

Danish Cancer Society Research 2022

ANNUAL RESEARCH IMPACT REPORT



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Danish Cancer Society

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Danish Cancer Society Research

Research is one of the Danish Cancer Society's core activities, aimed at providing better options for cancer patients and their relatives – progress reaching from the past into the future.

In 2022, chemist Morten Meldal became the 14th Dane to be awarded a Nobel Prize, earning him a place in history. The Nobel Prize is one of the most prestigious prizes in the world, but rather than prestige, its primary value relates to the advances and the knowledge it accounts for. Scientific research is one of the most important ways in which to bring about societal progress and find new solutions to challenges such as economy, climate, and health.

In 1926, Danish physician Johannes Fibiger was awarded the Nobel Prize in physiology and medicine for his studies of cancer in rats. In 1949, the Danish Cancer Society named our first biological research institute the Fibiger Institute as a compliment to Johannes Fibiger.

A few years previously – in 1942 – the foundations were laid of an invaluable tool for another important field: epidemiological cancer research, when DMSc Johannes Clemmesen founded the Danish Cancer Registry, in which all Danish cancer cases have been recorded since 1 January 1943. The Cancer Registry has contributed to placing Danish registry research in an international league of its own, as our registries include major, detailed quantities of knowledge.

Since then, research has developed into new directions, continuing to produce new breakthroughs. The Danish Cancer Society is proud of our contribution to developments, via the Danish Cancer Society Research Center and the annual funding granted to cancer research in Danish hospitals and research institutions. Our Knæk Cancer fundraising campaign has granted more than DKK 1 billion to research. And thanks to the support that we receive from Danes every year – from volunteers donating their work to private individuals and companies donating funds – the Danish Cancer Society has contributed to the progress made in a long series of fields such as basic biological research, that can lead to the development of new drugs, immune therapy, knowledge about social inequality, new use

of existing drugs, improved use of existing treatments such as radio therapy, research into long-term side effects and palliative care, etc, all of which cause progress to the benefit of cancer patients and their relatives. We are proud to introduce some of the progress in this English version of our annual research impact report concerning the Danish Cancer Society Research Center.

We have not solved the mystery of cancer, and bearing the complexity of the disease in mind, we will not do so any time soon. Cancer is not one, rather hundreds of diseases with highly different causes and requiring different treatments. Progress is made via ongoing efforts that all add to previous ones, continuously providing us with slightly better diagnoses, treatments, or other efforts to combat cancer. Eventually, the progress will mean that some cancer types are no longer fatal.

And, who knows, perhaps one of the Danish Cancer Society's Danish researchers will one day follow in the footsteps of their fellow-countrymen and be awarded a Nobel Prize. We aim to support the most competent and visionary of researchers, and no matter what happens, the researchers of the past, the researchers supported by the Danish Cancer Society today, and the ones we will support in the future will all help us move towards a future in which fewer people die of cancer and we have more to offer those who still contract the disease in spite of the progress made.

Happy reading!

Mads Melbye
Scientific Director

Jesper Fisker
CEO

The Danish Cancer Society has our own research centre, and we support cancer research in hospitals and research institutions throughout Denmark every year. The research spans all stages of the cancer trajectory – from basic research to research into palliation and long-term side effects. Photo: Hans Bach

This report includes charts with analyses of the funding granted by the Danish Cancer Society to research and the funding received by the Danish Cancer Society Research Center for research projects. Funding granted by the Danish Cancer Society to campaigns, information efforts, and short travel grants are not included in the charts.

The Danish Cancer Society supports research

The Danish Cancer Society supports three lines of research: independent research, strategic research, and research by the Danish Cancer Society Research Center.



Danish Cancer Society Research Center

The Danish Cancer Society Research Center is the Danish Cancer Society's research centre with a history dating back to the 1940s. Today, the centre employs a staff of 270 from 29 nations. The research covers a wide field, from computer-based, epidemiological research to basic research in modern labs, and the centre produces results of high international standards every year.



The Danish Cancer Society Research Center (DCRC) is based in the Danish Cancer Society's headquarters in Copenhagen, allowing close collaboration between the DCRC and the rest of the Danish Cancer Society and ensuring that new knowledge, efforts, and initiatives are shared with the various branches of the society working with patient support, prevention, policy efforts, fundraising, etc.

The DCRC employs researchers from many nations with many different professional backgrounds performing highly different kinds of tasks such as researchers specialising in epidemiological research working with large quantities of numbers and data and researchers in labcoats carrying out basic research in their labs.

The centre also boasts a strong infrastructure involving experts from five research support core facilities collaborating with the centre's researchers.

The DCRC publishes more than 300 high quality scientific articles annually, and the centre's results

form the scientific basis of occupational health and safety legislation and of improved treatment or support options for cancer patients, etc.

Moreover, the DCRC plays an important part in the training of future cancer researchers via its PhD student programme and by stimulating children and young people's interest in research and knowledge about cancer. The centre accepts elementary school work experience trainees and initiated the Danish Cancer Society's new visitors centre, udForsk (Explore), which was completed in late 2022 and developed in collaboration with the Experimentarium science centre and colleagues from the Danish Cancer Society.

Read more about the new visitors centre, a long series of research projects, and highly interesting results by the DCRC in the following.

Meet the Danish Cancer Society's new scientific director

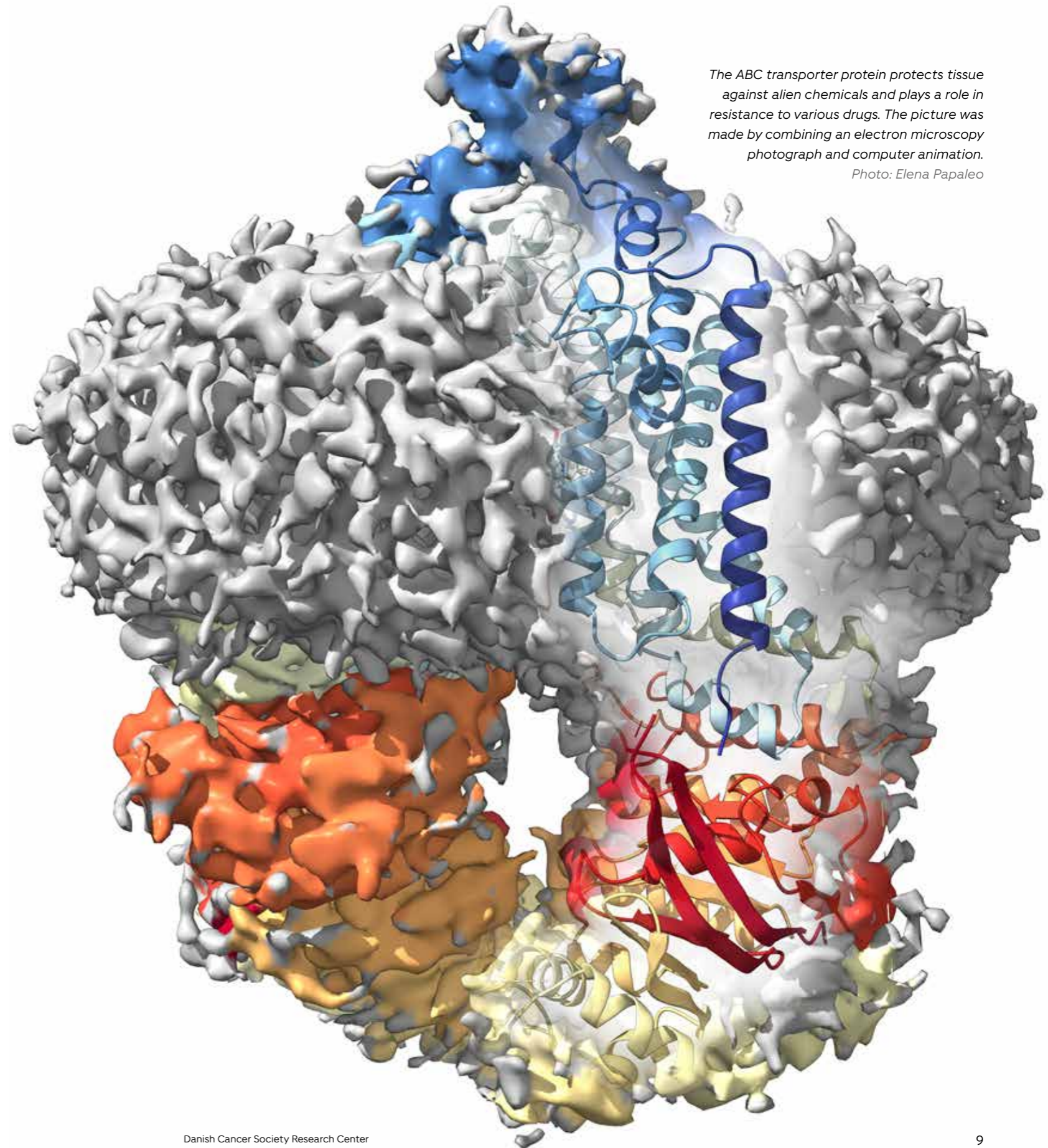
Mads Melbye is a doctor of medicine, professor of medical epidemiology, and internationally recognised for his research, which has made a difference to patients with cancer and HIV.

In 2022, the Danish Cancer Society assigned an experienced researcher and executive to head the Danish Cancer Society Research Center. Mads Melbye has published more than 600 scientific articles and was previously employed by Statens Serum Institut (SSI) for many years, founding its Department of Epidemiology and the Danish National Biobank and taking up the position of CEO in 2016-2020. Mads Melbye most recently held a position as professor at the Norwegian University of Science and Technology and as senior advisor to the Norwegian Institute of Public Health. He is currently also a professor of clinical epidemiology at the University of Copenhagen.

– I am deeply impressed with the amazingly high quality research carried out by the DCRC in Copenhagen, which undoubtedly ranks among the very best cancer research centres in Europe. I look forward to heading the DCRC, taking the research environment to new standards and leaving my mark on the society's research policy, Mads Melbye says.

Research groups

The Danish Cancer Society Research Center includes 23 research groups, which investigate cancer in many different ways – ranging from lab research into cancer cells and genetics to cohorts, etc.



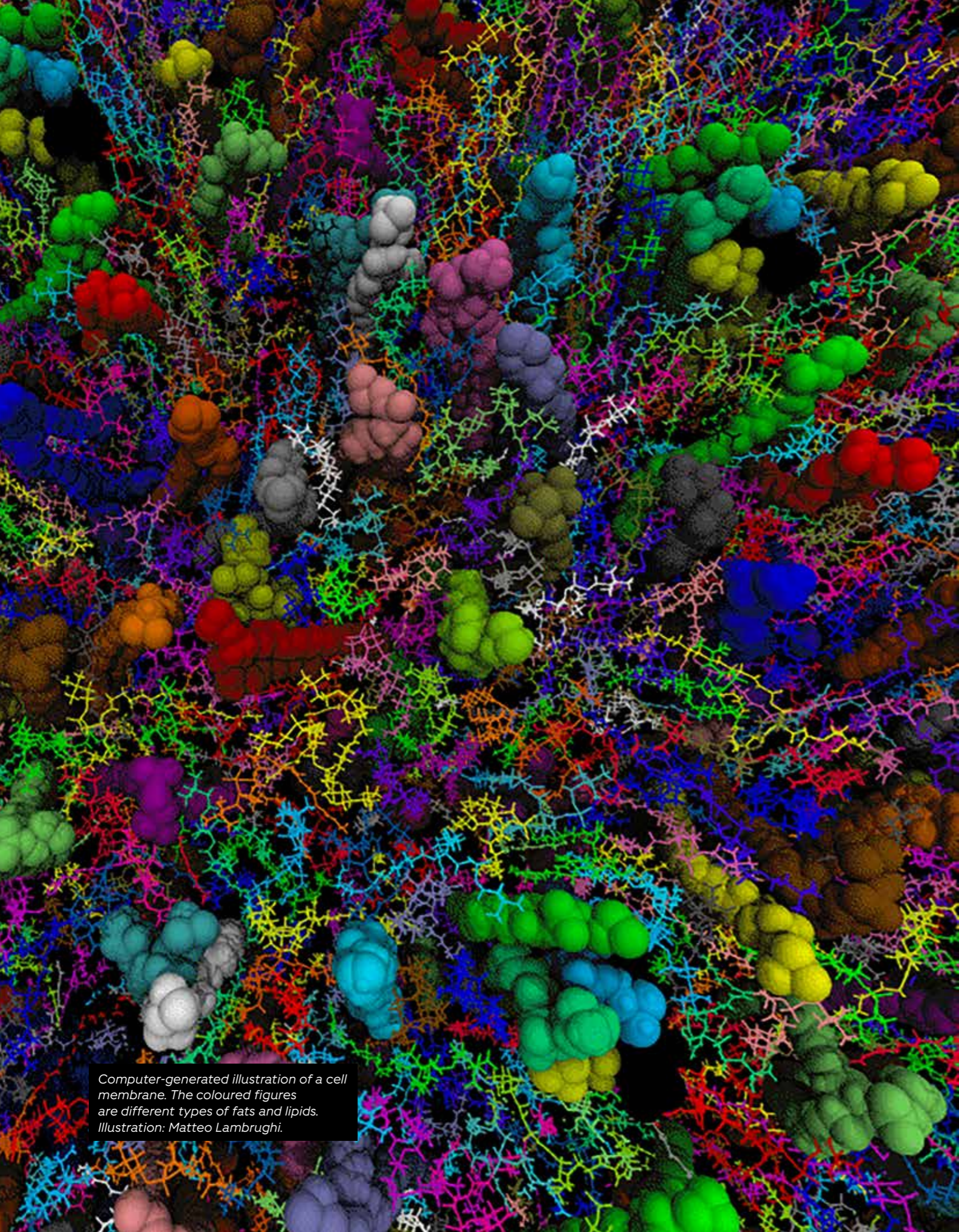
The ABC transporter protein protects tissue against alien chemicals and plays a role in resistance to various drugs. The picture was made by combining an electron microscopy photograph and computer animation.

Photo: Elena Papaleo

Photo: Sofie Ejlertsen



Scientific Director Mads Melbye



Computer-generated illustration of a cell membrane. The coloured figures are different types of fats and lipids. Illustration: Matteo Lambrugh.

Funding

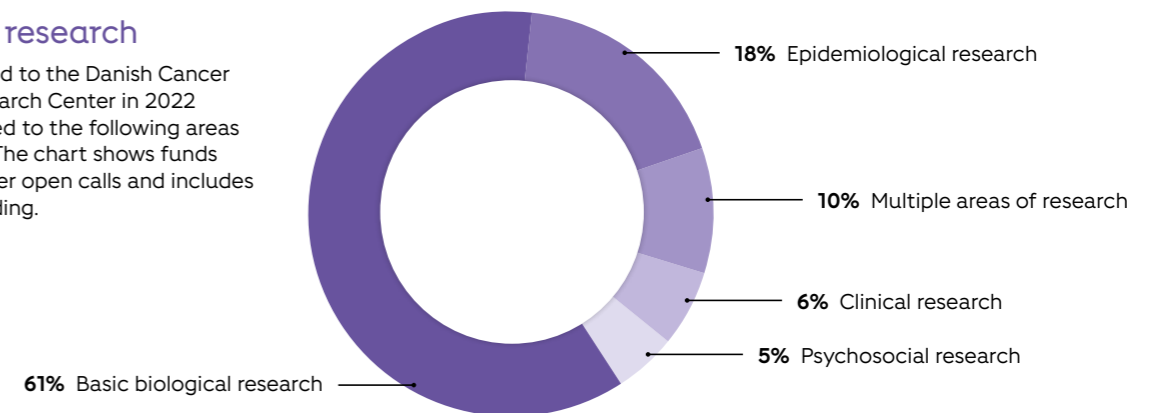
According to the annual accounts, the Danish Cancer Society Research Center spent a total of DKK 203.9 million in 2022. Of these, DKK 41.3 million were allocated to rent and IT, DKK 4.4 million to research evaluation and communication, DKK 3.6 million to administration, and DKK 154.6 million to the 23 research groups and core facilities. Basic funds from the Danish Cancer Society make up 57.3 % of the total budget. Note that this year,

the figures are actual, as compared to the budget figures of previous annual research impact reports.

In the course of 2022, researchers from the DCRC moreover received confirmation of grants worth a total of DKK 53.8 million from a large number of foundations. The money will be spent on research projects in the years to come. Read more about the Danish Cancer Society's financial position and see annual results at the society's website: www.cancer.dk.

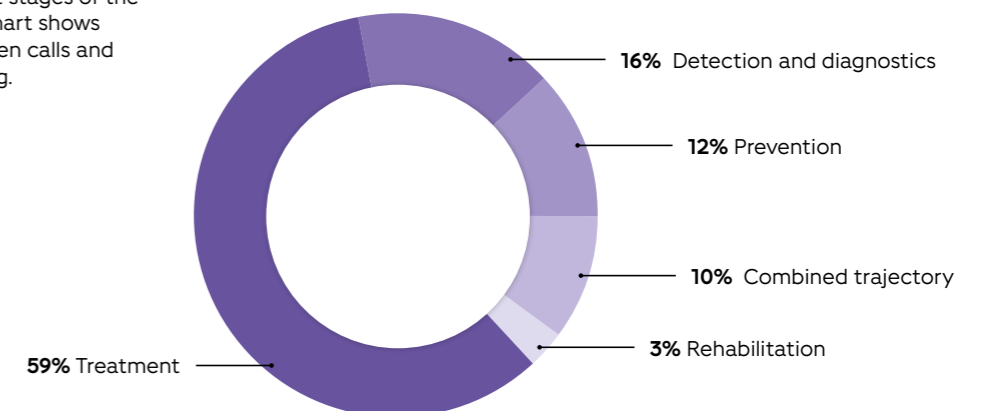
Areas of research

Funds granted to the Danish Cancer Society Research Center in 2022 were allocated to the following areas of research. The chart shows funds allocated after open calls and includes external funding.



Cancer trajectory

Funds granted to the Danish Cancer Society Research Center in 2022 went to research into different stages of the cancer trajectory. The chart shows funds allocated after open calls and includes external funding.



RESULT FROM 2022

Virus plays an important role in brain cancer

A widespread virus could be of great importance to glioblastoma brain cancer cells. Research demonstrates how the virus influences human cells and why it appears to be an important element of cancer treatment.

The virus that researchers investigated is Human Cytomegalovirus (HCMV): a virus discovered in a number of different cancer types, and previous research has demonstrated that it plays a role in tumour development. So far, researchers have not known exactly which characteristics of HCMV help cancer cells, but researchers from the Genome Integrity and DNA Replication and Cancer research groups have come one step closer to answering the question in 2022.

The researchers demonstrated that two genes of the virus – IE72 and IE86 – share characteristics with genes in human cells which are influenced, when our cells become stressed. When HCMV-infected cells are subjected to stress that causes DNA damage, such as during cancer treatment, the activity of the virus' IE72/IE86 genes increases, causing an increasing quantity of IE72 and IE86 proteins, resulting in accumulation of defects in human cell DNA – possibly making cancer cells more abnormal and aggressive.

Consequently, the researchers analysed glioblastoma brain cancer cells from patients showing signs of HCMV infection. By analysing samples taken before and after radio therapy and chemotherapy, the researchers could see that the quantity of IE72 and IE86 proteins increased following the treatment. According to the researchers, this could explain why HCMV is often activated in patients with brain

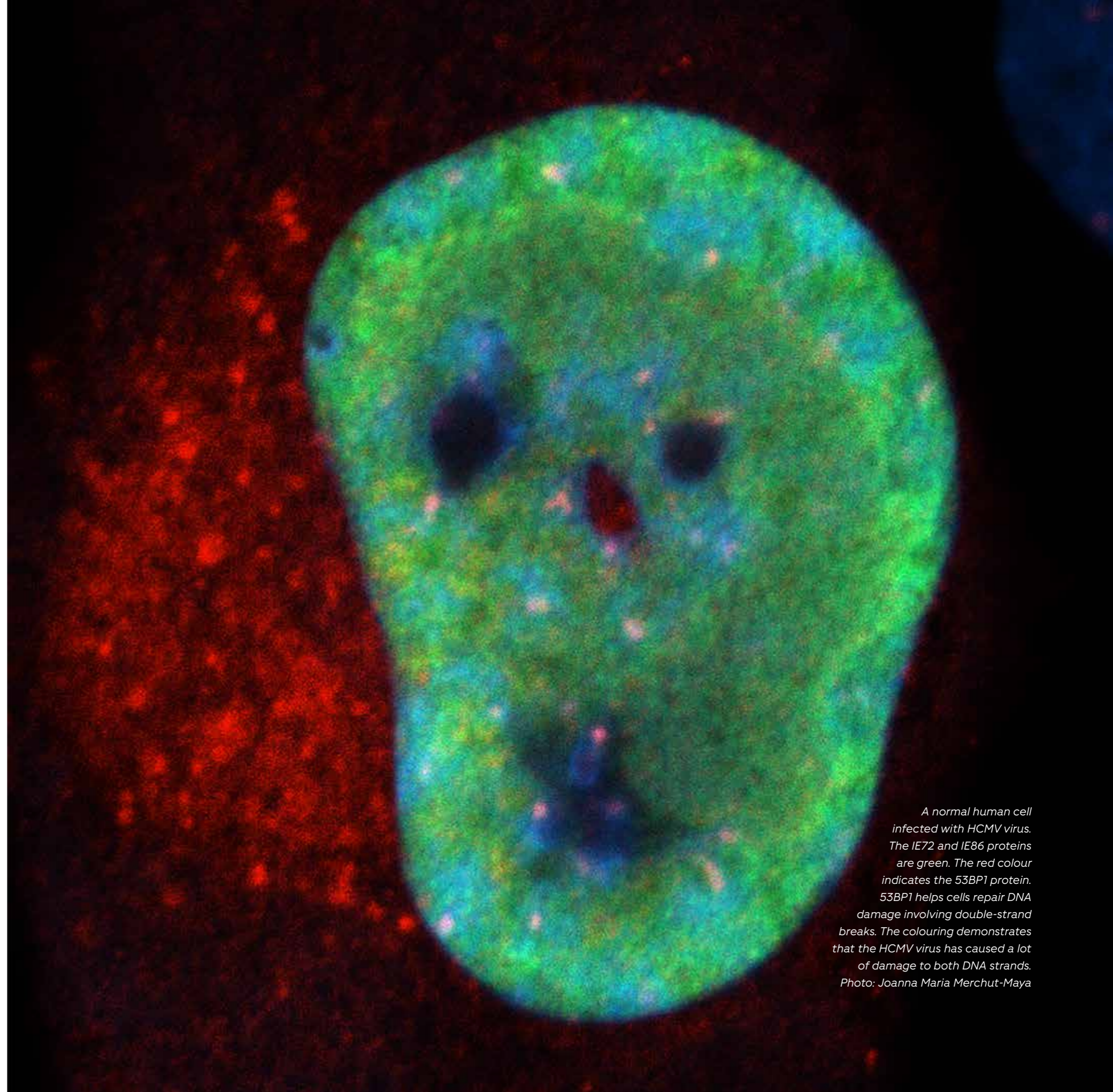
cancer – reducing their chances of survival. The results also indicate the relevance of further investigation of whether to check patients with glioblastoma for HCMV infection with the aim of treatment to eliminate the virus. This could concern both patients with glioblastoma and perhaps other types of cancer.

The results are published here: Merchut-Maya JM. et al.: Human Cytomegalovirus Hijacks Host Stress Response Fueling Replication Stress and Genome Instability. Cell Death Differ. 2022, Aug 29

Human Cytomegalovirus

Human Cytomegalovirus is related to the herpes virus group of infections. 60-90 % of the population are infected. Symptoms are sore throat, fever, and headache, but many do not experience any symptoms.

Sources: Sundhed.dk and the Danish Cancer Society.



A normal human cell infected with HCMV virus. The IE72 and IE86 proteins are green. The red colour indicates the 53BP1 protein. 53BP1 helps cells repair DNA damage involving double-strand breaks. The colouring demonstrates that the HCMV virus has caused a lot of damage to both DNA strands. Photo: Joanna Maria Merchut-Maya

NEW PROJECT FROM 2022

Side effects caused by hormonal contraceptives in women

Contraceptive pills, coils, and other types of contraceptives including hormones can cause side effects. Researchers from the Danish Cancer Society Research Center aim to map out the side effects and create an online tool that can make it easier for individual women to choose the right contraceptive.

More than 380,000 Danish women use hormonal contraceptives which could cause side effects, but in spite of the prevalent use of hormonal contraceptives, the possible side effects remain inadequately described.

– Some side effects are familiar, such as increased risk of depression or migraines, but many unknown factors remain. Some side effects may not be caused by

hormonal contraceptives, and others are probably so rare that they have not yet been recorded. Moreover, we still very much lack knowledge about the influence of the women's life style and biology on their risk of side effects, says Group Leader Lina Mørch from the Cancer Surveillance and Pharmacoepidemiology group.

Carried out using register data and a questionnaires, the new research is aimed at developing a digital tool for doctors and gynaecologists, ensuring that women can choose contraceptives on an informed basis and risk less side effects, Lina Mørch explains.



New research will provide more knowledge about the side effects of hormonal contraceptives. The aim is to develop a digital tool to advise women on the best types of contraception.

Photo: Adobe Stock

Researchers collaborate

The research is a collaborative project between clinicians, statisticians, and epidemiologists of the Danish Cancer Society Research Center, the University of Copenhagen, and Nordsjællands Hospital, Hillerød.

RESULT FROM 2022

New PhD builds a bridge between computer analyses and laboratory

In 2022, Valentina Sora completed her PhD at the Danish Cancer Society Research Center. She has developed software that researchers can use to improve research, saving both time and money in the process.

Valentina Sora has a PhD in *computational biology*. Her PhD project focused on proteins, and she developed several software tools. Based on biological lab data and computer predictions, the software can recognise and describe short linear motifs. These are areas that help two proteins to interact. Short linear motifs play an important role in several processes in the cells, for example apoptosis (programmed cell death) and autophagy, which is a process where cells under controlled conditions break down parts of themselves. These are important to the very basics of cells functions and is also of great importance for cancer cells.

The software programs that Valentina Sora has developed can predict where there might be short linear motifs in the proteins, something that can be of great help to researchers.

The software is now freely available to researchers throughout the world (open source).

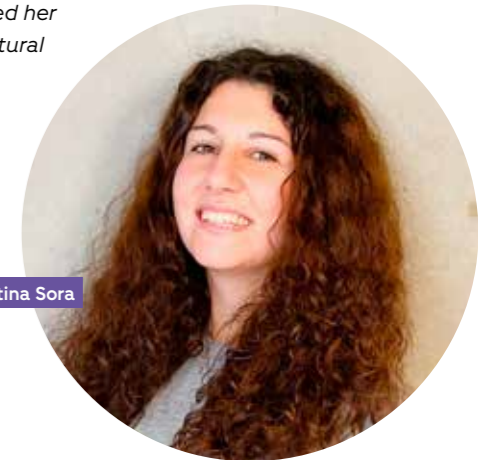
Broad knowledge and collaboration

Software and programming may be associated with lonely and nerdy work, but that was not the case for Valentina Sora, on the contrary. As the software aims to solve biological problems, she developed it in close collaboration with Danish Cancer Society Research Center colleagues specialising in biology.

Familiarising herself with the background of the problems to be solved required lots of preparation, so Valentina Sora published a series of scientific articles as part of her PhD programme, some of which describe the software, while others describe the biology behind short linear motifs. And the very versatility of the computational biologist job fills Valentina Sora with enthusiasm:

– I am involved in all stages of the development process. Understanding the problem, setting up the framework, and defining what the software must be able to do and the maths and coding to be used. Moreover, I need to make sure that the software is easy to use, write the programme, and subsequently improve it based on feedback from my collaborative partners. The versatility of it all is what I like the best, says Valentina Sora.

Valentina Sora completed her PhD in the Cancer Structural Biology research group.
Photo: Private



Valentina Sora

Valentina Sora defended her PhD thesis in May 2022, and now she is continuing her work in a postdoc position at the University of Copenhagen.

Training the researchers of the future

The Danish Cancer Society Research Center produced a total of seven PhD graduates in 2022. Visit www.cancer.dk/research/dcrc-research/phd-defences-2022/ for a full list.

RESULT FROM 2022

Firefighters suffer increased risk of cancer

Firefighters suffer an increased risk of at least two cancer types, according to an international scientific investigation to which the Danish Cancer Society Research Center (DCRC) contributed.

Being a firefighter involves contact with toxic smoke from homes full of electronics, asbestos, and furniture made of laminated plastic. Industrial and field fires. Varying working hours, night work, and rescue missions involving contact with unhealthy chemicals.

As a result of their occupation, firefighters suffer an increased risk of cancer, particularly bladder cancer and malignant mesothelioma (often pleural mesothelioma), according to an international task force set up by the International Agency for Research on Cancer (IARC) in 2022 based on all available knowledge from a long series of scientific studies concerning firefighters and cancer.

Firefighters probably also suffer increased risk of colon cancer, prostate cancer, testicular cancer, malignant melanoma, and non-Hodgkin's lymphoma, but in those cases, 'reasonable doubt' cannot be completely ruled out, i.e. the increased cancer incidence may be due to other factors than the job. Moreover, cancer may be spotted earlier in firefighters, because they get medical checks more often due to the job.

Finally, the investigation demonstrated strong evidence that firefighters have five in 10 biomarkers which normally exist, when people are subjected to carcinogenic factors such as genetic damage.

Firefighter job is 'definitely carcinogenic'

Senior DCRC researcher Johnni Hansen headed one of the working groups behind the IARC investigation, and the Danish Cancer Society contributed important parts of the research on which the investigation is based.

– According to a series of studies, firefighters suffer increased risk of bladder cancer and mesothelioma. The link is so well-documented that the firefighter job is now classified as 'definitely carcinogenic' on the IARC list of factors that can cause cancer in humans. The risk of a long series of other cancer types is also increased, but it cannot be completely ruled out that they are caused by other factors than the firefighter job, says Johnni Hansen.

According to the Danish Cancer Society, the new results should have consequences for firefighters:

– The conclusion is so clear-cut that it should trigger

occupational injury compensation for firefighters who developed cancer as a result of their job. Nobody should get sick from going to work. And in the future, any possible precautions must be taken to protect firefighters against carcinogenic factors, says CEO Jesper Fisker.



In 2022, an international task force concluded that the firefighter job can cause cancer, and this should trigger occupational injury compensation for firefighters and protective efforts in the future, according to the Danish Cancer Society. Stock photo: Colourbox

Malignant mesothelioma and asbestos

Mesothelioma is a very rare cancer type that only develops as a result of asbestos fibres exposure. The disease most frequently originates in the pleura, but in rare cases, it can also originate in other places such as the peritoneum, testicle membranes, and pericardium.

NEW PROJECT FROM 2022

New research into lymphoma-causing genes

Annually, 800,000 people throughout the world develop lymphoma. New research aims to investigate the genes behind the disease, possibly leading to improved prevention and treatment.

Researchers from the Danish Cancer Society Research Center and Rigshospitalet aim to investigate malignant lymphoma in a new project. The researchers aim to investigate whether some gene profiles influence the risk of lymphoma and whether genes influence the risk of different types of the disease or the link between malignant lymphoma and specific inflammatory diseases such as arthritis. Moreover, the analyses may be able to tell why some patients develop severe infection during treatment.

– Perhaps genes also play a role in this context. If we can determine who suffer a specific risk of severe infection, we may be able to customise the treatment even more to individual patients in the future, says Henrik Hjalgrim, who participates in the new research in his capacity as a consultant doctor and leader of the Hematology research group.

A new project from 2022 focuses on malignant lymphoma. The researchers investigate the role of genes in the disease and its course.

Photo: Adobe Stock and Tomas Bertelsen



Henrik Hjalgrim



Danish Cancer Society funding

The project 'Novel insights into the genetic architecture of malignant lymphomas' received DKK 1,867,500 from the Danish Cancer Society's Scientific Committee in 2022. It begins in 2023.

NEW PROJECT FROM 2022

Existing drug against gullet and stomach cancer

Researchers aim to investigate whether drugs currently used against e.g. ovarian cancer, are also efficient against gullet and stomach cancer.

The researchers are investigating two existing types of cancer drugs: PARP inhibitors developed for the treatment of ovarian cancer and alkylating drugs such as the experimental agent of Irofulven. Both are efficient against cancer cells with specific genetic changes, and researchers from the Translational Cancer Genomics group will investigate if gullet or stomach cancer cells also involve the genetic changes that allow the drugs to affect them.

– We hope that the research can prolong the lives of or cure more patients with gullet or stomach cancer. We have come a long way with PARP inhibitors, and we hope our research can soon influence patient treatment, explains Professor Zoltan Szallasi, who leads the Transla-

tional Cancer Genomics research group.

Approximately 576 Danes are diagnosed with gullet cancer annually, and 684 develop stomach cancer.



Danish Cancer Society funding

The project 'Improving survival in upper gastrointestinal cancer by targeting DNA repair deficiency specific therapeutic vulnerabilities' received DKK 2,625,000 kr. from the Danish Cancer Society's Scientific Committee in 2022.

Generous grant buys supermicroscope for cancer research

The Bioimaging group specialises in the use of microscopes. A new super microscope is to strengthen the group's efforts to find new drugs against cancer.

The Bioimaging group services all the researchers of the Danish Cancer Society Research Center who use microscopes to investigate cancer cells. In 2022, the experts were given the opportunity to buy a new microscope – a High Content Microscope – thanks to a DKK 49.7 million grant from the Danish Ministry of Higher Education and Science.

The microscope can reveal tiny constituents inside the cells and manage much larger quantities of cells at a time than what is possible now, and it can be used in research into whether existing drugs can eliminate cancer cells.

– We can peep into lysosomes, and different colouring agents can show whether specific proteins are absorbed by the lysosomes as a result of the treat-

ment, demonstrating if and how the drugs work, says the leader of the Bioimaging group, Christoffel Dinant.



The microscope (the big white box) is hooked up with computer monitors on which the images are displayed. The grant was given to the Danish Bioimaging Network to which the Danish Cancer Society Research Center is a party.

Photo: Christoffel Dinant

NEW PROJECT FROM 2022

Fruit flies to teach Catarina more about cancer and Alzheimer's

Catarina Dias investigates the changes taking place, as people develop cancer or neurological diseases such as Alzheimer's. In 2022, Lundbeckfonden granted DKK 2.5 million to her research.

Catarina Dias from the Membrane Integrity research group studies cell membranes.

– The membrane protects cells against breakdown, but cancer cells include other proteins in their membranes than healthy cells, influencing cancer cell functions and the body's reaction to them, Catarina Dias explains.

Her research into cancer cell membranes could also benefit other diseases, as the membrane also plays a role in acute and chronic neurological diseases such as brain injury and Alzheimer's disease.

– Neurological diseases often break down the cell membrane, causing nerve cell death or malfunction and ultimately disturbing brain activity, says Catarina Dias.

The research is carried out in collaboration with a lab in Portugal specialising in neurological diseases, which they investigate in fruit fly experiments.



Catarina Dias

Catarina Dias hopes that her research can help patients with cancer and neurological diseases. Photo: Private

The grant

Catarina Dias received a postdoc research grant of DKK 2.5 million from Lundbeckfonden.

New biostatistician to head the Statistics and Data Analysis group

In 2022, the Danish Cancer Society Research Center (DCRC) welcomed Susanne Rosthøj as Chief Statistician and leader of the Statistics and Data Analysis group. The latter is involved in many of the centre's research projects and performs a broad array of tasks.

The Statistics and Data Analysis group consists of six statisticians and a student assistant with backgrounds in theoretical statistics. In 2022, Susanne Rosthøj became the new leader of the group, which is one of the DCRC's core facilities and common resources employing experts within specific fields.

The statisticians of the group collaborate with many of the DCRC researchers, and they are responsible for the statistics on which the researchers base their conclusions.

– Working on research projects is an exciting and dynamic process. The best projects are the ones in which we are involved all the way: planning, purpose, design, and analysis, says Susanne Rosthøj.

Apart from contributing to the design and performing statistical analyses, the statisticians are typically also involved in the writing of the articles resulting from the research. Moreover, they collaborate with external researchers, who can buy their assistance.

The Statistics and Data Analysis statisticians also provide courses for researchers and frequently host a statistics workshop, providing researchers with quick answers to minor statistics questions. Last, but not least, focus on new statistical methods is also an important part of the group's efforts.

– Statistical methods is a rapidly developing field of research. It is important that we are up to date, so we can supply statistical analyses of high professional standards, and sometimes, we must adapt statistical methods to concrete problems, Susanne Rosthøj explains.

Developing new methods

Several of the statisticians have a PhD in biostatistics and experience with developing new methods adjusted to specific problems concerning specific types of data. One example is a DCRC research project involving analysis of data from the 'Diet, Cancer, and Health' cohort. The statisticians contributed to investigating the effect of the quantity of wholegrains consumed on the number of healthy years remaining in a person's life. The results demonstrated that if men double their wholegrains consumption, they can obtain an additional 0.4 healthy years.

– The method used on the 'Diet, Cancer, and Health' data was developed by one of our statisticians, when he was a PhD student, says Susanne Rosthøj.

From a statistician's point of view, the DCRC involves many exciting research projects, one of which concerns social inequality and the risk of dying of cancer. Statisticians contribute to analysing data about social classes and comorbidity.

– That is an example of a problem in connection with which we cannot use existing statistical methods, but our student assistant will be completing a master's thesis about it in the spring, so we hope to find a method for analysing the data, Susanne Rosthøj says.



The leader of Statistics and Data Analysis, Susanne Rosthøj, used to work for the University of Copenhagen. She has many years of cancer research experience. Photo: Sofie Eilertsen.

RESULT FROM 2022

Cancer cells evade existing brain cancer treatment

Research shows how glioblastoma cancer cells can evade treatment with the bevacizumab drug, possibly paving the way for the development of new treatments against the fatal disease.

Food and oxygen are vital to humans and cells, and in the case of both normal cells and cancer cells, the supplies come via the blood. Consequently, cancer cells often develop the ability to either attract blood vessels or boost the formation of new blood vessels, so they can get the supplies to new cancer tumours.

This is also the case with glioblastoma brain cancer. One of the treatments against glioblastoma is based on bevacizumab, which prevents cancer cells from forming new blood vessels, making the cancer cells starve to death. Unfortunately, glioblastoma cells often become resistant to the treatment, finding new ways to survive.

But now, researchers have come one step closer to influencing the resistant cells. In a study from 2022, researchers analysed cancer tissue from more than 200 patients with glioblastoma brain cancer, making experiments with cancer cells from tissue from brain cancer patients who had surgery at Rigshospitalet. The researchers demonstrated that the PFKM enzyme (phosphofructokinase-1) plays an important role in the cancer cells becoming resistant to bevacizumab. And among patients treated with bevacizumab in an experiment, those with high levels of PFKM had a poorer survival rate than those with low levels of PFKM.

The research also showed that PFKM has several functions. It can both help cancer cells spread and repair gene injury, possibly helping cancer cells survive radiotherapy.

– Bevacizumab resistance is a problem we can only solve, if we understand the mechanisms developed by cancer cells to escape the treatment. Our discovery of a high level of PFKM predicting a poor result for patients who get bevacizumab is a first step on the way to identifying a reliable biomarker, allowing us to select the patients who will benefit from the treatment. As encouraging as the results are, they are preliminary and require more validation, before they can influence treatments, says brain researcher Petra Hamerlik from the DCRC, who was in charge of the new research together with her colleagues Yi Chieh Lim and Kamilla Jensen.

Petra Hamerlik conducts research that provides new knowledge about brain cancer.

Photo: Kenneth Møller



Petra Hamerlik

Existing drug could pave the way for new treatments

It is the first time that research demonstrates that PFKM can help cancer cells become resistant to bevacizumab. In the study, the researchers also investigate how to prevent the effect. In lab experiments, they demonstrated that bupivacaine, a local anaesthetic, could prevent glioblastoma cells from becoming resistant to bevacizumab:

– It is interesting to study whether bupivacaine could form the basis of a new treatment, and properties have been identified that might be used in a new treatment to eliminate cancer cells, with a major potential effect on the development of future treatments, says Petra Hamerlik.

The results are published here: Lim YC. et al.: Non-metabolic Functions of Phosphofructokinase-1 Orchestrate Tumor Cellular Invasion and Genome Maintenance. Neuro Oncol. 2022, May 24

Researchers collaborate

The research was carried out in close collaboration between researchers from Denmark, the US, and Germany. Animal trial experiments, doctors from e.g. Rigshospitalet and Syddansk Universitetshospital, as well as patients have played important roles.

In September 2022, Petra Hamerlik was appointed Neuro-Oncology Chair by the University of Manchester. She remains a visiting researcher with the Danish Cancer Society Research Center. Photo: Danish Cancer Society



Meet our researchers

The Danish Cancer Society Research Center employs some of the world's leading cancer researchers:



Learn more about the Danish Cancer Society Research Center's work on Instagram: [science_kræftensbekæmpelse](#)

SUSANNE KRÜGER KJÆR, Professor

International expert on the relationship between Human Papillomavirus (HPV) and cancer. She demonstrated that HPV infection is a necessary precursor of the development of e.g. cervical cancer; knowledge which contributed to the development of a HPV vaccine.

“ The purpose of my research is to prevent women from developing cervical cancer in the future and to prevent a series of other cancer types in both men and women.

SUSANNE OKSBJERG DALTON, Professor

Denmark's leading expert on inequality in cancer. She showed that there is inequality throughout the cancer trajectory.

“ The purpose of my research is to document the importance of social inequality in the cancer trajectory – from diagnosis to rehabilitation – and what can be done to reduce inequality and give everyone the best prospects of surviving cancer.

JIRI BARTEK, Professor

Founded an international field of research focusing on how cells repair genetic damage which could otherwise develop into cancer.

“ I research cell repair mechanisms, because gene defects cause cancer. The ultimate aim of my research is always to find a new treatment.

MARIN BARISIC, Group Leader, PhD

Investigates the microtubule network: an important transport system for the distribution of molecules in cells. He showed that microtubule changes play a key role as a kind of navigation system in cells, contributing to the correct distribution of genetic material during cell division.

“ Several types of chemotherapy work by affecting the microtubule network. Improved understanding of microtubule changes could lead to improved cancer treatment with less side effects.

MARJA JÄÄTTELÄ, Professor

Leading international expert on cell death. Leader of the Danish National Research Foundation's Center for Autophagy, Recycling and Disease (CARD). She demonstrated that lysosomes play a key role in cell division.

“ The purpose of my research is to find knowledge about how cells work. Knowledge about cells' basic properties is the first step towards new cancer treatments, and lysosomes could play an important role.



RESULT FROM 2022

Soldier trick saves cancer cells from death by radio therapy

Can cancer cells use self-harm to survive radio therapy? It seems so, according to research from 2022, offering a surprising explanation of how cancer cells become resistant to one of the most commonly used cancer treatments.

The strategy has been used in many wars: the prospect of being sent into battle is so difficult to face for some soldiers that they choose to harm themselves instead. The damage is typically not severe, but sufficient to make them unfit for combat. Apparently, cancer cells use the same trick. Surprisingly, research demonstrates that cancer cells, which have been subjected to radio therapy, harm their DNA even more than the radiation did, says one of the researchers behind the study, Professor Jiri Bartek, who leads the Genome Integrity research group:

– It is quite surprising that DNA damage should be beneficial to cancer cells, but the point is that the self-harm is less severe than the harm caused by radio-therapy. On the other hand, the quantity contributes to ensuring that the cancer cells do not divide, while their DNA is harmed by the radiation, allowing them peace and quiet and time to repair all the damage done by both radiation and self-harm. In the end, this contributes to ensuring that the cancer cells survive, Jiri Bartek says.

The caspase-activated DNase (CAD) enzyme causes the self-harm to cancer cell DNA. Normal cells do not use the manoeuvre, which could prove beneficial, if the new research is to be converted into treatment some day, making up a target that is specific to the sick cells.

So far, the research has been performed in the lab, but the researchers hope to be able to help patients in the long term via drugs that inhibit CAD after radio-therapy. This could make radiation more efficient and provide better opportunities to cure the disease. Perhaps smaller radiation doses could be given to reduce side effects.

The results are published here: Larsen BD. et al.: Cancer Cells Use Self-Inflicted DNA Breaks to Evade Growth Limits Imposed by Genotoxic Stress. Science. 2022, April 29

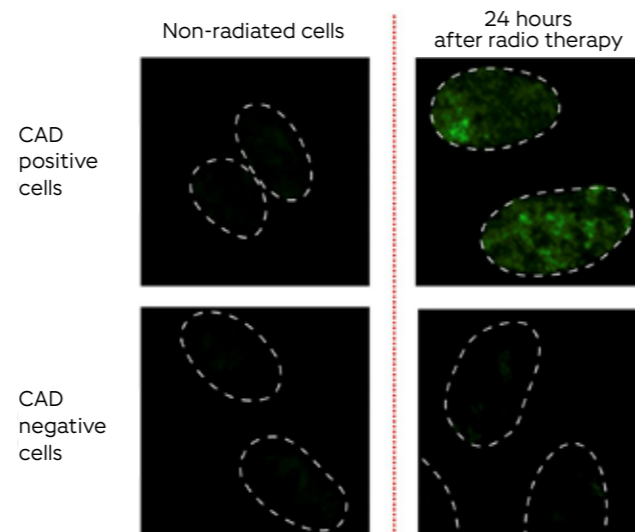


Photo of the self-harming cancer cells taken through a microscope. The lesions (green) are easy to repair, but helps the cancer cells avoid cell division, when the chromosomes are severely damaged due to radiation. The damage only occurs, when CAD exists in cells (CAD-positive cells). If CAD is removed (CAD-negative cells), the damage does not occur. Cancer cell nuclei are indicated by a white dotted line.

Photo: Brian Daniel Larsen

Researchers collaborate

The results were made in collaboration between researchers from the Danish Cancer Society and the University of Copenhagen plus Swedish, Canadian, Czech, and Swiss researchers. The research project was funded by the Danish Cancer Society, the Novo Nordisk Foundation, and the Independent Research Fund Denmark.



Founded in 1348, Charles University has proud traditions. Jiri Bartek was honoured for his ground-breaking efforts in cell biology and cancer research in the university's Great Hall. Photo: Vladimír Sigut, Charles University

Honorary doctorate for Professor Jiri Bartek

In 2022, Professor Jiri Bartek, the leader of the Danish Cancer Society Research Center's Genome Integrity research group, was awarded an honorary doctorate from Charles University in Prague. *Doctor honoris causa* is an honorary title awarded to people who have made considerable contributions to progress in fields such as science and culture or other contributions for the benefit of mankind.

Born in the Czech Republic, Jiri Bartek is now one of the most cited Czech researchers. His results have been cited by other researchers some 80,000 times, and his work has been published more than 500 times in reputable scientific journals such as *Nature*, *Cell*, and *Science*. Jiri Bartek has collaborated closely with Charles University for 40 years, resulting in exchange programmes for young researchers and a series of joint research projects.



Jiri Bartek and Professor and immunology expert Jaques J. M. van Dongen were both awarded a doctorate. Photo: Vladimír Sigut, Charles University

Experts meet

In the course of 2022, the Danish Cancer Society Research Center hosted conferences attended by experts from all over the world, prompting plenty of knowledge sharing and new ideas for the benefit of cancer research.

Nitric Oxide and Cancer

The International Workshop on Nitric Oxide and Cancer focused on nitric oxide, which plays a role in many of the processes going on in our cells, as we age, increasing the risk of cancer. The theme of the workshop was 'metabolism and ageing' – two popular fields of cancer research, in which nitric oxide is important, explains Giuseppe Filomeni, leader of the Danish Cancer Society Research Center's Redox Biology research group:

– There is lots of focus on the role of metabolism in cancer and on how to develop treatments to reduce the risk of cancer by influencing the metabolism, he says. Giuseppe Filomeni is proud of the results of the workshop:

– We have strengthened research into nitric oxide and its use in cancer treatment. And, just as importantly, we have drawn international attention to research carried out in Denmark.



The European Cancer Survivorship and Rehabilitation Symposium (ECRS)

The European Cancer Survivorship and Rehabilitation Symposium (ECRS) focused on rehabilitation, long-term side effects, and life after cancer. The participants discussed new treatments and efforts to help the rising number of cancer patients living with long-term side effects. Moreover, they debated the best way to solve the challenge of inequality in cancer also affecting life after cancer and how to introduce concrete solutions to make sure that all survivors, disregarding their social resources, get the best rehabilitation opportunities on the road back to work and their everyday lives.

Nordic Autophagy Society Conference

The Nordic Autophagy Society Conference discussed a number of topics such as the most recent knowledge about the mechanisms behind autophagy and the diseases in which autophagy plays a role, including cancer. Other than knowledge sharing, an important aim of the conference was networking, paving the way for new collaboration.



We have some of the best women researchers

The Danish Cancer Society Research Center employs some of the most competent women researchers in Denmark. According to an international survey, Professor Anne Tjønneland is the No. 1 Danish woman researcher (ranking No. 60 in the world). Professor Marja Jäätelä is the No. 1 Danish woman researcher in 'Biology and Biochemistry', and Professor Susanne Krüger Kjær ranks No. 6 on the list of Danish women researchers. We are very proud of our 3 researchers, who are engaged in improving cancer research and treatment on a daily basis.

Anne Tjønneland

Foto: Tomas Bertelsen

Visit from the Scientific Advisory Board

In late 2022, the Danish Cancer Society Research Center was paid a visit by the Scientific Advisory Board, SAB – which visits every other year to evaluate parts of or the entire centre. In the course of two days, 12 research groups presented their results and plans for the future. The SAB also met with the Association of Young Researchers, and Scientific Director Mads Melbye presented the centre's progress since the most recent SAB visit in February 2021.



The Danish Cancer Society Research Center was abuzz with activity, when the SAB visited. This is the SAB panel together with Scientific Director Mads Melbye. Front left: Professor Lonneke van de Poll-Franse, Dr Freddie Bray, Professor Carl-Henrik Heldin (Chairman), Scientific Director Mads Melbye, Professor Kevin Ryan, Professor Caroline Relton, and Professor, Dr René Medema (front right). Photo: Danish Cancer Society



- en kræftvirus

Visitors learn about research and cancer

The Danish Cancer Society's new visitors centre, udForsk (Explore), is primarily aimed at the oldest secondary school students and their natural science teachers, but anyone paying a visit to the Danish Cancer Society is more than welcome to explore the exhibition in the front desk area of the Copenhagen headquarters. Texts, photos, video, and physical interaction are used to answer visitors' questions concerning research and cancer.

Photo: Jørgen Bjørn Hansen and Kristina Øland Iskov. Art: Experimentarium



“ I definitely learned more from this visit than from class instruction.

– Comment from one of the students who visited udForsk.

UdForsk was developed in close collaboration with researchers from the Danish Cancer Society Research Center and the Experimentarium Science Centre. The project was funded by the Novo Nordisk Foundation, Jascha Fonden, Aage og Johanne Louis-Hansens Fond, and Familien Hede Niensens Fond.

Scan the QR code with your smartphone's camera to learn more about udForsk or consult the www.cancer.dk/udforsk website for more information and to book a free visit (all content is in Danish).



Human cell

The station teaches visitors how cancer originates. They can build DNA, watch a film about how healthy and sick cells divide, explore the history of cancer, and learn fun, fascinating, and interesting facts.



Malignant melanoma

The station allows visitors a close look at their own skin – including scratches, wrinkles, and hair – observing it through an UV camera to reveal sun damage and how sunscreen can protect the skin. Moreover, visitors learn about prevention and treatment of malignant melanoma, and they can watch video with malignant melanoma researcher Luca Di Leo.



Cancer treatment

The station teaches visitors about different types of treatment such as immune therapy, surgery, chemotherapy, and radio therapy. Visitors are introduced to various patients and their case histories and get the opportunity to try to choose the correct treatment themselves.



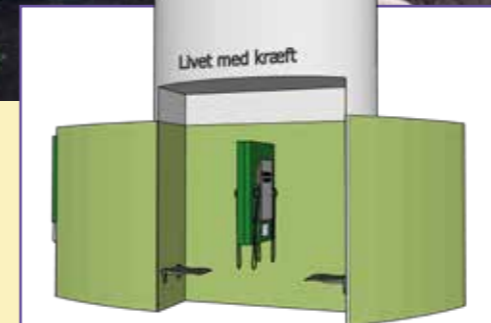
HPV

The station teaches visitors about HPV and some of the cancer types related to HPV infection. They can observe normal and cancerous cervix tissue in a microscope and watch video with HPV researcher Freja Lærke Sand.



A view into the body

On a large interactive dissecting table, visitors can see PET/CT scans from real cancer patients, illustrating what cancer looks like inside the body and how the disease can spread.



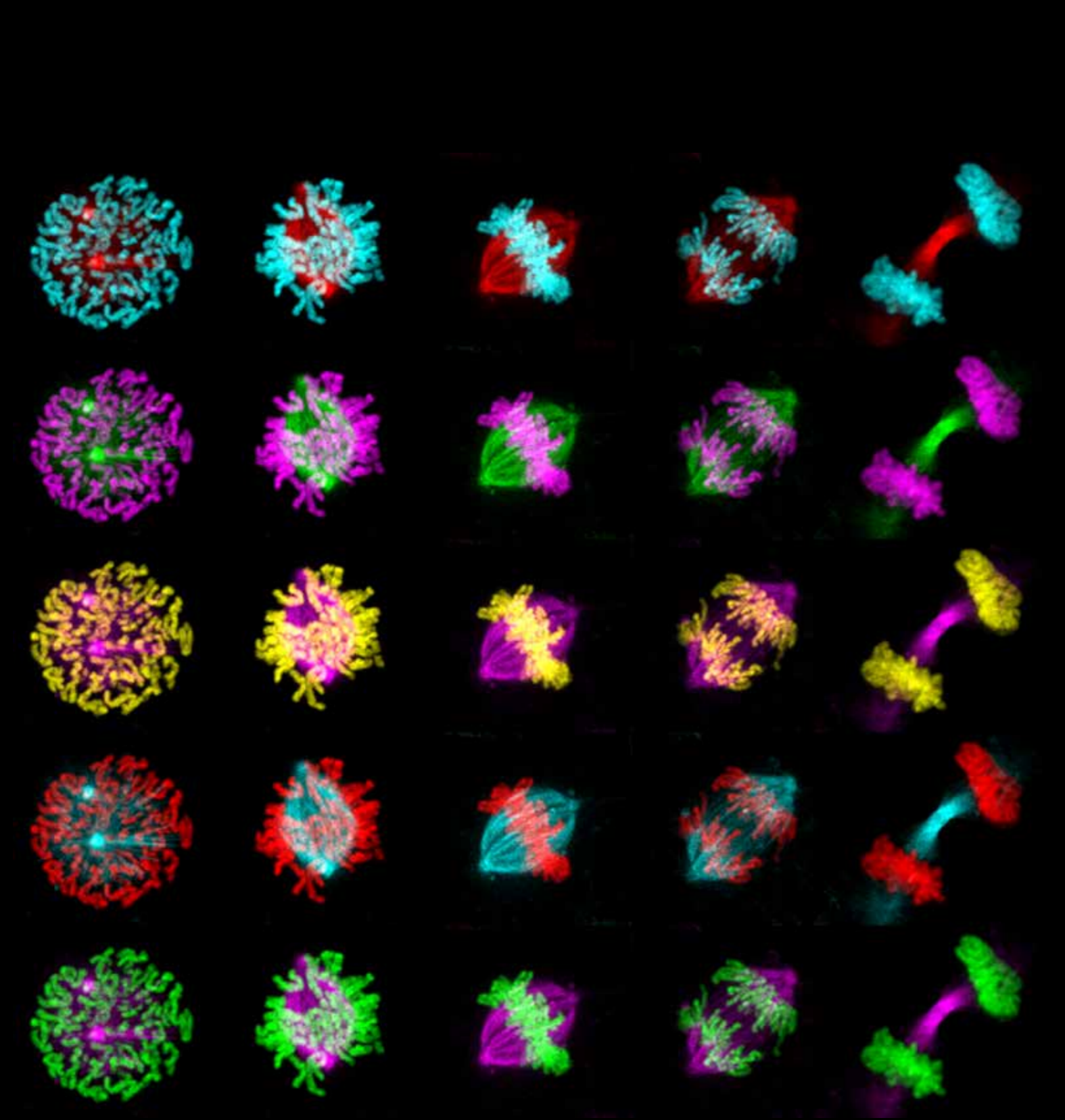
Life with cancer

Visitors can watch videos with three people, Channi, Kasper, and Lise, who have experienced cancer and death either as patients or relatives.



Disease progression

The station teaches visitors how cancer cells can spread in the body from the original tumour, as illustrated by a full size human body with blood vessels and lymphatic channels.



Cell division. DNA and microtubules are coloured. In the early process, the DNA is packaged in chromosomes, that are eventually separated. They are pulled in opposite directions by the microtubule network to form two daughter cells. The photo was taken by Group Leader Marin Barisic from the Danish Cancer Society Research Center. You can read more about Marin Barisic on page 23.

The Danish Cancer Society thanks everyone,
whose contribution makes the research possible.

In pursuit of a life without cancer



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