Research 23

Danish Cancer Society

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Design and layout: Maria Daring Haack, KB Design

Print run: 500

Printed by: Strandbygaard

Photo: Büro Jantzen

Photo: Morten Bengtsson

The Danish Cancer Society supports research

The Danish Cancer Society pursues a three-track research support strategy: Independent research, strategic research and the Danish Cancer Institute. This annual impact report comprises research supported through all three tracks.

Danish Cancer Society Research

The Danish Cancer Society allocates an average of DKK 418 million per year for research funding. Research is one of the primary objectives of the Danish Cancer Society, and each year we support a wide range of projects across Denmark. Among other outcomes, the research findings have prompted a targeted political emphasis on late effects and social inequality. This year, the Danish Cancer Society launched a new initiative to strengthen the society's strategic approach to research.

Research is international, and knowledge knows no borders. While competition may be fierce in the research world, research remains an arena that unites people across the globe in a shared mission to improve the lives of everyone affected by diseases, particularly cancer. This instils hope in a world where conflicts and crises dominate the agenda.

Denmark can be proud of our contribution to the international research agenda. Not least our epidemiological research, which is known worldwide for its high quality. At its core are the Danish registers which make it possible to follow Danes from birth to death. This enables researchers to gather data on the general population's health, diseases and factors such as the use of medicines. The quality and depth of the data surpass what many other countries can achieve, often relying on questionnaires for their research endeavours. It is therefore worth celebrating that 2023 marks the 80th anniversary of the Danish Cancer Society's establishment of the Cancer Registry. Since 1 January 1943, all Danish cases of cancer have been recorded in the Cancer Registry, making it the heart of Danish epidemiological cancer research.

Research is deeply ingrained within the Danish Cancer Society, and the work holds significant value across many parts of the society's efforts. Research provides knowledge that can lead to new treatments, improved prevention and improved offerings for cancer patients, and research generates knowledge that can be used in the society's political work, to name but a few areas. Remaining on the topic of register research, knowledge obtained from registries has in recent years contributed to raising political awareness about the inequality that exists throughout the cancer trajectory. And it has documented the need for enhanced efforts on late effects, which will hopefully leave an impact on the upcoming cancer plan, Cancer Plan V, that was launched this year.

As a natural extension of the value of research for the Danish Cancer Society, we have set up a new research strategic committee. Meeting for the first time in 2023, the committee consists of leading researchers from both Denmark and abroad as well as two patient representatives. The committee will provide advice to the Central Board, the Executive Committee and ourselves on overarching strategic issues in research. This is a valuable enhancement of our research strategy approach, creating a platform for discussing national and international cancer research. In this way, the committee builds naturally on the society's other advisory committees for patient and relative support, prevention and volunteers.

Considering the significant value that research creates for all of us, is it once again a pleasure to present examples of research to which the Danish Cancer Society has contributed. In this report, we present examples of the Danish Cancer Society's overall contribution to research in the form of independent research, strategic research and research from DCI. It is both exhilarating and uplifting to read.

We hope you enjoy your reading.

Mads Melbye
Research Director

Jesper Fisker
Managing Director

2020

Danish Cancer Institute

The Danish Cancer Institute aims to conduct world-class research. Every day, the employees spend a large part of their waking hours here. As one of the researchers interviewed in this report says: 'This is my scientific home'. This effort enables collaboration of newly educated researchers alongside experienced professors from across the globe, working together to create new knowledge about cancer.

Photo: Hans Bach

Photo: Hans Bach

The Danish Cancer Institute is a workplace for researchers from both Denmark and the rest of the world.

DCI enjoys a special position in the research world in Denmark. This is the only research institution in the country to focus exclusively on cancer research. At the same time, it gathers a wide range of leading experts under one roof. This ensures both breadth and depth in research. DCI's history dates back to the 1940's, but it is also a modern workplace that attracts leading researchers from Denmark and abroad, and that annually delivers research at a high international level. Furthermore, the institute is an attractive partner for researchers and institutions worldwide.

Sustained development and progress are required in order to strengthen the institute and maintain its strong position. To safeguard this, a number of initiatives were undertaken throughout 2023 to strengthen both the epidemiological research and the translational research conducted at DCI, where researchers from different fields collaborate to swiftly disseminate new research findings to patients. As a result of these initiatives, several research groups with expertise in epidemiology and biology have been amalgamated, and a new research group with a dedicated focus on translational research has been established. This enables us to build on the strengths that DCI already possesses, which are presented on the following pages.

Here, you can read examples of research completed by DCI in 2023 or initiated during the year, ranging from promising new treatments to novel insights that broaden our understanding of the mechanisms that take place in the body when we develop cancer. You can also meet some of our non-Danish researchers and read why they have chosen to travel to Denmark and work at DCI.

CIBER-ESP is a Spanish epidemiology and public health research consortium that promotes collaborations and research across research centres, universities and health institutions.

University of Copenhagen

Rigshospitalet

Aarhus University

International Agency for Research on Cancer (IARC) - WHO's cancer research institute

Karolinska Institutet

Aarhus University Hospital

German Cancer Research Center

Imperial College London

Lund University

Centro de Investigación Biomédica en Red de Epidemiología y Salud Pública (CIBER-ESP)

2019 - 2023

Partners

Collaboration at national and international level is crucial for the research conducted at the Danish Cancer Institute. The figure shows the research institutions that have published most joint research publications with DCI in the period 2019-2023.

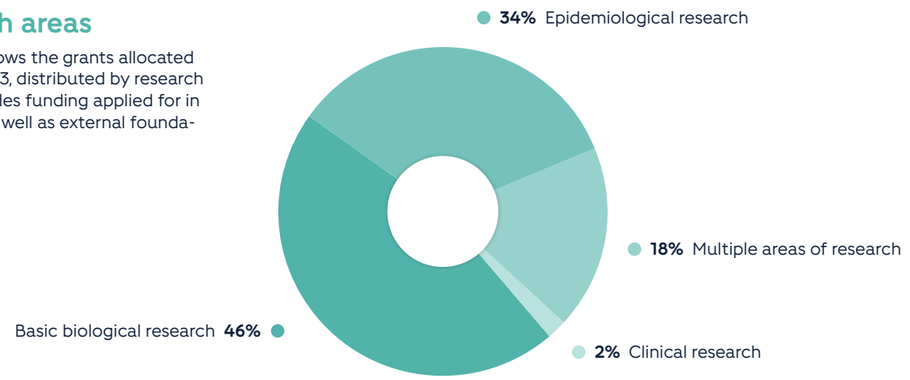
Learn more about the finances and see financial statements for the Danish Cancer Society as a whole on the Society's website: www.cancer.dk. Photo: Büro Jantzen

Finances

The aggregate financial statements for the Danish Cancer Institute show expenses of DKK 206.8 million in 2023, of which basic funding from the Danish Cancer Society amounted to DKK 77.9 million for payroll and operating expenses and DKK 48.9 million for fundamental costs. During 2023, researchers at DCI also received research grant pledges totalling DKK 79.6 million from a large number of foundations. The money will be used to fund research projects in the coming years. Learn more about the finances and see financial statements for the Danish Cancer Society as a whole on the Society's website: www.cancer.dk.

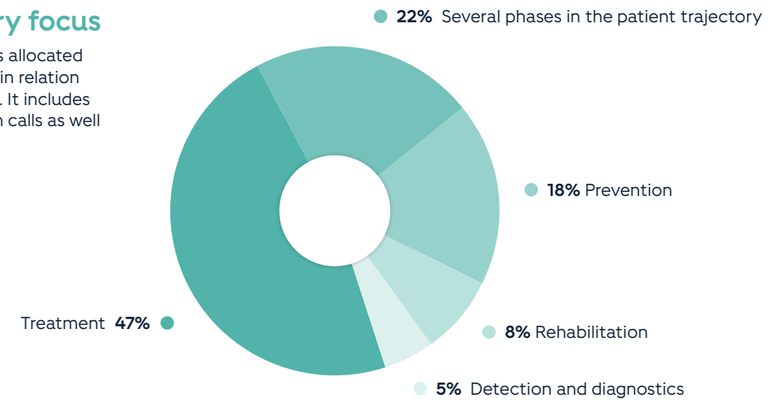
Research areas

The chart shows the grants allocated to DCI in 2023, distributed by research area. It includes funding applied for in open calls as well as external foundations.



Patient trajectory focus

The chart shows the grants allocated to DCI in 2023, distributed in relation to patient trajectory focus. It includes funding applied for in open calls as well as external foundations.



RESULT FROM 2023

– The results so far are very promising, and I think this can be a treatment that will have a great impact on patients, says group leader Zoltan Szallasi.

photo: Tomas Bertelsen

Hope for a new vaccine-assisted therapy in lung cancer

A new vaccine makes immunotherapy effective against ALK-positive non-small cell lung cancer. Following good results in the laboratory, the treatment is now ready for patient testing.

A new experimental therapy will hopefully soon be on its way to patients with non-small cell lung cancer whose disease is caused by activation of the ALK gene. Researchers from the Translational Cancer Genomics research group have developed a vaccine that allows patients to receive immunotherapy, which has so far been without effect on ALK-positive non-small cell lung cancer.

The new treatment applies a two-stage approach, starting with giving the patient the newly developed vaccine that activates the immune system.

In trials, researchers administered the vaccine to mice with ALK-positive non-small cell lung cancer before treating them with a combination of immunotherapy and so-called TKI drugs, which is the current treatment of choice for this disease. The combination prevented the cancer from spreading, and several of the mice were free from disease at the end of the trial. Postdoc Zsófia Sztupinszki and group leader Zoltan Szallasi from Translational Cancer Genomics participated in the research together with a number of international colleagues led by Professor Roberto Chiarle from Boston Children's Hospital. Zoltan Szallasi is very positive about the new results:

– The results so far are very promising, and I think this can be a treatment that will have a great impact on patients. Because ALK is expressed by only a few cells in the body, a possible future treatment is likely to only have few side effects, he says.

Rapid vaccine development

The immune system usually recognises foreign antigens in the body, including some of the cells that change into cancer cells. While the activation of the ALK gene found in ALK-positive non-small cell lung cancer is actually abnormal enough to capture the interest of the immune system, the activation of the immune response is too small to enable immunotherapy to trigger a reaction that kills the cancer.

However, the researchers identified a special part of the ALK gene which the immune system recognises, triggering a strong reaction. By using this part as a vaccine, thus activating the immune system, immunotherapy treatment suddenly became very effective. Administered together with TKI, the effect was so good that the team is ready to test it in patients – initially in the USA where part of the research has been carried out.

ALK-positive lung cancer

ALK-positive lung cancer is a rare form of cancer that mainly affects non-smoking young people under 50 years of age. A statement for the period 2018-2022 showed that on average, 36 patients with ALK-positive lung cancer lung cancer are found in Denmark each year (Danish Lung Cancer Registry Annual Report 2022).

The results are published here:
Mota I. et al.: ALK peptide vaccination restores the immunogenicity of ALK-rearranged non-small cell lung cancer. Nature Cancer. 2023, July 4. DOI: 10.1038/s43018-023-00591-2. Epub. 2023 July 10.

NEW PROJECT FROM 2023

Men and women have different risks of developing cancer

A new research project will investigate why gender plays a role in both our risk of developing cancer and the likelihood of survival.

The lifetime risk of being diagnosed with cancer is 37% for men and 31% for women in the Nordic countries when disregarding prostate, breast and skin cancers other than melanoma. The risk of dying from cancer also differs, being 19% for men, but only 15% for women. In fact, one in four male cancer deaths could be avoided if men experienced the same cancer incidence and mortality as women. Researchers are now launching a new research project to investigate the cause of these differences. They will look at whether the differences vary with age, examine whether social position or cohabitation is important and examine whether there are gender differences in the quality of treatment. They will also look into gender differences in medical contacts before diagnosis.

– I hope that my research can help us learn more about gender differences in cancer and help target efforts that can reduce inequality between men and women in cancer, says PhD student Fie Stegenborg Andersen from the Cancer Survivorship research group, who is participating in the project.

The Danish Cancer Society supports research

The project 'Mapping the epidemiology of the male disadvantage in cancer – studies of sex-differences in incidence and prognosis' received DKK 1,500,000 from the Danish Cancer Society Scientific Committee – People and Society in 2022.

RESULT FROM 2023

Researchers find an explanation as to why cancer cells spread

One of the most dangerous characteristics of cancer is the ability of the disease to metastasise in the body. Research shows how the GSNOR protein plays an important role in that process.

Many cancer cells either have less of the GSNOR protein than normal cells or lack the protein completely. This increases the likelihood of cancer metastasising and reduces the chance of the patient being cured. In 2023, researchers from the Redox Biology group showed why. The answer is to be found in the way cells grow. Normal cells must have contact with a substrate and other cells to survive and grow. In the absence of contact, cells are prevented from growing and usually die. However, cancer cells that lack GSNOR can grow and spread even if they are not attached. GSNOR is often lacking in aggressive cancer, which enables cancer cells to move to new places in the body and form new tumours. Researchers have tested investigational drugs on cancer cells with low amounts of GSNOR in the laboratory, which slowed the cancer cells' ability to spread.

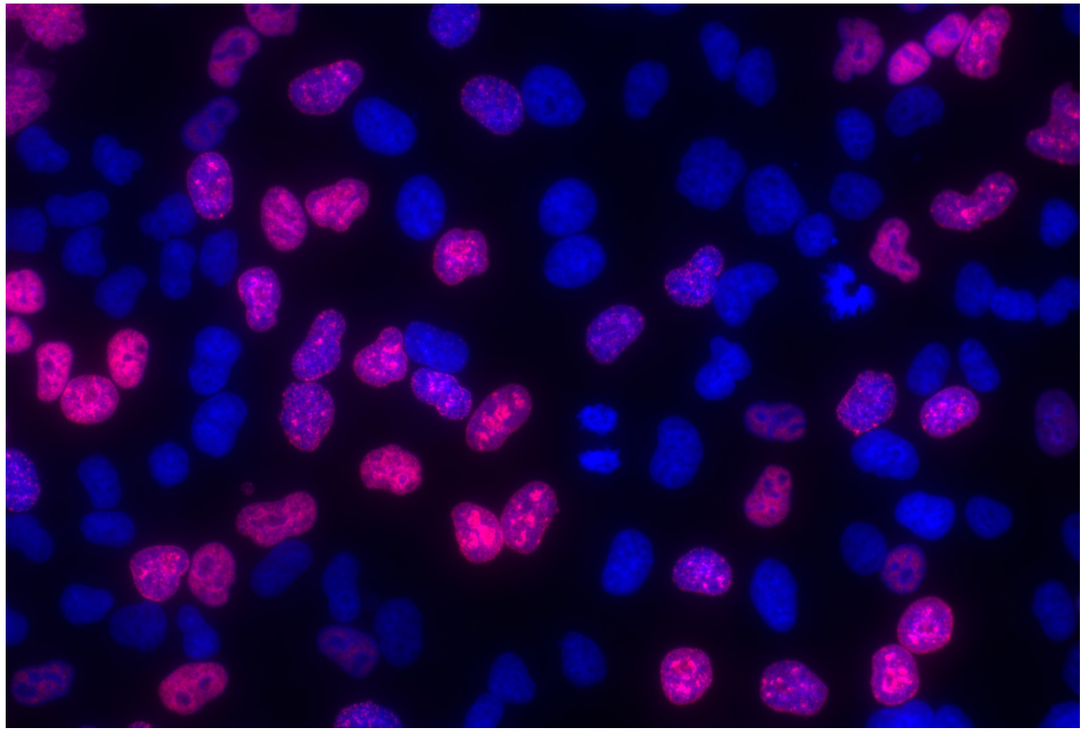
The Danish Cancer Society supports research

The project 'Deciphering the redox modifome of the oncogene TRAP1 to target cancer metabolism' received DKK 2,100,000 from the Danish Cancer Society Scientific Committee in 2016.

The project 'Discovering the tumor suppressor role of AMBRA1 in melanoma' received DKK 2,100,000 from the Danish Cancer Society Scientific Committee in 2018.

The project 'Unveiling the regulatory role of S-nitrosylation in cancer metabolism' received DKK 2,400,000 from the Danish Cancer Society Scientific Committee in 2019.

The results are published here:
Rizza S. et al.: GSNOR deficiency promotes tumor growth via FAK1 S-nitrosylation. Cell Rep. 2023, Jan. 31. DOI: 10.1016/j.celrep.2023.111997. Epub. 2023 Jan. 18.



Microscopic image of HeLa cancer cells with coloured DNA (blue) and ongoing DNA synthesis (red). Photo: from the researchers.

RESULT FROM 2023

Energy production – a possible vulnerability of cancer cells

NAD+ is an important molecule for cells' energy production. Researchers have now gained insight into how NAD+ regulates the division of cells and its potential to slow down aggressive cancer cells.

The study shows that the molecule NAD+ can be transported directly into the cell's energy factories, known as mitochondria, thereby affecting and increasing the cell's energy production. However, prolonged treatment with NAD+ leads to the depletion of certain mitochondrial functions within the cells. When this happens, the production of the essential building blocks for DNA and RNA slows down, and the cell stops dividing. Apolinar Maya-Mendoza, group leader for the DNA Replication and Cancer research group, which is behind the new result, explains:

– Certain cancer cells characterised by being particularly aggressive and having rapid cell growth are particularly sensitive to this influence. Our research shows that treating these cancer cells with a combination of NAD+ and specialised chemotherapy can effectively inhibit and kill the cancer cells, says Apolinar Maya-Mendoza.

The results are published here:
Munk SHN. et al.: NAD+ regulates nucleotide metabolism and genomic DNA replication. Nat Cell Biol. 2023, Nov. 13. DOI: 10.1038/s41556-023-01280 Z.

DKK

The Danish Cancer Society supports research

The project 'Targeting the link between energy metabolism and DNA replication for novel cancer therapies' received DKK 1,800,000 from Knæk Cancer in 2021.

Photo: Private

Senior Scientist Trille Kjær led the new study

RESULT FROM 2023

Several bouts of cancer: Research shows the risk of new cancer

A large study quantifies how many Danish cancer patients get new primary cancer. The results can indicate which groups of patients require special attention, and can be used in prevention and follow-up efforts.

Researchers from the Cancer Survivorship research group have investigated how many cancer patients get a new cancer disease later in life, i.e. not a relapse but a new primary cancer disease. Covering 27 cancers and including data from more than 457,000 Danes over the age of 40, the study is not only one of the largest of its kind, but also one of the few studies of adult cancer patients. This new knowledge can provide an important tool for both former cancer patients and their doctors:

– We now have a comprehensive overview of the incidence of new cancer occurrences among cancer patients, their prevalent forms of cancers and the types of subsequent cancers for which they are at the highest risk, depending on their specific prior diseases. This gives a good indication of which patient groups you should pay particular attention to, says Senior Scientist Trille Kjær, who led the new research.

Collaborating researchers

The new study was carried out in collaboration between researchers from the Danish Cancer Institute, CASTLE – the Danish Cancer Society's National Centre for Cancer Survivorship and Treatment Late Effects, Rigshospitalet, Zealand University Hospital, the Cancer Registry of Norway and Danish Multidisciplinary Cancer Groups (DMCG).

Can help with early detection of new cancer

There is variation among the 27 cancers as to how many people get cancer again and as to which type of new cancer is most common. Looking at the figures across all cancers, lung cancer is the most common second cancer, but if you dig into the figures for a specific cancer, such as uterine cancer, its most common second cancer is breast cancer.

The researchers also used the study to examine cancers caused by lifestyle. Once again, the results underline the value of taking action to prevent these cancers both in relation to the risk of developing cancer for the first time and the risk of developing a subsequent cancer. The figures show that if you have developed a cancer that is mainly due to alcohol, smoking, diet or virus, you are more likely to subsequently develop a new cancer with the same cause. In this context, smoking is a particularly significant risk factor. Cancer patients who have previously had a cancer attributed to smoking, such as lung or bladder cancer, face a 73% greater risk of developing a subsequent smoking-related cancer than patients whose initial cancer disease was not caused by tobacco.

Study results

In the study, the researchers calculate how many cancer patients experience new cancer after treatment. After five years, 6.3% have experienced a new cancer. This percentage increases to 10.5% after ten years and further rises to 13.5% when fifteen years have passed since their initial cancer diagnosis.

The results are published here:
Kjaer TK. et al: The cumulative incidence of new primary cancers in a large nationwide population-based retrospective cohort study of 457,334 Danish cancer survivors. Lancet Oncology. 2023, Dec. 1. DOI:10.1016/S1470-2045(23)00538-7.

That day I knew I was making a difference

Postdoc Panagiotis Galanos

Photo: Morten Andersen

For researchers, their work is a passion, and uncovering the answer to a compelling question leaves a special impression. This sentiment is familiar to postdoc Panagiotis Galanos of the Genome Integrity research group. Read his description here:

Standing there all by myself in the deserted laboratory, it felt eerily reminiscent of scenes from a horror movie, just waiting for the killer to jump out at any time. I was supposed to join the family for an Easter lunch like everyone else, but I had to cancel my plans. I couldn't go right now.

I had been tweaking the experiment for almost a month. As part of my PhD at the University of Athens, I was trying to replicate certain processes in the lab that take place in cancer tumours in humans.

In layman terms, cancer treatment causes cells to age and ultimately kills them. But a few cells escape and spread instead of dying. Together with some colleagues, I had been asking myself for a long time: How could this happen? And suddenly I discovered in the microscope – alone, at Easter, in the empty lab – how the cells escaped from what was previously considered a one-way process. It was huge. But it only took me a second before I became suspicious of my own experiment. This is a typical trait for a scientist: We want to prove our results again and again before we dare to believe them.

The dream job

As luck would have it, I later managed to replicate the experiment. So did colleagues in Denmark, Spain and Scotland, with whom I worked closely. But these things take time, and it took two years before we could publish an article in a recognised scientific journal. At that time, I was performing my military service in a military hospital, and my general showed no interest whatsoever. So I never really got to celebrate it. Fortunately, the article was positively received and has been cited many times. Within the research community, this signifies a job well done, as it demonstrates that others are building on your research.

One of the scientists I collaborated with on the study was Professor Jiri Bartek from the Danish Cancer Institute. He is globally renowned in my field, so when he proposed that I come to Denmark, I jumped right away. It is a bit of a dream location for me. Here are all the facilities I need, along with an environment featuring top researchers from all over the world.

Improved cancer treatments

I have been given the opportunity to assemble my own team of graduate and PhD students, and we are constantly building on the findings of that discovery. Over time, the goal is to help develop better cancer treatments. One of my first experiences at the Danish Cancer Society was an introduction course which took us through the sources of funding. I was impressed by how much the Danes give to cancer research. Just … wow! The widespread support for the fight against cancer further motivates me to make a meaningful impact in this field.

The only drawback of working in Denmark is the darkness in winter and the vegetables. I miss the fresh tomatoes from the garden. But beyond that, I feel very privileged.

RESULT FROM 2023

Pioneering cell research: Understanding cell movement

Culminating seven years of work, researchers in 2023 were able to explain a key characteristic of cells. The result is the first step toward treating diseases such as cancer.

Normally, cells are symmetrical. However, during the normal development of the body and in diseases such as cancer, cells must disrupt this symmetry and determine their orientation, distinguishing between front and back. In embryos, for example, this is required in order for the brain to develop normally. And in the case of cancer, it affects the ability of cancer cells to spread in the body. In 2023, the Cell Division and Cytoskeleton research group showed how this process takes place. In the cell, transport takes place by means of a form of 'railway track' that goes from the nucleus of the cell toward its membrane. The results show how a chemical process known as detyrosination changes the 'railway tracks' to guide the transport of proteins in the cell. The area along the cell membrane where the proteins are 'unloaded' is the part that becomes the front of the cell. This means that detyrosinisation serves as a kind of GPS, telling the cell where to unload proteins and thus determining the cell's direction of movement. The implications of this new knowledge are profound:

– Dysregulated detyrosination plays a role in cancer, neurological diseases and heart disorders. The first step towards novel treatments is to understand the cause and mechanisms behind the disease you want to treat. For this purpose, the knowledge we have acquired here is absolutely fundamental, says research group leader Marin Barisic.

Researchers film cells

The process of forming a front end and moving forward is typically initiated by the cell being exposed to chemical substances in the surrounding environment, such as growth factors. This initiates the transport of proteins toward what becomes the front of the cell. Where the tracks stop and the proteins are unloaded, the cell membrane is expanded. At the same time, what is now the front of the cell will attach more firmly to the tissue beneath it than the rest of the cell. This results in tension that leads to the rear of the cell being pulled forward and the cell moving accordingly. A bit like a balloon that stretches out and then contracts.

The results are published here:
Lavrsen K. et al.: Microtubule detyrosination drives symmetry breaking to polarize cells for directed cell migration. Proc Natl Acad Sci USA. 2023, May 30. DOI: 10.1073/pnas.2300322120. EPUB 2023 May 22.

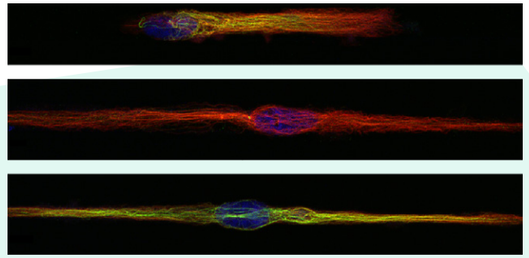


Photo: Girish Rajendraprasad, Kirstine Lavrsen and Marin Barisic.

Cells photographed through the microscope. The top image depicts a cell that has established a front and back end, while it is inhibited in the bottom two images. Here, the cell is pulled in two directions, resulting in an elongated shape. The blue colour shows the cell nucleus.

Watch the video by scanning this QR code.

See how a cell moves, filmed over 6 hours.

The video shows cells that establish a front and rear end (rows 1, 4 and 7) and cells where the process is inhibited by interfering with the detyrosination of microtubules (the 'railway track' of the cell). When detyrosination is disrupted in this manner, the cell becomes elongated without establishing a distinct front end (rows 2, 3, 5, and 6). Over a span of six hours, the cells move about 100 µm, i.e. 0.1 millimetre.

The Danish Cancer Society supports research

The project 'Tubulin post-translational modifications in cancer – the impact on aneuploidy and metastasis' received DKK 2,100,000 from the Danish Cancer Society Scientific Committee in 2016.

RESULT FROM 2023

Hormonal disorder increases the risk of ovarian cancer

Women suffering from polycystic ovary syndrome (PCOS) are at increased risk of developing ovarian cancer after menopause.

PCOS, which leads to hormonal disturbances, increases the risk of ovarian cancer in postmenopausal women. This is the first time that scientists have demonstrated that the disorder increases the risk of ovarian cancer in the slightly older women. According to the study, women with PCOS have twice the risk of developing ovarian cancer compared to women without PCOS. However, this should be seen in the context that the risk of developing ovarian cancer without PCOS is very small. Clarissa Frandsen and Allan Jensen from the group Virus, Lifestyle and Genes, the scientists behind the research, therefore emphasise that the most important finding in the new study is that it provides novel insights that can raise awareness of early symptoms among both doctors and women with PCOS.

Photo: Adobe Stock

The study is based on data from more than 1.7 million women.

The results are published here:
Frandsen CLB. et al.: Risk of epithelial ovarian tumors among women with polycystic ovary syndrome: A nationwide population-based cohort study. Int J Cancer. 2023, Sep. 1. DOI:10.1002/ijc.34574.celrep.2023.111997. Epub. 2023 Jan. 18.

NEW PROJECT FROM 2023

Can air pollution cause breast and central nervous system cancers?

Outdoor particulate pollution increases the risk of lung cancer, but may also increase the risk of breast and central nervous system cancers. A new research project will examine this in more detail.

Can ultrafine particles in the air around us increase the risk of breast and central nervous system cancers? Researchers from the Work, Environment and Cancer group will now look into this connection which has been suggested by previous research, but not yet conclusively proven. They will also examine the amount of particles necessary to potentially pose harm, as well as whether there are particular life stages when exposure to the ultrafine particles is especially dangerous. One theory of the possible correlation is that the ultrafine particles have hormone-like effects and thus increase the risk of breast cancer. At the same time, the particles are so small that they can migrate from the airways and reach other organs in the body, including the central nervous system.

The new research project will begin in January 2024.

The Danish Cancer Society supports research

The project 'Ultrafine particles and other air pollutants and risk of breast cancer and tumors of the central nervous system' received DKK 1,400,000 from the Danish Cancer Society Scientific Committee – People and Society in 2023.

NEW PHD & RESULT FROM 2023

New PhD: Research on senescent cells

Photo: Büro Jantzen

In 2023, Aida Rodríguez López received her PhD degree from the Danish Cancer Institute. Her research has illustrated the mechanisms of senescent cells, for instance in moles, and has contributed to our knowledge of what happens when we get cancer.

Many moles are completely harmless, but they sometimes develop into melanomas. One factor that prevents this process is senescence, which can be likened to a hibernation stage that some cells within the mole undergo. Cells in senescence secrete proteins that can cause neighbouring cells to enter senescence as well, which slows their growth and thus provides protection against the development and spread of cancer. In other cases, the opposite can happen, and the cells secrete proteins that promote inflammation and the development of cancer. Aida Rodríguez López' research shows that cells in senescence break down the so-called ribosomes, which are small protein factories within the cells. This is the first time that ribosomes have been shown to degrade in senescent cells, and the research explains how and why this happens. The researchers theorise that senescent cells may be able to regulate the production and secretion of proteins to neighbouring cells in this manner. At the same time, cells can access nutrients by recycling the degraded parts, providing energy that contributes to their survival.

– When cells undergo senescence, there is a shift in the proteins they secrete. Our results suggest that this can be directly related to the degradation of certain types of ribosomes. Depending on the type of ribosomes that remain in the cells, it may affect which proteins are secreted, and it may affect the development of cancer, says Aida Rodríguez López.

The results are published here:
López AR. et al.: Autophagy-mediated control of ribosome homeostasis in oncogene-induced senescence. Cell Rep. 2023 Nov. 5. DOI:10.1016/j.celrep.2023.113381.

Meet Aida Rodríguez López

35-year-old Aida Rodríguez López was born in Spain. After her master's degree in Molecular Biology and Genetics, she worked for four years in a laboratory in the Netherlands before travelling to Denmark to pursue her dream of a PhD degree. Here, she became one of the first PhD students in the newly founded Cellular Homeostasis and Recycling research group under group leader Lisa Frankel.

– I was very privileged to be able to influence the content of my PhD studies and at the same time be part of the group from the beginning. I have been really happy to work here, says Aida Rodríguez López.

In June, Aida Rodríguez López defended her PhD thesis, and she will remain employed at Cellular Homeostasis and Recycling for the rest of the year.

Educating future researchers

A total of 13 PhD students graduated from DCI in 2023 See the complete list on *www.cancer.dk/phd-defences-2023/*

The Danish Cancer Society supports research

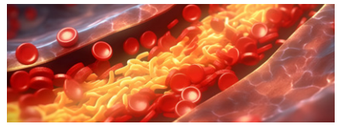
The project 'Selective ribosome degradation by autophagy in cancer development' received DKK 2,680,000 from Knæk Cancer in 2018. The project 'Characterization of oncogenic RNA-binding proteins in the autophagy-cancer interplay' received DKK 2,325,000 from the Danish Cancer Society Scientific Committee in 2020.

RESULT FROM 2023

Aggressive breast cancer cells eat cholesterol

Research shows how aggressive breast cancer cells use cholesterol to grow and spread. The research also describes a new mechanism in which cancer cells absorb the fat.

The Cancer Invasion and Resistance research group showed in 2023 that ErbB2-positive breast cancer cells absorb cholesterol from the blood and tissues around them. This happens via a process called macropinocytosis, by which substances are absorbed through the membrane of the cancer cells and encapsulated in small spheres of membrane that are transported further into the cell. Once cholesterol has been absorbed into the cancer cell, it is transported into the cells' lysosomes, which are small acid-filled compartments within the cells' interior. Here, a part of the cholesterol molecule is split off, and the new form of cholesterol can now be transported out of the lysosomes using the molecule NPC1 and incorporated into the membrane of the cancer cell. This can convey properties to the cancer cell that promote its growth and ability to spread in the body.



Previous research has indicated that other cancer cells, such as pancreatic cancer cells, also absorb cholesterol. Photo: Adobe Stock

The results are published here:
Skorda A. et al.: Activation of invasion by oncogenic reprogramming of cholesterol metabolism via increased NPC1 expression and macropinocytosis. Oncogene. 2023, July 7. DOI: 10.1038/s41388-023-02771-x.

The Danish Cancer Society supports research

The project 'Screening for new treatment possibilities and for ErbB2-positive, invasive breast cancer' received DKK 100,000 in a scholarship from the Danish Cancer Society Scientific Committee in 2018. The project 'The role of lysosome distribution in the regulation of ErbB2-induced cancer cell invasion' received DKK 50,000 in a scholarship from the Danish Cancer Society Scientific Committee in 2020.

NEW PROJECT FROM 2023

Denmark's first major study on late effects after cervical cancer

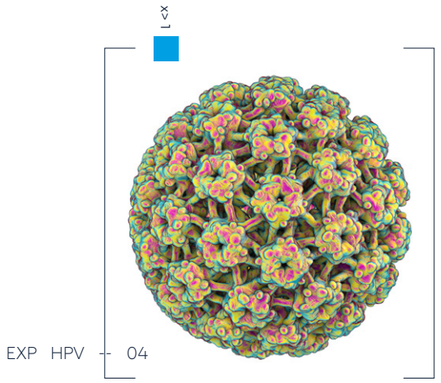
60,000 questionnaires sent to Danish women will provide more information about the late effects of cervical cancer. A new study aims to break taboos and pave the way for improved treatment.

The study examines both the extent and types of late effects of cervical cancer and the potential late effects associated with various treatment modalities. This can provide knowledge of the late effects that you need to be aware of and facilitate early detection as a strategy in prevention and treatment. In some cases, it can also provide a more informed basis for selecting treatment options. In addition, researchers hope that the study will make it easier to talk about late effects. For instance, many people lack the courage to openly discuss injuries that impede their ability to control bladder or bowel functions or to perform their job due to anxiety or depression. Hopefully, raising awareness about the prevalence of these struggles can initiate change.

The Danish Cancer Society supports research

Postdoc Gunn Ammitzbøll from the Cancer Survivorship research group at DCI contributes to the study. It is headed by the National Centre for Research on Survivorship and Late Adverse Effects after Cancer in the Pelvic Organs, which was established with the support of Knæk Cancer in 2017.

No HPV – no cervical cancer



This is one of the great successes in the world of cancer research: In a span of just 30 years, the HPV virus has been identified as a cause of cervical cancer, and a vaccine has been developed that effectively prevents the disease. Over the years, the Danish Cancer Society has supported HPV research in a number of projects.

The human papillomavirus (HPV) is transmitted by sexual contact and is so prevalent that most of us have had it. A little jokingly, scientists call it 'a sex cold'. The body will often fight HPV itself, but the infection becomes chronic in some cases, which can lead to cancer. HPV causes hundreds of thousands of cases of cervical cancer every year. HPV is also the cause of other and more rare cancers such as anal cancer, penile cancer and head and neck cancer. It is also the cause of genital warts.

However, thanks to research, there is a prospect that the picture will change, and in the future women may no longer develop cervical cancer due to HPV.

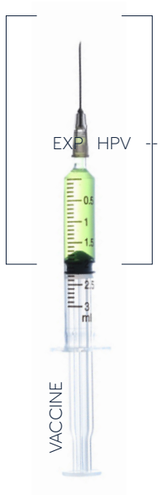
The major breakthrough in HPV research occurred in 1984 from German virologist Professor Harald zur Hausen. Among other things, he described that HPV is present in cancer cells from cervical cancer. He proved that chronic infection with HPV types 16 and 18, in particular, might lead to cervical cancer. He was awarded the Nobel Prize for his discovery

1984 Professor Harald zur Hausen proves that chronic infection with HPV types 16 and 18, in particular, can lead to cervical cancer.

1991 Professor Mads Melbye and colleagues show that there is a strong correlation between the risk of cervical cancer and anal cancer. According to the researchers, this makes it likely that the diseases have the same cause.

1997 Research led by Professor Mads Melbye shows that anal cancer is caused by a sexually transmitted infection. The results show that it is probably HPV 16 – meaning that you can prevent most cases of anal cancer.

1970 1980 1984 1991 1997 2000



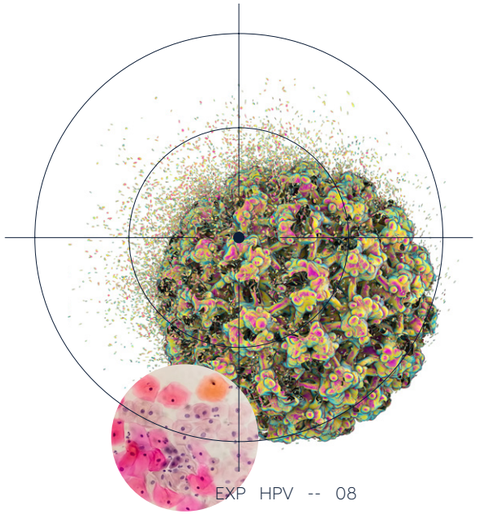
EXP HPV -- 07

in 2008. Danish researchers have also left their mark on HPV research. This includes Susanne Krüger Kjær, who is a professor of cancer epidemiology, consultant at Rigshospitalet and leader of the research group Virus, Lifestyle and Genes at the Danish Cancer Institute. She has been researching HPV since her university days and has since become one of the world's leading authorities on the link between HPV and cervical cancer. Her research topics include the effect of the HPV vaccine.

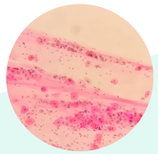
– I have been studying HPV throughout my career. And it is the strongest risk factor for the development of cancer I have seen. In all studies, we consistently observe a definite link between HPV and the risk of cervical cancer. In other words: No HPV – no cervical cancer, says Professor Susanne Krüger Kjær.

Because HPV is a virus, researchers managed to develop a vaccine against HPV in 2006. Since then, well-controlled clinical studies have repeatedly documented the efficacy of the vaccine among the girls and women who have received it. The importance of the HPV vaccine in the real world was also irrefutably documented in 2023 with the publication of the annual cancer statistics on the number of women developing cervical cancer in Denmark. They showed that the number of women who developed cervical cancer decreased significantly from 367 in 2012 to 274 in 2021.

– The decrease has occurred after the introduction of the HPV vaccine, and it is precisely the effect of the vaccine that we can now see in the cancer figures, says Susanne Krüger Kjær.



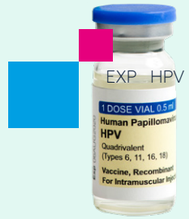
EXP HPV -- 08



Next steps: Individual screening programme

Thanks to the HPV vaccine, thousands of people will be spared from cancer in the future. Still, research has the potential to improve our health even more. Because of the high efficacy of the vaccination against HPV, we will need to adjust screening for cervical cancer in the future, according to Susanne Krüger Kjær. Together with a number of colleagues, she is testing a screening method which uses the woman's HPV status to determine which examinations she should be offered, and at which intervals. HPV status means an analysis of whether the woman is infected with HPV in the cervix and, if so, which type.

– We are currently offering smear testing to all women aged 23 to 64 every three or five years but I believe that in the future, we will tailor the screening to the individual woman, based on a risk assessment. This will both provide safer screening and spare women from unnecessary examinations, says Susanne Krüger Kjær.



EXP HPV -- 09

2006 Gardasil becomes the first approved vaccine against HPV, partly based on research in the FUTURE-II study. The vaccine protects against four types of HPV, including types 16 and 18, which cause about 70% of all cervical cancer, and types 6 and 11, which cause about 90% of all genital warts.

2009 HPV vaccination is included in the Danish child vaccination programme for girls, and there is great support for the new vaccine. Not least thanks to the 'Vidunderlivet' campaign, which the Danish Cancer Society is behind. Denmark quickly becomes one of the countries in the world with the highest level of vaccine support, reaching as high as 90% for some year groups.

2015 The HPV vaccine faces resistance following a television documentary about girls who believe they have become seriously ill after receiving the HPV vaccination. However, science supports the safety and efficacy of the vaccine. Several studies show that the HPV vaccine has no more side effects than other paediatric vaccines. Together with other initiatives, the information campaign 'Stop Cervical Cancer – Get vaccinated', which is a collaboration between the Danish Cancer Society, the Danish Health Authority and the Danish Medical Association, aids in shifting public sentiment. More girls are being vaccinated, and while only about 15,000 girls started their HPV vaccination in 2015 and 2016, the figure has more than doubled by 2018, to 40,000.

2017 A new HPV vaccine, Gardasil 9, is introduced to the market. It protects against nine HPV types, potentially protecting against 90% of all cervical cancers as well as anal cancer and genital warts. This vaccine has been used in the child vaccination programme since 2019.

2019 The HPV vaccine is incorporated into the child vaccination programme for boys.

2021 Professor Susanne Krüger Kjær and her research team show that HPV vaccination has a protective effect against severe precursors/cancers of the female external genitalia and vagina. For the female external genitalia, this risk has been reduced by 78%, while the risk has been reduced by 84% for severe vaginal precursors.

2021+22 Susanne Krüger Kjær's research documents that the effect of the HPV vaccine protecting against four types of HPV lasts at least 14 years. It also shows the effect of the vaccine against nine types of HPV, which currently lasts at least 8 years after the first dose. The results show that both vaccines protect against severe precursors of cervical cancer, and there are no signs yet that their effect is diminishing.

2023 Research conducted by Susanne Krüger Kjær's research group shows that the HPV vaccine protects against severe precursors and anal cancer.

– Denmark is one of the few countries that can measure the effect of the vaccine on rare cancers and precursors, such as anal cancer, thanks to our extensive registers and vaccination covering a wide age range (so-called catch-up vaccinations). This enables us to document that vaccination not only protects against cervical cancer, but that it works against more diseases than we dared to hope for, says Susanne Krüger Kjær.

2006 2009 2015 2017 2019 2020 2021 2022 2023

News in brief

Photo: Hans Bach

In 2023, the second edition of the white paper on social inequality in cancer was published. The first edition came out in 2019.

Significant social inequality in all aspects of the cancer trajectory

If you have a short-cycle education, low income or live alone, you are more likely to be worse off during a cancer trajectory than cancer patients who have a higher education, higher income or live with a partner. These findings were presented in the first white paper on social inequality in cancer in Denmark, which was produced by DCI in 2019. The updated 2023 version of 'Social inequality in cancer in Denmark' emphasised that there is social inequality in all aspects of a cancer trajectory. Moreover, the new white paper shows that there are still gaps in our knowledge about social inequality in cancer. This includes the fact that there are only few studies of initiatives to reduce social inequality in the cancer trajectory. We have a gap in our knowledge about social inequality between the first symptom of cancer and the diagnosis. And there is a requirement for updating our insights. By way of example, the studies of palliation and rehabilitation are based on patients who received palliation or rehabilitation 10-15 years ago, and these findings probably no longer reflect reality.
You can read the white paper here: www.cancer.dk/hvidbog2

Research into cancer and dementia

Research group leader Marin Barisic received the Lundbeck Foundation's Ascending Investigator grant in 2023. Marin Barisic is head of the Cell Division and Cytoskeleton group and was awarded DKK 6 million for the project 'Targeting microtubule detyrosination in neuroblastoma and neurodegenerative disorders'. Marin Barisic's research focuses on the so-called microtubule network in cells. This plays a role in the dissemination of cancer as well as for neurodegenerative diseases such as dementia and Alzheimer's. One of the main objectives of the research is to develop a new class of substances that can potentially prevent both cancer and neurodegenerative diseases. Ascending Investigator grants are awarded to established and talented researchers at Danish research institutions. You can read more about Marin Barisic's research on page 18.

Photo: Danish Cancer Society

The Youth Democracy Festival covers topics such as climate, politics and health.

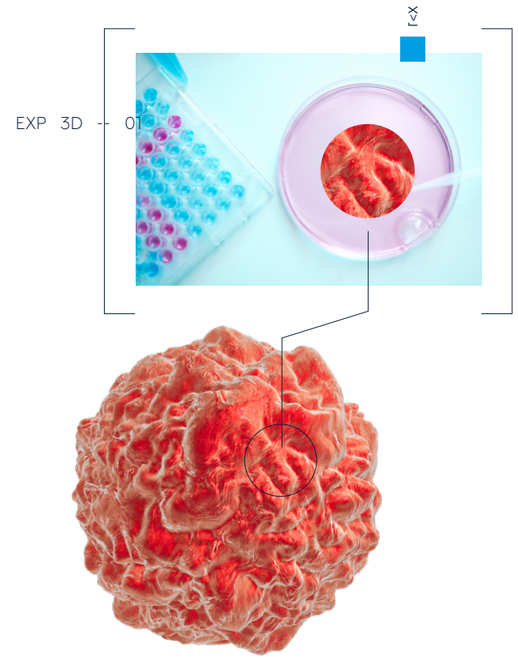
Youth Democracy Festival

For the first time, the Danish Cancer Institute participated in the Youth Democracy Festival in Valbyparken, Copenhagen. For two days, the festival was visited by hundreds of young people from all over Denmark. DCI shared a tent with the Prevention Department where guests could play a DNA game and ask about anything related to research and cancer. Postdoc Panagiotis Galanos and PhD student Kezia Oxe were present to answer questions from the curious guests. You can borrow the DNA game free of charge from the Danish Cancer Society by contacting us at udforsk@cancer.dk.

Mini-cancer tumours in 3D

One of the focus areas for the researchers in the Cancer Invasion and Resistance research group is ovarian cancer that has become resistant to standard treatment. The researchers have introduced a new technique, which involves removing ovarian cancer tumours, cutting them into pieces and cultivating the cancer cells as mini-tumours in 3D in the lab. The mini-tumours are very similar to tumours growing in the patient and can provide researchers with insights into the mechanisms of cancer cells that become resistant. This allows researchers to test a number of different treatments on the mini-tumours – treatments that would not be possible to test on a patient. The use of these so-called tumour organoids in research is a rather novel technique. It is technically advanced and quite expensive, but it has a number of advantages, says research leader Tuula Kallunki from Cancer Invasion and Resistance.

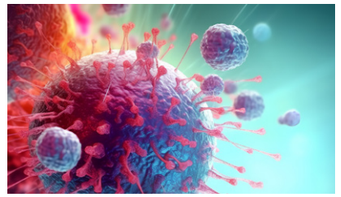
To analyse the mini-tumors, researchers use technologies such as advanced 3D microscopy, which you can read more about on page 34.



RESULT FROM 2023

Research will enable more patients to benefit from immunotherapy

Immunotherapy has led to significant advances in cancer treatment. However, there are still a number of cancers for which the treatment is ineffective. Basic research may have found a solution to this, and the findings were tested in 2023 in trials with patients at Rigshospitalet.



New study combines immunotherapy and chemotherapy. Photo: Adobe Stock

In 2023, Rigshospitalet's Phase 1 unit started experimental treatment combining immunotherapy and chemotherapy. The aim is to make immunotherapy effective in patients who have either developed resistance to treatment or in those with cancer types where immunotherapy has no effect. The trial in the Phase 1 unit was initiated on the basis of results from the laboratory of Associate Professor Daniela de Zio's Melanoma Research Team in the Cell Stress and Survival research group at the Danish Cancer Institute. In experiments with mice, researchers have combined the chemotherapy thiopurine with checkpoint inhibitors, which are immunoregulating drugs. The results were excellent:

– Treatment with thiopurine caused the immune system to rush to the tumour site and attack the cancer. This slowed the cancer growth, and we saw an additional slowdown when administering immunotherapy at the same time, says Associate Professor Daniela De Zio from the Melanoma Research Team, who led the trials.

Genetic changes reveal cancer cells

Patients at Rigshospitalet therefore receive a combination of thiopurine and a checkpoint inhibitor. First, however, they have an analysis made to determine the extent of genetic changes in the patients' cancer cells and assess the likelihood of the cancer cells developing new genetic changes. This is because genetic changes are key to how the combination of thiopurine and immunotherapy works, and these changes are what triggers the immune system to detect the diseased cells and kill them. This happens either naturally or when the immune system is aided through immunotherapy.

However, some cancer cells can become resistant to immunotherapy. And in some cancers, the cancer cells are not sufficiently different from normal cells for the immune system to recognise them, even with the assistance of immunotherapy. This is where thiopurine enters the picture:

– Thiopurine increases the number of genetic changes in cancer cells. This makes the cancer cells visible to the immune system, which then attacks the cancer cells as shown by the tests from the laboratory. In patients, this will hopefully enable the immune system to fight cancer. This means that patients in the study should preferably have cancer cells with a particular propensity for genetic alterations to enhance the likelihood of thiopurine being effective, says consultant Kristoffer Staal Rohrberg, who leads the trials in the Phase 1 unit.

The results are published here:
Nazerai L. et al.: Thiopurine 6TG treatment increases tumor immunogenicity and response to immune checkpoint blockade. Oncoimmunology. 2022, Dec. 17. DOI: 10.1080/2162402X.2022.2158610.

The Danish Cancer Society supports research

The project 'Thiopurine-based therapy as a new strategy to increase tumor immunogenicity and enhance response to ICI-therapy' received DKK 1,550,000 from the Danish Cancer Society Scientific Committee in 2022 for talented young cancer researchers (Loulieta Nazerai). The research was carried out in collaboration with CONTROL - National Research Center for Childhood Cancer, which was established with support from Knæk Cancer in 2019.

Photo: Büro Jantzen

The research conducted by Associate Professor Daniela de Zio can contribute further knowledge about which patients will benefit from immunotherapy.

RESULT FROM 2023

Research will predict the effect of immunotherapy

The protein Ambra1 may predict which melanoma patients benefit from immunotherapy.

The amount of the protein Ambra1 is of paramount importance in determining the behaviour of the immune system towards cancer and the effectiveness of immunotherapy using checkpoint inhibitors. This is demonstrated by research conducted by the Melanoma Research Team within the Cell Stress and Survival research group, which has measured the amount of Ambra1 in melanoma tumours. The research showed that low amounts of Ambra1 in the cancer cells provide a microenvironment that is particularly susceptible to immunotherapy. And when the researchers removed Ambra1 in mice, treatment with checkpoint inhibitors worked particularly well. The team hopes that over time, Ambra1 can be used to predict which patients will benefit from treatment with checkpoint inhibitors. This will spare patients who do not benefit from the treatment from experiencing side effects and allow them to swiftly pursue different and potentially more effective treatment options.

The results are published here:
Frias A. et al.: Ambra1 modulates the tumor immune microenvironment and response to PD-1 blockade in melanoma. J Immunother. Cancer. 2023, Mar. 11. DOI: 10.1136/jitc-2022-006389.

The Danish Cancer Society supports research

The project 'Discovering the tumor suppressor role of AMBRA1 in melanoma' received DKK 2,100,000 from the Danish Cancer Society Scientific Committee in 2019.

RESULT FROM 2023

DNA testing can help patients with rare cancers

A newly developed DNA test may enable screening for rare cancers in children and young adults in the future. The test will now be evaluated in a large-scale research project.

The new DNA test may make it possible in the future to screen all newborns for rare genetic changes that increase the risk of diseases such as cancer. The Hematology research group has contributed to the development of a method that reimagines how existing techniques for genetic analysis are conducted. This makes it more efficient and much cheaper to test large groups of individuals. The hope is that the method will make it possible to identify children at high risk of disease, such as cancer, before they become ill. This may facilitate monitoring of individuals at risk, enabling the early detection and diagnosis of diseases when treatment options are optimal. For other diseases, treatment may be offered so that the disease does not occur at all. This gives researchers a cautiously optimistic hope that a number of serious diseases can be prevented in the future.

The results are published here:
Stoltze UK. et al.: Combinatorial batching of DNA for ultralow-cost detection of pathogenic variants. Genome Medicine. 2023, March 14. DOI: 10.1186/s13073-023-01167-6.

International researchers

The Danish Cancer Institute is a workplace for researchers from across the globe. Here, you can meet some of them and learn about why they have chosen to travel from afar to conduct research in Copenhagen's Østerbro district.

Beverley Lim Høeg

Postdoc

From Malaysia

My research

I conduct research on the psychosocial aspects of cancer, with a focus on enhancing the quality of life for individuals living with and beyond a cancer diagnosis. This includes both patients and their relatives, such as their spouse or children. I also conduct research on bereavement, with a particular emphasis on the significance of losing a parent early in life.

Why I work here

Because of the international environment and the high quality of the research carried out here. Being part of the Danish Cancer Society, which works for cancer patients and their relatives, also means that our research results are used to directly influence the healthcare system. I value being a part of something bigger and the sense of making a difference.

One of my most important achievements

In national register studies, I have shown that losing a parent early in life (before the age of 18) has consequences for your level of education, the use of psychiatric medicine and the risk of divorce in adulthood. The Danish Cancer Society uses this knowledge to advocate for legislation to ensure that children as relatives are entitled to systematic support and help in the school and healthcare systems. I am proud to be able to contribute to this effort through my research.

Nicola Patricia Dalgaard

Postdoc

From South Africa, raised in Australia

My research

The overall focus of my research is to investigate the role of bioactive compounds from plants in the prevention of chronic diseases, including cancer, cardiovascular diseases, diabetes, dementia and chronic obstructive pulmonary disease (COPD). I believe that diet plays a crucial role as a modifiable risk factor for most diseases, and I am dedicated to providing people with knowledge about how their dietary choices can help them live a longer and healthier life.

Why I work here

I had collaborated with my wonderful colleagues in the Diet, Cancer and Health group for a couple of years before the opportunity arose for me to relocate to Denmark. I can't imagine working anywhere else!

One of my most important achievements

I have published a number of observational studies in the Danish Diet, Cancer and Health cohort showing that increased intake of flavonoids, bioactive plant compounds found in tea, dark chocolate, fruit, vegetables and red wine, correlates with reduced risks of cancer mortality, diabetes, dementia, cardiovascular disease and COPD. The most significant effects are observed in high-risk populations, namely smokers.

Tuula Anneli Kallunki

Research group leader

From Sweden,
raised in Finland

My research

In my group, we cultivate and study three-dimensional (3D) tumour organoids from ovarian cancer tissue. Using 3D tumour cultures enables us to work as close to the patient as possible, but in laboratory conditions where tumour cultures resemble the original tumours and allow for personal, translational cancer research without exposing patients to a range of different treatments.

Why I work here

My husband and I are both researchers, and we came to Copenhagen when we both had the opportunity to pursue the research we wanted. I have worked at DCI for several years and I enjoy it: The working environment here is excellent and all my colleagues are super cooperative, helpful and supportive. This is my scientific home.

One of my most important achievements

Looking at 2023, I would like to highlight the discovery of a novel mechanism by which cancer cells absorb cholesterol, as well as the significance of cholesterol uptake for the invasive characteristics of aggressive breast and ovarian cancer cells. Additionally, our collaboration which led to the identification of new subgroups of ovarian cancer, along with the development of methods for 3D imaging and image analysis of ovarian cancer organoids. In the coming years, I anticipate that our efforts will make a significant difference in the survival and quality of life of ovarian cancer patients.

Matteo Bordi

Senior scientist

From Italy

My research

I have extensive knowledge in cell and molecular biology, specialising in the fields of mitochondrial homoeostasis, cell metabolism and signalling pathways. My research focuses particularly on investigating the mechanisms employed by cells to detect and break down damaged or redundant mitochondria.

Why I work here

I think the Danish Cancer Institute provides a stimulating research environment. What propels my aspiration to work here is the opportunity to leverage my expertise in investigating the mechanisms underlying tumour development and understanding how cancer cells can develop resistance to treatment by altering their metabolism.

One of my most important achievements

I have discovered a new molecular process that exists across two separate organelles: Lysosomes and mitochondria. Currently, I am investigating how cancer cells can use this mechanism to improve their own survival.

Apolinar Maya-Mendoza

Group leader

From Mexico

My research

Since my studies, I have focused on understanding how cells copy their DNA and on the intricate regulatory mechanisms that govern this vital biological process. Today, I place particular emphasis on understanding the changes present in cancer cells compared to normal cells. The overarching goal of my research is twofold: to contribute to the development of novel cancer treatments in clinical settings and to elucidate the fundamental principles underlying the process of healthy ageing.

Why I work here

I suppose it is a combination of destiny and free will. 12 years ago, there was a vacancy as a senior scientist in a research group led by Professor Jiri Bartek. I applied and got the job. My research was a good fit for the group's work – which is why I'm still here after almost 12 years.

One of my most important achievements

There are many, but I can highlight three results from the work of the last 12 years:

1 we have contributed to the understanding of how PARP-1/2 inhibitors work at the molecular level. These inhibitors are currently used in the treatment of advanced breast cancer, ovarian cancer and disseminated prostate cancer.
2 our research indicates that Ganciclovir may be an effective drug to treat patients with glioblastoma.
3 we have opened up new opportunities to find vulnerabilities in the metabolism of cancer cells, which can have a clinical impact on the treatment of cancer.

26

Nationalities

26 different nationalities work at DCI.

Microscopes look deep into cells

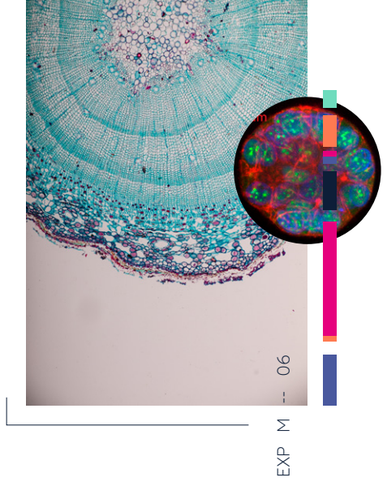
In 1590, two Dutch spectacle makers developed the first microscope. Today, microscopes can visualise objects as small as atoms, making them indispensable tools in cancer research by enabling researchers to observe and analyse the smallest components within cells. Read more here about how cancer researchers use microscopes.

Analyses

In the past, you would describe or illustrate what you observed through a microscope. Today, microscopes can take pictures and make analyses. If you label cell components, such as proteins, DNA or organelles with fluorescent dyes, the microscope can see and count them. This method reveals the location of proteins in the cell, for instance. If several proteins occur in the same place, this may indicate that they are interacting.

Artificial intelligence

Microscopes generate vast amounts of data. A single experiment produces thousands of images with millions of cells, and artificial intelligence is therefore used for analysis and pattern identification. It requires powerful computers that can analyse millions of images in a day. Using a regular PC, it would take about a month of continuous analysis to process just one experiment.

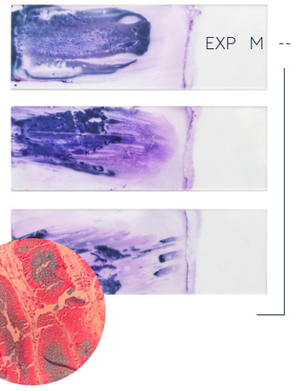


Laser

Microscopes can use lasers for precision manipulation, such as creating a hole in the membrane of cells to observe how the damage is repaired. Cancer cells that metastasise throughout the body have a great need to repair their membranes. Researchers are exploring whether existing, authorised medicines can be repurposed to inhibit this process, thus killing the cancer cells.

Tissues

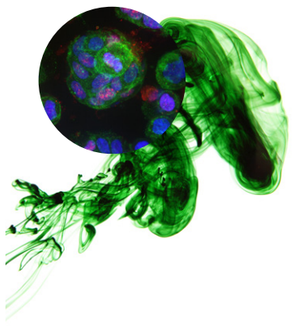
Microscopes are constantly improving. For instance, they are becoming better at analysing thick samples such as tissue samples. This means that you can look into tissues from various sources such as skin or organs. By using fluorescent dyes, researchers can see how different structures within the tissue interact with each other.



Millions of cells

A high-throughput microscope can analyse mini-tumours or cancer cells cultivated in plates with 384 separate wells and treated with different substances. In the microscope, researchers can observe whether the treatments induce changes, such as alterations in certain proteins or in the DNA. They can also see which cells react to which substances and investigate what happens in cells that become resistant to treatment.

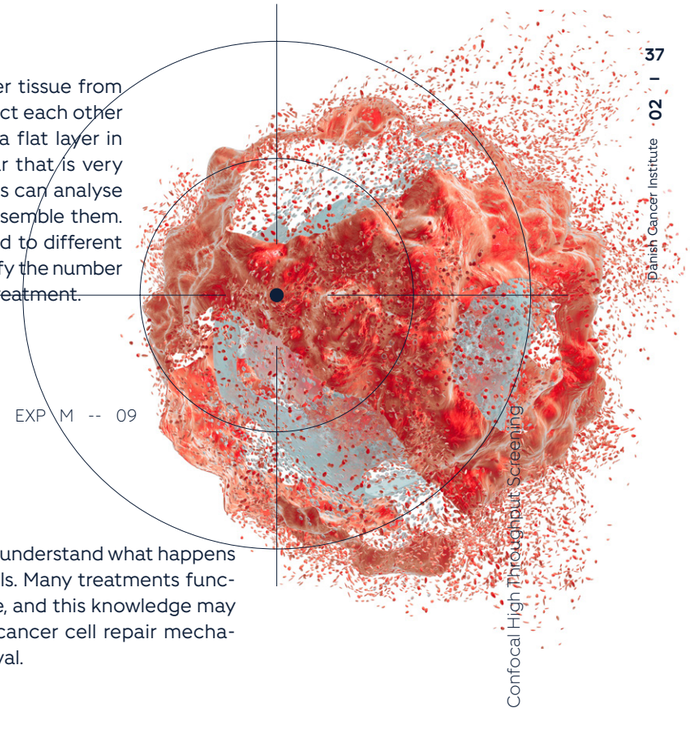
Dyes



One of the dyes used to stain molecules in the cells originates from jellyfish found in the North Atlantic. It lights up green when illuminated with a specific wavelength. Other dyes are sourced from organisms like sea anemones, offering a variety of colours such as green, red and blue.

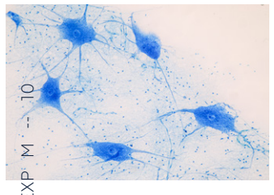
Mini-tumour

A new technique involves culturing cancer tissue from patients in a 3D gel matrix. Cells in 3D affect each other and grow differently than cells grown in a flat layer in a Petri dish. In 3D, you get a mini-tumour that is very similar to tumours in patients. Microscopes can analyse the small tumours without having to disassemble them. It can show how the mini-tumours respond to different treatments, and the microscope can quantify the number of cells within a tumour that react to the ~~treatment~~.



DNA repair

Microscopes help researchers understand what happens when you damage DNA in cells. Many treatments function by inducing DNA damage, and this knowledge may consequently help us block cancer cell repair mechanisms and prevent their survival.

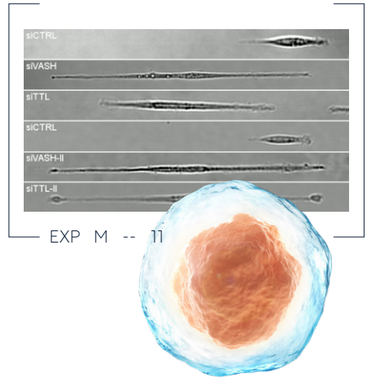


Networks

In Denmark, both the Danish Cancer Institute and most universities are part of a bio-imaging network. Members learn about each other's technologies and share experiences about which microscopes are most suitable for various tasks. They also provide each other with access to equipment when needed.

Hear and see how cancer researchers use microscopes

Use the camera on your smartphone to scan the QR code and observe how some of the researchers at DCI use microscopes in their work. The video is in Danish.



The image depicts patient-derived organoids, which are cancer cells obtained from a patient and cultured in 3D in the laboratory. The organoids are stained to assess if they exhibit stem cell-like characteristics, which means they are more aggressive. All the nuclei are stained blue and the cytoplasma (all cell contents other than the nucleus) is stained red. Stem cell-like cells contain a protein that is stained green in their cell nuclei. The patient-derived organoids typically range in size from 20 µm to 80 µm.

Photo: Cancer Invasion and Resistance research group

In pursuit of a life without cancer

On behalf of the Danish Cancer Society, we thank everyone who has helped to make our research possible.

Danish
Cancer Society

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