spain and I was working on that in Germany before coming to the APC. But being surrounded by experts in microbiota allowed me to increase my knowledge of the field of microbiota-gut brain axis, and the APC gave me the confidence and support to apply for and win prestigious ERC funding.

Now I have built my own research group of seven people at APC, and we are looking at the role of these special and understudied brain cells, and how they interact with the gut microbiome. What we are finding will inform what we understand about the gut microbiome-brain axis and perhaps even the development of conditions such as autism. In the future I hope the research could inform new ways to support healthy brain development and function through precision medicine. I believe the APC is the perfect environment in which to be looking at these fundamental questions."

Dr María Rodriguez Aburto, Lecturer and APC Funded Investigator at University College Cork.

APC AND THE ARTS

The arts represent a rich vein of transdisciplinary collaboration for APC, and a fantastic medium to connect with and impact society.

Image curtesy of the artist Laura Gowers

"Gut bacteria and its role in human health is, today, an explosive area of modern scientific research with significant and powerful implications for health and disease.

My passion as a graphic artist and storyteller has always been focused on how to communicate this complex scientific information in an accessible manner to a non-specialised audience.

Working together with the scientists at APC Microbiome Ireland over the past four years has enabled me to draw together the threads of this research to construct a useful, meaningful and accessible narrative along with a strong visual language – and this has resulted in my book ' you are an ecosystem' - as well as the collaboration with Prof Fergus Shanahan of APC on his new book 'Listen to Your Microbes' which explores the narrative of the wonderful world of microbes within our guts in a playful way, and communicates how important our relationship with these creatures is to maintain a healthy and happy life."

Laura Gowers, Graphic Designer and Microbiome Evangelist

Credit: Provision

"APC have collaborated with the Glucksman over the years on several wonderful exhibitions giving our audiences fantastic insight into microbiome science research and sparking curiosity and creative thinking about societal challenges as well as art."

Professor Fiona Kearney, Director, The Glucksman, University College Cork, Ireland

Credit: Image courtesy of the artist Shevaun Doherty

"I was delighted to work with renowned visual artist Shevaun Doherty on our SFI funded STEM-Art project 'The Invisible made Visible'. Using lino printing, animation and storytelling we were able to really engage with both primary school children and adults to communicate complex scientific concepts and to stimulate an interest in both science and the arts!"

Prof Cormac Gahan, Principal Investigator, APC Microbiome Ireland

"When the Alimentary Pharmabiotic Centre opened its doors in 2003, the term microbiome wasn't even in use. But I knew from my research as a gastroenterologist that if we didn't understand the 'gut flora', the trillions of microbes in the gut, we would never understand health. Without knowing the gut bugs, we would see only the crescent and not the whole of the moon, as The Waterboys sang.

The 20 years since of exploration and discovery have been driven by ambition, passion, collaboration, cohesion and above all a shared belief in the microbiome as a driver of health.

Today APC Microbiome Ireland is the oldest and largest microbiome research centre in the world, and we work hand in glove with industry, food producers, clinicians, patients and society to deliver impact for everyone. It's amazing what we can achieve when we work together."

Emeritus Professor Fergus Shanahan, ex-Director (Founding) of APC Microbiome Ireland

"Having reviewed the 15-year APC Microbiome Ireland Impact Report five years ago, I was delighted to be asked back to review 20-year version recently. The progress and additional impact is clear for all to see as the Institute continues to generate significant positive impacts, both economically and societally.

This is an excellent summary report. The economic analysis captures all the direct, indirect and knock-on (induced) impacts of the activities of APC Microbiome Ireland. The analysis illustrates the significant economic and employment impact that the institute has on an ongoing basis.

This analysis is based on a long-standing methodology and the authors have been able to successfully capture the growing economic impact of APC Microbiome Ireland (now calculated at €73.7m annually, up from €65m 5 years ago), but also the wider benefits in terms of developing people, the scientific impacts, as well as evidencing social and societal contributions.

In an age when Research Institutes must increasingly demonstrate return on investment, this summary report does that convincingly. This report endorses the SFI funding model which has aided its growth and expansion and reiterates the importance of investing in research institutes of this standing and calibre."

Professor Brian Lucey, Trinity College Dublin,
External Reviewer, November 2023

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20 YEARS OF APC IMPACT