ICR The Institute of Cancer Research

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search

For supporters of The Institute of Cancer Research

Harnessing the power of Big Data

Focus on breast cancer

Cyclist raises £250,000

Our mission is to make the discoveries that defeat cancer.

Written and produced by the ICR

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Editorial

It's been an exciting time for the ICR as we are putting plans in place to shape the direction of cancer research for years to come.

We want to place at the heart of our organisation the need to overcome the problem of drug resistance – a major barrier to the success of current treatments. So we were delighted that Professor Raj Chopra, who has international experience in drug discovery, joined the ICR earlier this year – hear more from him on page 8.

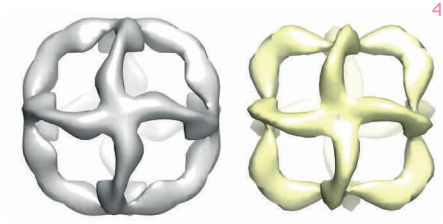
We are investing in major infrastructure to support our mission. This includes computing capacity that far surpasses that of many other institutions and enables us to handle the huge quantities of scientific data required to truly understand cancer. You can read more about this on pages 10-11.

We plan to develop brand new approaches to defeating cancer, and we can only do this with your continued support.

I hope you enjoy reading Search and you feel proud of the discoveries you've already helped us to make possible.

Thank you.
Lara Jukes
Director of Development

Artificial DNA could build new generation of cancer drugs



A 3D model from electron microscopy data of an octahedral nanostructure composed entirely of artificial XNA polymers (image: A.Taylor, F. Beuron, S-Y. Peak-Chew, E.P. Morris, P. Herdewijn, P. Holliger)

ICR scientists have built the first 3D nano-sized objects using artificial DNA, which could be used to deploy cancer treatments inside tumour cells.

They have created microscopic pyramid and diamond-shaped 3D 'packets' by folding together artificial nucleic acid building blocks called Xeno nucleic acids (XNAs). They saw that the XNA-made pyramid packets were more stable in biological environments than DNA-made structures, keeping their shape for eight days compared with DNA nanostructures, which degraded after two.

DNA nanotechnology is an exciting new way to manipulate genetic material, which could have huge benefits for biomedical research and clinical care. Dr Edward Morris, Leader of the ICR's Structural Electron Microscopy team, said: "DNA has shown great promise as a potential building material for nano-molecular scale objects, but unfortunately they tend to get broken down quite quickly by our bodies and this may limit their clinical use. Our research shows that you can make robust microscopic 3D shapes using this novel chemistry which can stand up to conditions inside the body."

The findings are an important first step for this exciting new genetic construction technique, which could lead to new ways to target cancer treatments directly at cancer cells.

New 'ecosystem' test strongly predicts ovarian cancer survival

Scientists at the ICR and collaborators in China have found that assessing the cell 'ecosystems' at sites where ovarian cancer has spread around the body strongly predicts the chances of surviving the disease.

A new computerised test using software designed to study plant and animal ecosystems measures diversity among cells in the environment around secondary tumours after cancer's spread. Our scientists found a staggering difference in survival rates between women with high and low levels of diversity at these metastatic sites.

The fully automated test could identify those women who have the most life-threatening disease, and who urgently need the most aggressive treatment.

Gene testing in sarcoma could uncover 'cancer families'

Genetic testing of patients with sarcoma – a rare form of cancer that can affect children and young adults – can pick out genetic errors hidden in their family tree which increase the risk of a wide variety of other cancer types.

A team of scientists – including researchers at the ICR – looked at patients with sarcoma to shed light on the genetic causes of multiple cancers within families. Inherited cancer-causing gene mutations can create a phenomenon of 'cancer families' where multiple family members develop cancer – sometimes many different types of cancer.

The researchers found that over half of 1,162 patients with sarcoma who were tested were born with mutations in at least one gene already known to increase cancer risk.

Some of the most common inherited mutations occurred in genes known to drive the development of multiple tumour types, putting these patients at increased risk of other cancers such as breast, ovarian or bowel cancer. When mutations like these are found, families may be offered genetic counselling and screening, where appropriate.

New Regius Professor

The ICR's Professor Johann de Bono has been named Regius Professor of Cancer Research.

The award recognises his outstanding work in the clinical development of personalised cancer treatments. The ICR was among a select group of 12 institutions across the UK to be awarded a highly prestigious and rare Regius Professorship by Her Majesty the Queen to mark her 90th birthday.

Gruelling cycle ride raises £250,000 for cancer research

Tim Morgan has faced an extraordinary challenge in a cycle ride pitched as the 'hardest event in the Cycling Weekly Sportive Series' to raise funds for our research. His amazing efforts have already raised £250,000.

Tim was diagnosed with bowel cancer in 2015 and is raising funds for the ICR to bring improved treatments to patients sooner.

Tim said: "Following two big operations and several rounds of chemotherapy and immunotherapy I am currently receiving a new targeted treatment which is the result of extensive and ongoing research. These kinds of discoveries are exciting and game-changing and the ICR is a global leader in this field.

"The proceeds from this ride will help fund research into personalised therapy and immunotherapy, which are shaping the future of cancer treatment."

Tim cycled the challenging 'Dartmoor Demon' – 90km long with a total climb of 1600m. His intrepid team of family and friends grappled with the punchy climbs and the long, drawn-out ascents to support our vital research into life-changing treatments.

ICR COO joins #teamICR for Vitality run

Dr Charmaine Griffiths, Chief Operating Officer of the ICR, along with Senior Trials Managers Monique Tomiczek and Laura Stevenson, and eight other #teamICR runners completed one of the world's greatest road races this summer.

The Vitality British 10K London Run took participants across the heart of central London, passing many of the capital's most historic and well-known landmarks.

Dr Griffiths says: "Like so many ICR colleagues, many of my friends and family have been affected by cancer, making it even more of a privilege to be part of a world-leading team working to defeat the disease. Taking part in this fabulous 10k event is my way of personally helping to raise the vital funds we urgently need to power our research."

Last year our brilliant supporters raised over £600,000 for the ICR through runs and other challenge events. **Join in at: www.icr.ac.uk/sports**

Date set for Carols from Chelsea

On Tuesday 6 December, The Royal Hospital Chelsea will play host to our flagship annual carols service, Carols from Chelsea.

The service features a wonderful programme of readings, traditional carols and music, including seasonal favourites by Handel and Bach.

Last year's event featured readings from actors Dominic West, Charles Dance, Patricia Hodge and broadcaster Alice Beer, as well as superb musical performances from the baritone Peter Sidhom and the BBC Radio 2 Young Choristers of the Year, Angus Benton and Agatha Pethers. The event raised £115,000 and this year we hope to top that figure.

This truly is the perfect event to start the festive season. Tickets for Carols from Chelsea will be on sale from 1 October.

www.icr.ac.uk/carols

Appeal raises £50,000 for pioneering microscope research

Our supporters have helped to raise an incredible £50,000 for cancer research using state-of-the-art microscopy. The money raised will support ICR scientist Professor Jonathon Pines's pioneering research using a new lattice light sheet microscope.

The new microscope was featured in the spring edition of Search magazine. Unlike traditional microscopes, which use light, the lattice light sheet microscope uses 'Bessel beams'. These beams are so narrow they reveal details unseen using normal light. These beams sweep across the cell sample while rapidly switching on and off to avoid damaging the cell – producing unprecedented images.

The new microscope will help us further our understanding of cell division and how this complex process goes wrong in cancer cells. If by studying living cells we can understand the fundamental causes of cancer, its complexity and how it evolves, we can outsmart cancer and discover smarter, kinder treatments.

The ICR will be the first research organisation in the UK to acquire this new microscope.

Help support this innovative research: www.icr.ac.uk/microscope

Jonathon Pines FRS is Professor of Cell Division at the ICR and Head of Cancer Biology.

Designing cancer drugs that work in new ways

Professor Raj Chopra is a scientist and clinician with international experience in drug discovery. He joined the ICR in January 2016 as head of our Division of Cancer Therapeutics, and leader of the world's most successful academic centre at discovering innovative new cancer drugs.

Cancer cells are adaptable, and we know that they can evolve and develop resistance to treatments. Our research seeks to develop new approaches to treatment that overcome this adaptability, or even prevent it in the first place.

Some very effective cancer drugs work by blocking the action of specific proteins in cancer cells, known to be important in these cells' growth and spread. The drugs attach themselves securely to the cancer protein, like a key in a lock, and block the protein's effects – with potentially catastrophic consequences for the cancer cells.

Professor Chopra's personal research interests focus on drugs for cancer proteins where this 'lock and key' approach won't work. Some proteins are simply not druggable in this way; for instance some proteins physically change shape when a drug binds, overriding the drug's effects.

His alternative approach explores 'protein degradation' – developing drugs which lock onto the cancer protein and stimulate the cell's machinery to degrade the protein, rather than block its action. Degradation is a normal part of cell biology, but it is under tight control. Professor Chopra's research aims to take over this control, so we can degrade cancer proteins that previously evaded treatment. Professor Chopra says: "Hardly anyone else in the world is doing this research. With the multi-disciplinary teams at the ICR, coupled with our expertise in cancer biology and access to patient data, we could see a step change in drug discovery in the coming years."

Name
Professor Raj Chopra

Joined the ICR
January 2016

Specialist subject
Using biology to guide new approaches to cancer drug discovery, blood cancers, solid tumours and immunotherapies

Greatest achievement
"I was part of the team that discovered a novel approach to red blood cell development. It is now in clinical trials for patients with thalassemia – an inherited blood disorder where the body does not make enough haemoglobin for the red blood cells – and it could transform their lives."

In his own words
"I came to the ICR because of its innovative approaches to discovering new types of treatment for cancer patients. Cancer is devious; we need to develop a range of different therapies to cut off its many escape routes. I am excited to be playing a leading role in the place to do this."

Harnessing viruses as weapons against cancer

Professor Alan Melcher is a clinician and a scientist who has recently joined the ICR as Professor of Translational Immunotherapy. His team is studying how genetically modified viruses can kill cancer cells, while also stimulating the immune system to do the same. These 'oncolytic' viruses are already approved for clinical use and could offer major benefits to cancer patients.

Our immune system is the body's natural defence against infection and disease. The goal of cancer immunotherapy is to stimulate cells of the immune system to recognise and attack tumour cells. The problem is that cancer cells are very good at hiding from the immune system.

However, cancer cells are not very good at evading viruses. Professor Melcher's research focuses on oncolytic viruses, which have been modified to preferentially seek out, infect and kill cancer cells. While doing this they also alert the immune cells to the presence of the tumour cells – making the tumour cells immunologically 'hot'.

As Professor Melcher is also a melanoma doctor, he is especially interested in optimising the use of oncolytic viruses for patients – for example by changing the way they are administered, investigating whether they are more effective in combination with other treatments, or developing better tests to monitor how well they are working.

Professor Melcher is optimistic that oncolytic viruses could be widely used in the clinic within the next five years, potentially becoming the standard of care for certain cancer patients. He says: "We are working on new clinical trials designed to treat patients whilst also improving our understanding of how immunotherapy works. Armed with this knowledge, we can optimise treatment and enhance its benefits."

The extensive clinical trial activity at the ICR and The Royal Marsden was one of the main attractions for Professor Melcher when deciding to join the ICR. He joins a growing team, as part of the ICR's commitment to expanding our research into immunotherapy.

Name
Professor Alan Melcher

Joined the ICR
April 2016

Specialist subject
How to activate the immune system to recognise and attack cancer. In particular, working on anti-cancer 'oncolytic' viruses, which work mainly as a type of immunotherapy. He is a specialist in melanoma.

Greatest achievement so far
Achieving positive biological results in virotherapy clinical trials.

In his own words
"I am excited by the translation of my research from the lab into the clinic. I am a medical doctor treating patients with melanoma, as well as a scientist, and I want to be able to tell my patients that there is another treatment option for them to pursue."

Using Big Data to unravel cancer's complexity

At the ICR we are leading the way in using data from scientific experiments and from cancer patients to find new treatments.

Developments in research and healthcare are generating vast quantities of data that include genetic information from tumours, patient data, clinical imaging and more. We are gathering data at an unprecedented rate – the amount of genetic data we are accumulating is starting to outstrip even that of scientific disciplines such as astronomy, which are known for the volume of data they generate.

All of this means that we are in exciting times for cancer research. Advances in technology are transforming scientific research and offering rapid progress in our understanding of cancer and how to treat it. It is an opportunity that we plan to take full advantage of.

Pioneering approach

With Big Data comes big challenges. While researchers are now able to access unprecedented volumes of data, making sense of it is more difficult. Cancer-relevant data is collected from many different areas of science such as biology, medicinal chemistry and medical physics, as well as from the experiences of patients in the clinic. To make the best use of the data, we must 'translate' it all into a single language. We are taking new approaches to this challenge by integrating and analysing the entire complexity of data as a whole, rather than looking at each individual type of data separately.

canSAR

We have already demonstrated that such data integration can be achieved in drug discovery through our canSAR database which now contains billions of pieces of experimental cancer data.

Dr Bissan Al-Lazikani, the ICR's Head of Data Science, explains: "In drug discovery, we must select the best targets to develop drugs against. To inform these decisions, we need to analyse complex data from multiple disciplines. Our canSAR database integrates and translates

data from different sources into the same language, allowing us to analyse them together."

canSAR can dramatically speed up research into new cancer drugs as all of the data can be accessed in one place. It also serves to enhance knowledge sharing across the wider research community.

Knowledge Hub

Integrating research data with a patient's clinical data is a real challenge. Some types of data have common agreed standards and formats but others do not – some clinical notes may exist only as hand-written comments.

Our sophisticated new Knowledge Hub will help to standardise data across the ICR and our hospital partner The Royal Marsden, so that it can be understood and analysed by all of our researchers. It will bring teams together and help them to collaborate on complex datasets to identify new approaches to cancer treatment.

A key goal of our Knowledge Hub is to use artificial intelligence technologies to enable the creation of personalised therapies, which adapt to each individual patient and their changing condition.

Investing in the future

To make the most of these opportunities we are improving our ability to navigate, store, share, integrate and analyse Big Data effectively. It is critical for us to build more capacity, storage and transfer capability to share data effectively across the research community, both independently and in collaboration with major national initiatives.

Our new data storage initiative will increase the total digital storage space for research in the initial phase to 6 petabytes – greater than comparable scientific institutes – and it will be expandable to 20 petabytes. When you consider the fact that it would take more than 223,000 DVDs to hold just one petabyte, you can get a sense of the ambition of our plans.

The best people

Another vital area of investment is ensuring there are people with the right skills to innovate in Big Data projects. In addition to a new Head of Data Science we have drawn in expertise from other disciplines to share their knowledge. Dr Carmen Rodriguez Gonzalvez was previously an astrophysics research scholar, with a strong background in the analysis of data. She has now joined the ICR as a leading data scientist applying analytical and statistical techniques developed over decades by the astrophysics community to biological challenges.

Investments like the ones outlined here are powerful catalysts for scientific innovation. They will help to unravel cancer data to open up new avenues for treatment and prevention.

Our canSAR database:

- **Has been accessed by 180,000 users worldwide**
- **Is accessed in over 180 countries**
- **Contains more than 1 billion experimental data points from across different domains of science**
- **Uses artificial intelligence to predict which targets are most suitable for drug discovery**

Demonstrating canSAR's potential, the team analysed an existing list of 479 cancer genes. They found 46 potential drug targets that had until now been ignored.


Dr Bissan Al-Lazikani

Illuminating cancer

Our researchers are lighting up cancer cells with high-tech imaging to guide treatment.

Cancer cells develop when normal cells in our body malfunction. Their similarity with normal cells makes them difficult to treat and difficult to locate. When researchers need to view cancer cells amongst normal cells they need to find ways to tell them apart. Our scientists are using new ways of tagging and tracking cancer cells to identify specific cancer types, monitor treatments and even guide surgery.

Molecular imaging

Dr Gabriela Kramer-Marek is investigating new ways of using an approach called molecular imaging to view cancer cells and predict a patient's response to treatment.

Dr Kramer-Marek's research focuses on a patient's cancer at the molecular level. Her team can view a specific drug target, administer a treatment and watch as the drug takes effect within a matter of hours. They use an imaging technique called positron emission tomography (PET) which takes a snapshot of biological processes inside the body, rather than in a petri dish in the laboratory or on a slide under the microscope. PET uses molecules that bind to sites that are common in tumours and can detect biochemical changes specific to cancer cells. By doing so it can reveal even minuscule tumours within healthy tissues.

Of particular interest are proteins called human epidermal growth factor receptors. One member of this family, HER3 (human epidermal growth factor receptor 3), is often overproduced

Dr Gabriela Kramer-Marek leads the Preclinical Molecular Imaging Team within our Centre for Cancer Imaging.

in cancer cells and is a critical player in the progression of breast, lung, ovarian, bowel, and head and neck cancers. Several targeted therapies directed at the HER3 receptor are now in clinical trials.

Experts recommend that patients are tested for the presence of these growth factors because the results can have a significant impact on treatment decisions. Testing has traditionally been carried out using invasive biopsies with results available weeks later. Dr Kramer-Marek is developing a non-invasive molecular tag that allows clinicians to visualise HER receptors within a patient's body. She employs radioactive probes that bind to the receptor so that they can spy on the cancer's behaviour.

"We are developing molecular probes for the non-invasive imaging of HER receptors within a patient," she says. "This approach would light up receptors across the entire tumour and can be easily repeated to monitor any changes during treatment."

Using Dr Kramer-Marek's approach, researchers could adjust the dose and treatment schedule for individual patients, based on the real-time visualisation of these receptors.

Image-guided surgery

The same team is also working on ways of illuminating cancer cells during surgery. While many techniques have been developed to help surgeons identify cancer cells during surgery, the human eye remains key in deciding which tissue needs to be removed. This means that many surgical procedures require the removal of a margin of healthy tissue to ensure no cancer cells remain.

Dr Kramer-Marek's team is hoping to identify cancer cells with infrared light so that tumours are more recognisable and are lit up during surgery. They are developing near-infrared optical probes that accumulate only in cancer tissue and glow when exposed to specific wavelengths of light.

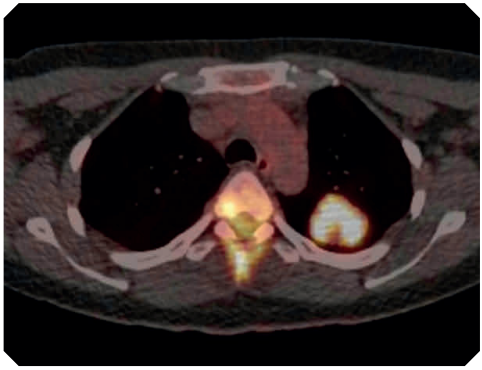
While they have only been tested in the lab so far, the team hopes to collaborate with other researchers to use the technique for image-guided surgery.

Light-based treatments

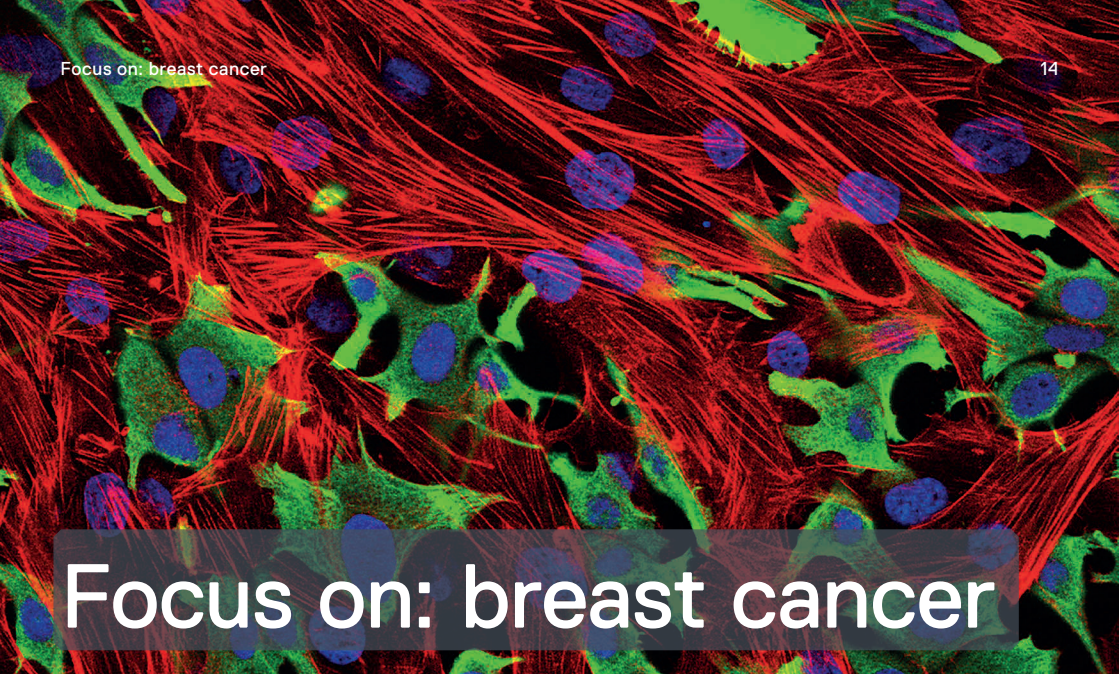
While these techniques can help us to see tumours, a similar approach might even enable us to use light as a cancer therapy.

Dr Kramer-Marek's team is investigating using fluorescently labelled probes to carry therapy directly to the tumour. The treatment, called photoimmunotherapy, gives off a form of reactive oxygen when it is exposed to certain types of light and this is toxic to cells. By combining it with their probes, only cancer cells would be damaged when the light was switched on.

While many of these techniques are in early stages, initial results are promising. When it comes to illuminating cancer more effectively to reveal its secrets, there is light at the end of the tunnel. Research like this could change the way we view cancer forever.



PET (positron emission tomography) uses radioactive probes that travel to cancer cells and light them up.



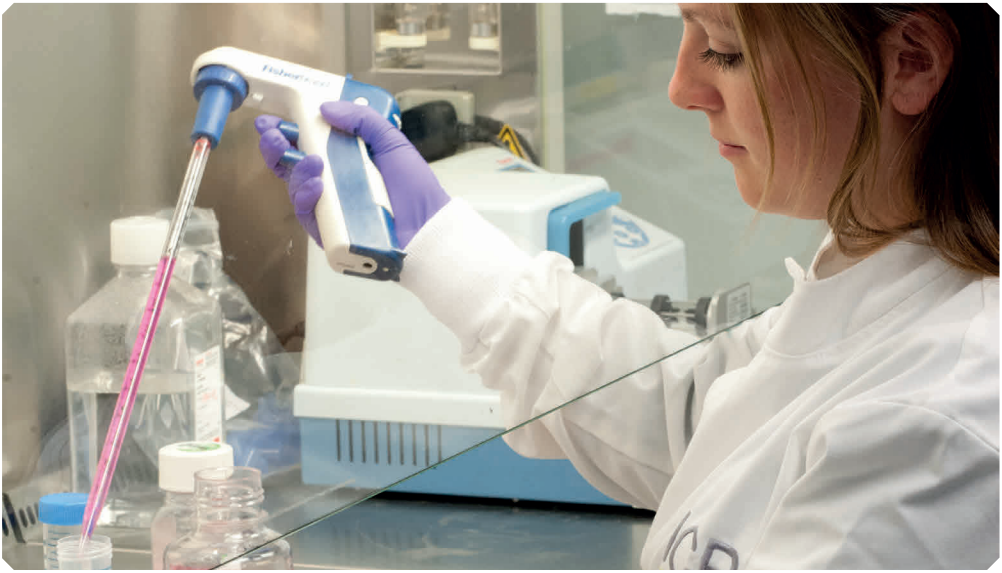
Focus on: breast cancer

For decades, scientists at the ICR have been working tirelessly to improve our understanding of breast cancer - and make the discoveries to defeat it. Our research is helping more patients survive breast cancer today.

Here are just some of the discoveries our scientists have made.

Our scientists identified the breast cancer gene BRCA2, which enabled families with a history of breast cancer to be assessed for future risk, and laid the groundwork for developing novel forms of therapy for BRCA-associated cancers.

Our research has been instrumental in the development of a new class of drugs called PARP inhibitors. PARP inhibitors exploit a weakness in cells with mutations to the BRCA genes. They have been shown to be effective in patients who developed breast, ovarian or prostate cancer after inheriting mutations in BRCA1 or BRCA2. One of their strengths is that cancer cells are much more sensitive to them than healthy cells, and so they cause fewer side-effects than traditional chemotherapies.



A blood test for women with breast cancer can identify women who will benefit from the targeted treatment Herceptin without the need for uncomfortable tissue biopsies. The 'liquid biopsy' uses cutting-edge genetic techniques to detect breast cancer DNA in the bloodstream, and was developed by a team at the ICR and The Royal Marsden.

ICR scientists working on the Male Breast Cancer Study at the ICR discovered that mutations to the gene RAD51B can increase the risk of breast cancer in men by around 50%. RAD5B1 has a role in DNA repair and can also increase the risk of breast cancer in women.

A unique study by scientists at the ICR showed that the height and weight of girls before they reach puberty can determine the likelihood of them developing cancer at a young age. The study added to increasing evidence that the development of breast cancer can be attributed to influences at key stages throughout a woman's life. Further results from the same study also found that day-to-day psychological stress and adverse life events are unlikely to increase a woman's risk of developing breast cancer.

78%

of women now survive breast cancer for 10 or more years

Climb of Life celebrates ten years of support for the ICR

This November, the annual 'Climb of Life' event celebrates ten years of raising vital funds for the ICR's research to defeat cancer.

The challenge sees more than 100 hardy trekkers taking to the Lake District National Park to conquer some of its most difficult trails and peaks. The theme of this year's event will be 'ten top peaks for ten years' – a gruelling challenge that the trekkers will relish.

The event is organised every year by Graeme Chapman MBE. Graeme is an experienced mountain climber and a dedicated ICR fundraiser. Over the past nine years the Climb of Life event has raised an incredible £650,000 for the ICR. In this 10th year, Graeme and his team are aiming to raise over £100,000.

Professor Keith Jones, ICR Team Leader and Deputy Dean, represented the ICR home team at last year's Climb. He enjoyed it so much, he's

taking part again in 2016.

Keith said: "I was truly inspired by the enthusiasm and positive energy displayed by everyone who raised funds and took part in the event. I thoroughly enjoyed meeting all of the participants and talking to people from many different walks of life."

The ICR is grateful to all those who have participated in this challenge and supported the event over the past 10 years. Their contribution has raised a significant amount to support the ICR's research and is helping to make the discoveries that defeat cancer.

Particular thanks must go to Graeme for his unwavering dedication to raising money for the ICR. We wish all those taking part this November another very successful climb.

If you would like to take on a challenge, please contact the Events Team on 020 7153 5307 or by email at sports@icr.ac.uk or visit icr.ac.uk/challenge

Clockwise from L-R: In 2014 the trekkers raised over £100,000; ICR supporters on one of the Lake District's peaks; Graeme Chapman MBE; Climb of Life trekkers braving the bad weather to raise funds for the ICR.

A lasting memory

Husband's memory inspires donation for novel lung cancer research

Leon Gold was a keen scuba diver, glider pilot and skier, who embraced life to the full. It is this which inspired his wife, Dr Sally Gold, to make an in-memory gift to the ICR after he tragically passed away from lung cancer in April 2012.

Sally says: "He faced it unflinchingly and with immense courage and unfailing cheerfulness."

"Leon chose aggressive treatment which was cutting-edge. All such research and treatments are supported, and in many cases made possible, by institutions such as the ICR."

In memory of Leon, Sally has chosen to support the research of Professor Caroline Springer, a Team Leader at the ICR, who is developing a novel, targeted treatment for lung cancer. The therapy uses a modified virus to attack cancer cells and leave the healthy cells unaffected.

Remembering her husband, Sally says: "Leon was intellectually gifted and an accomplished academic with a PhD in psychology. His message to those he left behind is simple and immensely inspiring: to find the joy in life. And that is something we must surely all endeavour to do."

Making a donation in memory of a loved one is a wonderful way to celebrate their life, while also helping to fund pioneering research at the ICR. With your support, we will make the discoveries that defeat cancer.

If you have any questions about making an in-memory gift to the ICR, our team are here to help.

You can contact them on:
020 7153 5387 or
supportercare@icr.ac.uk

Events calendar

Whether you like to run, cycle, trek, or simply enjoy festive carols, we have an event for you. By taking part you'll be helping us make the discoveries that defeat cancer.

Run

adidas Silverstone Half Marathon
12 March 2017

Join #teamICR and head to the world-famous motor racing track for a unique road race that is a great event for beginners.

Cycle

Prudential RideLondon
Sunday 30 July 2017

Cycle 100 miles past some of London's most famous landmarks, and through the beautiful Surrey countryside.

Trek

Great Wall of China Trek
6 May 2017

If you have a passion for adventure, this is the perfect way to get involved while raising vital funds for our research.

TrekFest
June and September 2017

The ICR is charity partner of this challenging event, which sees participants trekking in either the Brecon Beacons or the Peak District.

Carols from Chelsea
6 December 2016

In Christopher Wren's beautiful chapel at the Royal Hospital, Chelsea, we invite you to join us for an evening of traditional Christmas carols.

If you are already taking part in an event, get in touch and use your own place to raise funds for us.

See our website for our full events calendar at icr.ac.uk/challenge, or contact the team on 020 7153 5307 or email sports@icr.ac.uk

www.icr.ac.uk