

CRYONICS INSTITUTE

M A G A Z I N E

Cryonics insights and
information for members
and friends of the
Cryonics Institute

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cryonics.org • info@cryonics.org • 1 (866) 288-2796



Hello Everyone,

Cryonics Institute (CI) continues its steady and careful growth as we navigate the future. We proudly maintain the largest membership globally for cryonics, alongside having the most individuals in suspension. Our organization boasts over 50 years of experience since incorporation, a legacy enriched by the foundational work of those involved with the Immortalist Society prior to CI. Indeed, the journey began with Professor Robert Ettinger, whose groundbreaking book, *The Prospect of Immortality*, published in 1962 set the stage for cryonics as we know it today.

Despite the challenges of inflation, our base price of **\$28,000** remains unchanged. Some detractors suggest that one must spend significantly more for a quality suspension. However, CI offers some of the industry's best suspension services, a distinction made possible largely through our pre-planning and strategic services team (SST). We encourage local SST arrangements, as well as optional remote services that complement CI's offerings. These professional SST services, when combined with CI's pricing, keep us far ahead as the most affordable option available.

We are committed to staying ahead of the competition by continually enhancing our methods and technologies. Our investment in state-of-the-art facilities and equipment ensures the highest standards of preservation. Our dedicated team of professionals, including doctors, scientists, and engineers, is focused on advancing cryonics and providing our members with the best possible care.

Looking forward, we are thrilled by the new research and development projects on the horizon. Collaborations with leading institutions in the field of cryobiology aim to enhance

our preservation techniques significantly. By improving these techniques, we not only hope to achieve even more optimal preservations but also to lay the groundwork for potential rejuvenation therapies that could revolutionize human lifespan.

Thank you for being part of our journey. We look forward to achieving incredible milestones together as we explore the frontiers of life extension. Your belief in our mission strengthens our resolve and our commitment to making cryonics a viable option for all who wish to embrace this revolutionary path.

We are also proud to announce our **50th Anniversary Annual General Meeting (AGM)**, which will take place at **Ford House off Lake St. Clair in Michigan on September 13th**. Be sure to mark your calendars! We aim to make this event exceptionally memorable. If you're a fan of cryonics and wish to learn more about CI, we warmly invite you to join us as our guest for the weekend.

What's New at CI?

Since the 49th AGM, we've welcomed aboard a new director, **Steve Lebel**, who brings extensive experience in managing hospitals across the Michigan area. We're fortunate to have him on our team. We also re-elected **Dr. Don Kliensek** and **Dr. Kevin Doyle**, and we're thrilled to have long-time director **Paul Hagen** back.

Following the AGM, CI held a special strategic meeting to reflect on our past 50 years and discuss how we can adapt and evolve for the next 50. One of Steve's initiatives includes developing a trust system for CI and our members to set aside funds for revival, reintegration, and as insurance for CI's long-term survival. Additionally, we are exploring various projects for the coming year, including staff expansion and a revamp of our website and databases.

In summary, despite rising costs, CI remains committed to providing exceptional services at a fair price. Thank you for your continued support as we embark on this exciting journey together!

Dennis Kowalski

President - Cryonics Institute



CRYONICS INSTITUTE MAGAZINE

The digital newsletter of the Cryonics Institute
24355 Sorrentino Ct.
Clinton Township, MI 48035-3239

Phone: 1 (586) 791-5961
Toll-free: 1 (866) 288-2796 (North America)
FAX: 1 (586) 792-7062
Email: info@cryonics.org

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ARTICLE SUBMISSIONS

Cryonics Institute or cryonics-related articles are welcome. Submissions: dg@cryonics.org

E-SUBSCRIPTIONS

* As a CI member, you are automatically added to our email reminder list. To unsubscribe, please use the "unsubscribe" link at the bottom of your email.

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Call toll-free **1-888-224-8256** to speak to a live operator at any time.

Or, go to LifeExtension.com/CI.

Use code **TPX2501A** to get these savings • Offer expires December 31, 2025



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Membership Benefits

Why join the Cryonics Institute?

The choice is clear: Irreversible physical death, dissolution and decay, or the possibility of a vibrant and joyful renewed life. Don't you want that chance for yourself, your spouse, parents and children?

1) **A Second Chance at Life**

Membership qualifies you to arrange and fund a vitrification (anti-crystallization) perfusion and cooling upon legal death, followed by long-term storage in liquid nitrogen. Instead of certain death, you and your loved ones could have a chance at rejuvenated, healthy physical revival through cryopreservation.

2) **Affordable Cryopreservation**

The Cryonics Institute (CI) offers full-body cryopreservation for as little as \$28,000.

3) **Affordable Membership**

Become a Lifetime Member for a one-time payment of only \$1,250, with no dues to pay. Or join as a Yearly Member with a \$75 initiation fee and dues of just \$120 per year, payable by check, credit card or PayPal.

4) **Lower Prices for Spouses and Children**

The cost of a Lifetime Membership for a spouse of a Lifetime Member is half-price and minor children of a Lifetime Member receive membership free of charge.

5) **Quality of Treatment**

CI employed a Ph.D level cryobiologist to develop CI-VM-1, CI's vitrification mixture which can help prevent crystalline formation at cryogenic temperatures.

6) **Standby Options and Assistance**

CI's use of Locally-Trained Funeral Directors means that our members can get knowledgeable, licensed care. Or members can arrange for professional cryonics standby and transport by subcontracting with [Suspended Animation, Inc](#) or [International Cryomedicine Experts](#) (I.C.E.) CI also offers Standby

Training Materials and Kits for members who choose to perform Local Standby.

7) **Affordable Funding Options**

Cryopreservation with CI can be funded through life insurance policies issued in the USA or other countries. Prepayment and other options for funding are also available to CI members.

8) **Cutting-Edge Cryonics Information**

Members receive a free e-subscription to the Cryonics Institute Newsletter, as well as access to our Facebook page, Twitter feed, YouTube channel and an official members-only forum.

9) **Helpful, Professional Support**

CI's professional staff is available to answer any questions and address any concerns you may have about CI, your membership or Cryopreservation.

10) **Additional Preservation Services**

CI offers a sampling kit, shipping and long-term liquid nitrogen storage of tissues and DNA from members, their families or pets for just \$98.

11) **Support Education and Research**

Membership fees help CI to fund important cryonics research and public outreach, education and information programs to advance the science of cryonics.

12) **Member Ownership and Control**

CI Members are the ultimate authority in the organization and own all CI assets. They elect the Board of Directors, from whom are chosen our officers. CI members also can change the Bylaws of the organization (except for corporate purposes).



To get started, contact us at:

(586) 791-5961 • email: info@cryonics.org

Visit us online at www.cryonics.org



SAVE THE DATE

Cryonics Institute Annual Meeting & *50th Anniversary Celebration*



THE FORD HOUSE

1100 LAKE SHORE ROAD, GROSSE POINTE SHORES, MI 48236

SUNDAY, SEPTEMBER 13, 2026

3:00 - 7:00 PM

Please join us for dinner, drinks
and special presentations to
celebrate the 50th Anniversary of
the Cryonics Institute!

Dress to Impress | Adults Only



2025 Board of Directors Elections

Board Members serve three-year terms, with four positions up for election each year on a rotating basis. Board positions are open to Voting Members only

*I - incumbent / C - Candidate

Elected



Kevin Doyle, Ph.D (I)
76 votes



Paul Hagen (C)
76 votes



Don Kleinsek (I)
80 votes



Steve Lebel (C)
82 votes

Runners-Up



Nicholas R Vendermeulen (I)
66 votes



Nicolas LaCombe (C)
28 votes

Member Readiness Checklist

*You've signed up for cryonics -
what are the next steps?*

Welcome Aboard! You have taken the first critical step in preparing for the future and possibly ensuring your own survival. Now what should you do? People often ask "What can I do to make sure I have an optimal suspension?" Here's a checklist of important steps to consider.

- Become a fully funded member through [life insurance](#) or easy pre-payments
Some members use term life and invest or pay off the difference at regular intervals. Some use whole life or just prepay the costs outright. You have to decide what is best for you, but it is best to act sooner rather than later as insurance prices tend to rise as you get older and some people become uninsurable because of unforeseen health issues. You may even consider making CI the owner of your life insurance policy.
- Keep CI informed on a regular basis about your health status or address changes. Make sure your CI paperwork and funding are always up to date. CI cannot help you if we do not know you need help.
- Keep your family and friends up to date on your wishes to be cryopreserved. Being reclusive about cryonics can be costly and cause catastrophic results.
- Keep your doctor, lawyer, and funeral director up to date on your wishes to be cryopreserved. The right approach to the right professionals can be an asset.
- Prepare and execute a Living Will and Power of Attorney for Health Care that reflects your cryonics-related wishes. Make sure that CI is updated at regular intervals as well.
- Review the [CI Standby Manual](#) and other materials designed to help you with you Standby Planning. Also, consider joining or forming a local standby group to support your cryonics wishes. This may be one of the most important decisions you can make after you are fully funded. As they say-"Failing to plan is planning to fail".
- Always wear your cryonics bracelet or necklace identifying your wishes should you become incapacitated. Keep a wallet card as well. If you aren't around people who support your wishes and you can't speak for yourself a medical bracelet can help save you.
- Get involved! If you can, donate time and money. Cryonics is not a turnkey operation. Pay attention and look for further tips and advice to make both your personal arrangements and cryonics as a whole a success. The stronger our organization is, the stronger your chances of success.
- Keep your records, contact information and contracts up to date. It is recommended you review your relevant information annually at a minimum. One way is to schedule time to review all your materials at the same time you submit your required Annual Proof of Funding to CI. Also, Be especially aware of easy to forget things like a new email, phone number or address. Remember, you can also contact us at any time to ask if you have any outstanding paperwork or other info that needs to be updated.

The online [CI Members' Information Form](#) is a great resource for updating your current information on file.



DNA and Tissue Sample Preservation Services

Lifetime and Annual Members of the Cryonics Institute can have DNA / Tissue Samples cryopreserved by CI. Annual Members must have fully paid for no less than one year, i.e. have paid \$120 yearly dues (plus the initial \$75 initiation fee if it is their first year) for a full year's Membership.

CI provides a DNA sampling kit for hair, skin, and/or inner cheek samples from living persons or pets. Tissue samples may be extracted from a deceased person or pet by a funeral director or veterinarian, respectively. A CI Member may store DNA/tissue for \$98 for four samples that will each fit into a 1.8ml sample vial. Some members choose to store larger samples, which cost more and that cost is calculated based on the size of the sample. The cost includes a DNA sampling kit which consists of four 1.8-milliliter nalgene vials, swabs, instructions, tissue storage contracts and labels that can be placed on the vials, along with a mailing envelope. Each nalgene vial can be individually labeled for content. Each full kit is labeled, identified by a tissue storage contract and stored in liquid nitrogen at the Cryonics Institute.

Tissue samples need not be sent to CI in the DNA sampling kit. Any small vial or container can be used, and CI will transfer samples to nalgene vials for storage in liquid nitrogen.

For more information on DNA and Tissue Storage Cryopreservation, please contact us at info@cryonics.org or visit cryonics.org:

Who will be there for YOU?



Don't wait to make your plans. Your life may depend on it.



Suspended Animation fields teams of specially trained cardio-thoracic surgeons, cardiac perfusionists and other medical professionals with state-of-the-art equipment to provide stabilization care for Cryonics Institute members in the continental U.S.

Cryonics Institute members can contract with Suspended Animation for comprehensive standby, stabilization and transport services using life insurance or other payment options.



Speak to a medical representative for more information.

..... **Call 1-949-482-2109**

or email info@suspendedanimationinc.com



Worldwide Cryonics Groups

AUSTRALIA: The Cryonics Association of Australasia offers support and information for Australia & nearby countries.

caalist@prix.pricom.com.au.

Their Public Relations Officer is Philip Rhoades.

phil@pricom.com.au GPO Box 3411,
Sydney, NSW 2001 Australia. Phone: +6128001
6204 (office) or +61 2 99226979 (home.)

BELGIUM: Cryonics Belgium is an organisation that exists to inform interested parties and, if desired, can assist with handling the paperwork for a cryonic suspension. The website can be found at www.cryonicsbelgium.com. To get in touch, please send an email to info@cryonicsbelgium.com.

BHUTAN: Can help Cryonics Institute Members who need help for the transport & hospital explanation about the cryonics procedure to the Dr and authorities in Thimphu & Paro. Contacts : Jamyang Palden & Tenzin Rabgay / Emails :
palde002@umn.edu or jamgarnett@hotmail.co Phones : Jamyang / 975-2-32-66-50 & Tenzin / 975-2-77-21-01-87

CANADA: This is a very active group that participated in Toronto's first cryopreservation. President, Christine Gaspar; Vice President, Gary Tripp. Visit <http://www.cryocdn.org/>. There is a subgroup called the Toronto Local Group. Meeting dates and other conversations are held via the Yahoo group. This is a closed group. To join write: csc5@cryocdn.org

ALBERTA: Founded in Calgary in 2024, Futurist Club is a cryonics-centered community hub for exploring emerging technologies and future trends, with a facility located in downtown Calgary. Get in touch with Carrie Radomski at carrie@futuristclub.com or visit futuristclub.com.

BRITISH COLUMBIA: The Lifespan Society advocates for radical life extension. They also organize conferences and educational outreach events on life extension issues. Lifespan welcomes all Canadians as members, although voting in the society is open to BC residents. Contact Robert Lang, President at robert@lifespanbc.ca. Web site www.lifespanociety.com

QUEBEC: Contact: Stephan Beauregard, C.I. Director & Official Administrator of the Cryonics Institute Facebook Page. Information about Cryonics & perfusion services in Montreal for all cryonicians. Services available in French & English:
stephan@cryonics.org

CHILE: Community oriented to provide reliable information on human cryopreservation, as far as technical scientific as well as other practical aspects. Dissemination, awareness and education on issues related to the extension of life in general and cryonics in particular. Contact José Luis Galdames via galdamesh.jl@gmail.com.

FINLAND: The Finnish Cryonics Society, (KRYOFIN) was established in 2008 and is an organization collaborating with all nearby groups and organizations. Contact them at: kryoniikka.fi Their President is Ville Salmensuu ville@salmensuu.fi

FRANCE: SOCIETE CRYONICS DE FRANCE is a non profit French organization working closely with European cryonics groups. For more information: J.Roland Missionnier: phone: 33 (0) 6 64 90 98 41 or email: cryonicsnews.inpi@gmail.com • [Facebook group](#)

<https://www.francecryonics.fr/a-propos/>
Vivien Gruss, member of Cryonics Institute, has opened a web site for the information of persons interested in cryonic suspension.

GERMANY: DGAB There are a number of Cryonicists in Germany. Their Organization is called "Deutsche Gesellschaft für Angewandte Biostase e.V.", or short "DGAB". More information on their homepage at www.biostase.de. If there are further questions, contact their Board at vorstand@biostase.de

GERMANY: CRYONICS-GERMANY is an active group providing cryonics support, including a special 8-member Standby Response Team. Members from Germany or Internationally are welcome to join. at <http://cryonics-germany.org>. Direct inquiries to contact@cryonics-germany.org.

INDIA: Can help Cryonics Institute Members who need help for the transport & hospital explication about the cryonics procedure to the Dr and authority in Bangalore & Vellore Area. Contacts : Br Sankeerth & Bioster Vignesh / Email : vicky23101994@gmail.com Phones : Bioster / 918148049058 & Br Sankeerth / 917795115939

ITALY: Onoranze Funebri Polistena has several locations in Italy and has already sent people to Russia, to Kriorus and also to the Cryonics Institute.

Vitto Claut - tel: +39 335294154

Daniele Chirico - tel: +39 3495146943

Filippo Polistena tel: +39 370 321 0052

<https://www.filippopolistena.it/contatti/>

<https://www.filippopolistena.it/le-nostre-composizioni/fiori-piante-cor-one-floreali-anche-a-domicilio/>

Kriorus Italy: Representative Filippo Polistena, email: filippopolistena45@gmail.com. com. phone: +39 334 298 9378

JAPAN: Takaaki Kaburagi is President Japan Cryonics Association. Formed in 1998, our goals are to disseminate cryonics information in Japan, to provide cryonics services in Japan, and eventually, to allow cryonics to take root in the Japanese society. Contact kabu@ops.dti.ne.jp or <http://www.cryonics.jp>

NEPAL: Can help Cryonics Institute Members who need help for the transport & hospital explanation about the cryonics procedure to the Dr and authorities in Kathmandu. Contact : Suresh K. Shrestha / Email : toursuresh@gmail.com Phone : 977-985-1071364 / PO Box 14480 Kathmandu.

THE NETHERLANDS: Dutch Cryonics Organization is the local support group since 2002 and able to provide advice, standby, perfusion and shipment 24/7, in case of need. We are an active group utilizing the latest equipment. New members from The Netherlands welcome.

E-mail: info@cryonisme.nl

website: <http://www.cryonisme.nl>

NORWAY : Can help Cryonics Institute Members who need help for the transport & hospital explication about the cryonics procedure to the Dr, funeral home and authority at Sandvika. Contacts : Gunnar Hammersmark Sandvika Begegravelsesbyraa / Phones : 011-47-2279-7736

RUSSIA: KrioRus is a Russian cryonics organization operating in Russia, CIS and Eastern Europe that exists to help arrange cryopreservation and longterm suspension locally, or with CI or Alcor.

Please contact kriorus@gmail.com for additional information or visit <http://www.kriorus.ru>. Phone: +7 962 947-50-79

SPAIN: <https://asociacioncrionica.es/> The Spanish Cryonics Association (ACE). A group of enthusiastic civilians, scientists and medical volunteers dedicated to research, education and support in the field of cryonics. We offer information, advice and support to those interested in cryonics including consultation, legal advice, financial planning and veterinary services.

SWEDEN: www.kryonik.se or Facebook:

Svenska Kryonikföreningen. Initially, the society will focus on providing information and assistance to those who wish to sign up for cryonics. Eventually, we also hope to provide practical assistance in cases, possibly in collaboration with other European groups.

SWITZERLAND: www.cryosuisse.ch

CRYOSUISSE The Swiss Society for Cryonics is an active group with over 30 members. To join, email info@cryosuisse.ch

UNITED STATES:

Minnesota: Minnesota Cryonics Rapid Response (MCRR) is a nonprofit standby, stabilization and transport group based in Minneapolis, Minnesota. We have a strong, longstanding working relationship with local funeral directors, and have successfully participated in significantly more-timely suspension efforts in Minnesota in cooperation with both Alcor and the Cryonics Institute. Contact: President, Chuck Bartl, chuckbartl@yahoo.com.

Washington DC Metro Region: Life Extension Society (LES) is a nonprofit organization of area cryonicists dedicated to enhancing local capabilities for standby, stabilization and transport. Members from both Alcor and Cryonics Institute are welcome. Contact: Mark Mugler, mugsim2@gmail.com.

Southeast Wisconsin: Great Lakes Cryonics Association. CI President Dennis Kowalski's cryonics group serving the Greater Milwaukee and Southeastern Wisconsin region. Phone: 1-414-322-1320 Dennis@cryonics.org.

Seattle, Washington: Seattle Cryonics is an active community of cryonicists who meet quarterly in person to build local connections and capabilities. Members of all cryonics organizations are welcome. Contact: seattlecryonics@gmail.com. Meetup page: <https://www.meetup.com/seattle-cryonics/>

UNITED KINGDOM: Cryonics UK is a nonprofit UK based standby group. www.cryonics-uk.org Cryonics UK can be contacted via the following people: Tim Gibson: phone: 07905 371495, email: tim.gibson@cryonics-uk.org. Victoria Stevens: phone: 01287 669201, email: vicstevens@hotmail.co.uk. Graham Hipkiss: phone: 0115 8492179 / 07752 251 564,

email:

ghipkiss@hotmail.com. Alan Sinclair: phone: 01273 587 660 / 07719 820715, email: cryoservices@yahoo.co.uk

Can help Cryonics Institute Members who need help, funeral home, transport at London. Contact : F.A. Albin & Sons / Arthur Stanley House Phone : 020-7237-3637

INTERNATIONAL: The Cryonics Society is a global cryonics advocacy organization. www.CryonicsSociety.org. They publish an e-newsletter *FutureNews*. Phone: 1-585-643-1167.

PROFESSIONAL STANDBY:

Companies providing professional standby, stabilization and transport services.

International Cryomedicine Experts (ICE):

<https://www.cryomedics.org/>

info@cryomedics.org

844-INTL-CRYO (468-5279)

Suspended Animation Inc:

<https://suspendedanimationlabs.com/>

info@suspendedanimationlabs.com

1-949-482-2109

HELP US STAY UP-TO-DATE!

Please send any corrections or changes to the address below. If you know of, or are considering starting a support, standby or other cryonics-related group in your area, please send details to

dg@cryonics.org.



Please note, this list is provided as an information resource only. Inclusion on the list does not constitute an endorsement by the Cryonics Institute or our affiliated organizations. We urge our readers to use this list as a starting point to research groups that may meet their own individual needs. We further note that readers should always use their own informed judgment and a reasonable amount of prudence in dealing with any organization and/or individual listed.



Credit: Getty images

A dementia vaccine could be real, and some of us have taken it without knowing

Getting vaccinated against shingles could protect you from getting dementia, or slow the progression of the disease, says a new study

by Hatty Willmoth December 2, 2025

A shingles vaccine could reduce your risk of dementia by 20 per cent or slow the progression of the disease once you've got it, according to recent research led by Stanford University, in the US.

If these findings can be backed up in future research, the vaccine – which is already available – could be used to help prevent and treat dementia: an incurable disease that affects an estimated 57 million people globally.

In a study published in *Nature*, the scientists analysed the health records of more than 280,000 adults in Wales between the ages of 71 and 88 years old. They were aiming to understand the effects of a shingles vaccination programme that began in 2013.

They found that older adults (aged 79–80) who had received the shingles vaccine were 20 per cent less likely to develop dementia by 2020, compared to those who hadn't been eligible to receive it.



An illustration of the Varicella zoster virus, which causes chickenpox and shingles - Credit: Getty images

Senior author Dr Pascal Geldsetzer, assistant professor of medicine at Stanford, said this was “a really striking finding,” adding: “This huge protective signal was there, any which way you looked at the data.”

What’s more, in a recent follow-up study published in *Cell*, the same scientists discovered that the shingles vaccine seemed to have a protective effect even among those who’d already been diagnosed with dementia by 2013.

Of the 7,049 Welsh adults included in the study who had dementia, nearly half had died within the following nine years. But among those who had received the shingles vaccine, only 30 per cent had died.

“The most exciting part is that this really suggests that the shingles vaccine doesn’t have only preventive, delaying benefits for dementia, but also therapeutic potential for those who already have dementia,” said Geldsetzer.

accine and dementia protection, but all of them were weakened by the fact that those who get vaccinated tend to also lead healthier lives in general (so their protection from dementia may have come from elsewhere).

But in this study, that bias wasn’t such a problem. That’s

because the vaccination programme was only eligible to a specific group of people: those who were 79 years old on 1 September 2013.

“We know that if you take a thousand people at random born in one week, and a thousand people at random born a week later, there shouldn’t be anything different about them on average,” said Geldsetzer. “They are similar to each other apart from this tiny difference in age.”

In other words: the scientists could directly compare two groups, with the same average mixture of more health-conscious and less health-conscious people, born only a week apart. The only difference between them was their eligibility for this vaccine – making its efficacy against dementia much easier to spot.

Shingles is an infection caused by the Varicella zoster virus – the bug to blame for chickenpox. Its symptoms include a painful rash, burning or tingling feelings, headaches, fever and fatigue.

The virus affects the nervous system, but scientists aren’t yet sure exactly how a shingles vaccine might protect the brain from cognitive decline.

Finding immune cells that stop a body from attacking itself wins medicine Nobel

The 2025 prize goes to 3 researchers who ID'd T-regs and their role in autoimmune disease

By Tina Hesman Saey October 6, 2025



Mary Brunkow (left), Fred Ramsdell (middle) and Shimon Sakaguchi (right) have won the Nobel Prize in physiology or medicine for discovering regulatory T cells, which keep the immune system from attacking the body. NIKLAS ELMEDH © NOBEL PRIZE OUTREACH

Work on peacemakers in the immune system won the 2025 Nobel Prize in physiology or medicine.


The peacemakers are regulatory T cells, a type of immune cell that calms the immune system after it has finished fighting infection or healing a wound. These special T cells also prevent the immune system from attacking the body. If they fail in this mission, autoimmune disorders or damaging inflammation can result. These cells are also important to prevent rejection of the fetus during pregnancy.

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ScienceNewsExploresfrom SNEXPLORES.ORG

A new type of battery is based on a material discovered with the help of artificial intelligence.

DAN DELONG/MICROSOFT

Artificial intelligence helped design a new type of battery

**The process narrowed 32 million candidate materials
to a few dozen in just 80 hours**

Author: Emily Conover March 25, 2024

With more and more devices being powered by batteries, there's a hunt to find new, safer and cheaper materials to use in those batteries. Doing that has traditionally involved tinkering in the lab — with lots of trial-and-error. But artificial intelligence (AI) could speed up that process, new research shows. And it hints that computers might help identify new materials for batteries to meet specific needs.

A team of 11 researchers in Washington started with a huge pool of potential materials for a new battery. Some of the researchers worked for Microsoft in Redmond.

Others worked at the Energy Department's Pacific Northwest National Laboratory (PNNL) in Richland. In all, the team came up with more than 32 million candidate materials. The group then used AI to help narrow that list down to just 23 promising options. From there, they picked one — and built a working battery.

It's not the first time scientists have used AI to predict how materials might behave. But past work typically hasn't led to making a new material.

"The nice thing about this paper is that it goes all the

way from start to finish,” says Shyue Ping Ong. He is a materials scientist who did not take part in the new research. He works at the University of California, San Diego.

They focused on the electrolyte

Batteries work by converting chemical energy to electrical energy. (That’s true for AA batteries and for the lithium-ion (Li-ion) batteries in your phone and laptop.) Batteries do this with the help of something called an electrolyte. Atoms that have an electric charge — ions — can flow through that electrolyte.

Electrolytes can be liquid or solid. Standard Li-ion batteries use a liquid type. But those liquids can pose risks, such as leaks or fires. So scientists have looked to design solid electrolytes. The Washington team hoped to make such an electrolyte for batteries.

To create their initial set of possible candidates, they looked at the structures of materials in known electrolytes. Then they asked a computer to swap different elements into those electrolyte recipes. It was like a game of chemical mix-and-match. That’s how the researchers came up with those 32 million candidate electrolyte recipes.

Sorting through this giant list with traditional methods would have taken decades, says Nathan Baker. He’s a chemist at Microsoft who led the new research. But with AI, the researchers were able to pare down the list in just 80 hours. They used a type of AI called machine learning. It can make quick predictions based on patterns learned from known materials.

Solid results

The Washington team then used AI to drop from the list any potential ingredient too unstable to exist in the real world. That brought the list down to fewer than 600,000 candidates. Next, AI selected ones likely to have traits that would be good for batteries.

From there, the researchers used methods that are more accurate than AI. They applied tried-and-tested, physics-based methods. These complex calculations required a powerful supercomputer. It helped model what features the materials might have as an electrolyte. The team also weeded out what would be rare, toxic or expensive ingredients.

Now, only 23 candidates were left. Five were already known. The research team picked a new material that seemed promising. It was stable and conducted electricity well. And it was related to materials the researchers already knew how to make.

Back in the lab, they produced this novel electrolyte. Then they used it to make a prototype battery — which worked.

“That’s when we got very excited,” says Vijay Murugesan. He’s a materials scientist on the team at PNNL. From when they started trying to make the material to when they had a working battery took only about six months. “That is superfast,” he says.

The team shared its findings in a paper published January 8 on arXiv.org. (Studies on this site have not yet been vetted by other experts.)

An unexpected matchup

The new electrolyte is similar to a known one. It contains lithium, yttrium and chlorine. But the new one swaps in sodium for some lithium. That’s an advantage, as lithium is costly and in high demand.

Mixing lithium and sodium is uncommon in electrolytes. Usually, “we would not mix these two,” says Yan Zeng. She works at Florida State University in Tallahassee. A materials scientist, she did not work on the new project. It’s more common to use either lithium or sodium ions, not both.

The two types of ions both conduct electricity. So they might be expected to compete with one another, lowering an electrolyte’s overall performance. But the new material highlights one of AI’s benefits, Zeng notes. It “can sort of step out of the box” to try things human minds might not.

This is another in a [year-long series](#) of stories identifying how the burgeoning use of artificial intelligence is impacting our lives — and ways we can work to make those impacts as beneficial as possible.

Next gen cancer drug shows surprising anti aging power

A next-gen drug and a surprising enzyme system reveal new clues about how aging may be slowed.

Queen Mary University of London December 5, 2025



A new study shows that rapalink-1 can extend yeast lifespan and uncover a hidden metabolic loop linked to aging. The findings suggest that diet and gut microbes may play a larger role in longevity than previously realized. Credit: Shutterstock

Researchers at Queen Mary University of London's School of Biological and Behavioural Sciences have demonstrated that the experimental TOR inhibitor rapalink-1 can extend the chronological lifespan of fission yeast, a simple organism widely used to explore basic biological processes.

A study published in *Communications Biology* by Juhi Kumar, Kristal Ng and Charalampos Rallis reports that

both pharmaceuticals and naturally occurring metabolites can influence lifespan through the Target of Rapamycin (TOR) pathway.

TOR Pathway's Central Role in Growth and Aging

The TOR pathway is an evolutionarily conserved signalling system found in organisms ranging from yeast

to humans. It plays a vital part in regulating growth and aging and is closely linked to major age-related conditions, including cancer and neurodegenerative diseases. Because of its broad influence, TOR has become a major target in anti-aging and cancer research, with drugs such as rapamycin already showing an ability to extend healthy lifespan in several animal models.

Rapalink-1, the compound examined in the investigation, is a next-generation TOR inhibitor currently being studied for potential use in cancer therapy. The research team found that rapalink-1 slowed certain aspects of yeast cell growth while also extending their lifespan. The effect appears to operate through TORC1 -- the growth-promoting component of the TOR pathway.

Discovery of a Metabolic Feedback Loop Involving Agmatinases

The study unexpectedly identified a significant role for a group of enzymes known as agmatinases, which convert the metabolite agmatine into polyamines. These enzymes appear to participate in a previously unrecognized "metabolic feedback loop" that helps maintain balanced TOR activity. When agmatinase activity was disrupted, yeast cells grew more quickly but showed signs of premature aging, revealing a trade-off between rapid growth and long-term cell survival.

The team also found that adding agmatine or putrescine (a related compound) supported longevity in yeast and improved growth under specific conditions.

"By showing that agmatinases are essential for healthy aging, we've uncovered a new layer of metabolic control over TOR -- one that may be conserved in humans," said Dr. Rallis. "Because agmatine is produced by diet and gut microbes, this work may help explain how nutrition and the microbiome influence aging."

Caution Around Agmatine Supplementation

Rallis noted that agmatine supplements are available commercially but emphasized caution: "We should be cautious about consuming agmatine for growth or longevity purposes. Our data indicate the agmatine supplementation can be beneficial for growth only when certain metabolic pathways related to arginine breakdown are intact. In addition, agmatine does not always promote beneficial effects as it can contribute to certain pathologies."



Image by [Tung Lam](#) [Pixabay](#)

**INTERESTING
ENGINEERING**from [INTERESTINGENGINEERING.COM](https://www.interestingengineering.com)*Tesla Optimus running on a lab floor*

Video: Elon Musk's Optimus humanoid robot masters human-like smooth running

The humanoid robot ran like humans on a lab floor.

by Atharva Gosavi December 4, 2025

EV maker Tesla has shared a new update of its humanoid robot Optimus on X (formerly Twitter) on Dec. 3.

The short clip shared by the official Tesla Optimus account and Elon Musk, showing Optimus running in a lab, is going viral on social media.

The video, captioned "Just a new PR in the lab," shows the new performance record set by the robot.

The Tesla Optimus stands tall at 5 feet 11 inches and weighs 160 pounds, featuring over 40 degrees of freedom, including highly dexterous 11-DoF hands de-

signed for human-like interaction.

It runs on a 2.3 kWh battery, enabling nearly all-day operation, with exceptional energy efficiency ranging from just 100W at rest to 500W while walking.

A significant development

Running robot <https://t.co/ua8FocTGnz>

— Elon Musk (@elonmusk) December 2, 2025

The short video showed that Tesla Optimus has improved in balance, coordination, and gait control. Up-

dates shared in the past focused on showing the robot mastering basic skills, such as controlled walking, object handling, and posture training.

Tesla Optimus Robot's incredible progress after only 2.5 years. pic.twitter.com/ESTXSofJha

— Nic Cruz Patane (@niccruzpatane) December 2, 2025

Simultaneously, another 8-second split-screen video clip of the humanoid has gone viral, showcasing its progress from May 2023 to December 2025.

The first part of the video shows a group of Tesla robots taking their very first steps in a factory, with the latest progress video shown in the second part.

The new update on the running ability marks a significant development that will contribute towards Elon Musk's broader vision of deploying 5,000 Optimus robots by the end of 2025.

A timeline of progress

By mid-2025, Tesla demonstrated that Optimus was performing increasingly complex tasks, including walking, lifting small objects, and executing scripted tasks such as pick-and-place operations and basic assembly work.

In early September, the automaker released its first demo of the humanoid, titled 2.5 Gen Optimus, in which the robot appeared sluggish when tasked with a simple task.

In October, the robot showed significant improvements in performing Kung Fu moves alongside a trained professional. The robot's gait and full-body coordination became smoother, with improved whole-body control rather than isolated limb scripts.

Still under active development, Optimus is expected to enter mass production soon, according to Tesla. Elon Musk previously estimated that once manufacturing scales, the robot's price could fall between \$20,000

and \$30,000.

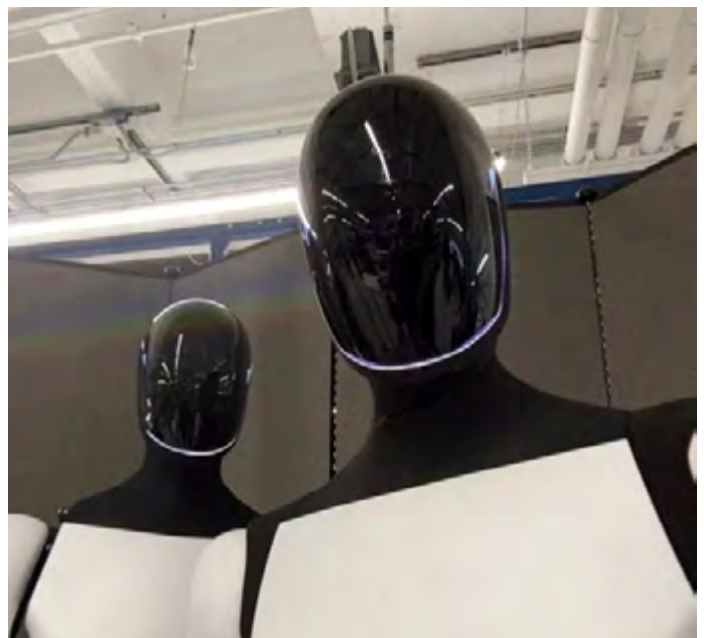
Musk also outlined Tesla's ambitious new manufacturing vision built around "self-replicating" technology. In the near future, he claimed, robots could build other robots, effectively removing humans from major parts of the production line.

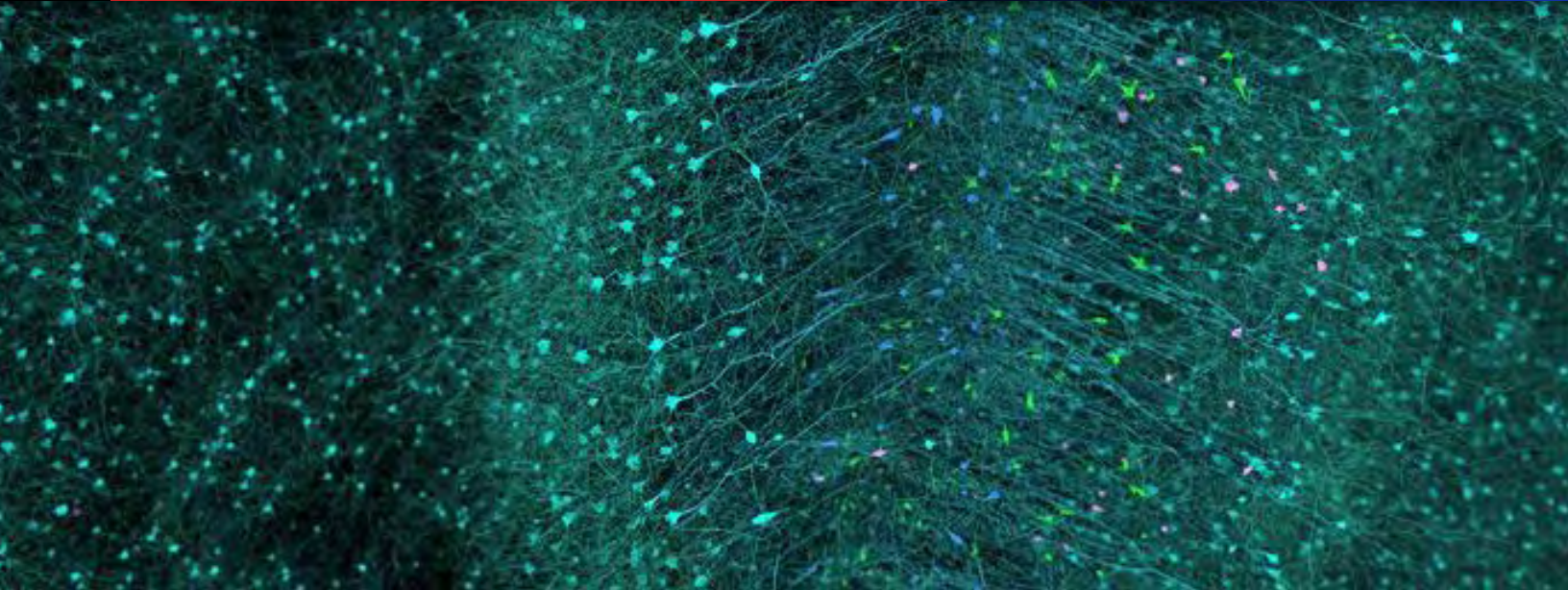
The next frontier for the automobile?

Tesla's Optimus' rapid progress comes at a moment when the auto industry is reimagining its future. Car-makers are pivoting toward robotics because EVs and humanoid robots share the same foundational technologies – batteries, AI chips, sensors, and autonomous navigation.

Modern factories already rely heavily on industrial robots, and humanoids represent the next step: machines that can perform the tasks current robots can't. As labor costs rise and global competition intensifies, automakers see robotics as both a cost-saving strategy and a new frontier of innovation.

Tesla's ambitions may be bold, but the industry trend toward robot-assisted manufacturing is unmistakable.





Detailed image of the reconstructed neocortical circuit with a selection of neurons highlighted in different colors according to their morphological types. CREDIT: COPYRIGHT © 2015-2024 BLUE BRAIN PROJECT/EPFL

The Open Brain Institute announces the dawn of a new frontier in neuroscience

The Open Brain Institute launches as a not-for-profit organization to make the 18-million-line software recipe to build and simulate mammalian digital brains developed in the Blue Brain Project openly available through AI-powered Virtual Laboratories

BUSINESS ANNOUNCEMENT: OPEN BRAIN INSTITUTE

LAUSANNE, March 18, 2025 - The Open Brain Institute (OBI) launches today as a groundbreaking non-profit organization, transforming neuroscience from the physical to the virtual world. Building on the pioneering achievements of the EPFL's Blue Brain Project, OBI opens the era of simulation neuroscience—empowering researchers to build and simulate digital brains with unprecedented detail, scale, and speed.

AI has been given access to the software recipe to build digital brains, providing natural language support to researchers to ex-

plore, build and simulate digital brains, petabytes of brain data collected from global databases, and the world's cumulative knowledge of the brain and its diseases.

Establishing Simulation Neuroscience

The Blue Brain Project, founded and directed by Professor Henry Markram, was on a 20-year mission to work out how to forward engineer mammalian brain tissue on supercomputers from lim-

ited experimental data and discovered a revolutionary approach to reverse engineer the brain and a recipe to build digital brains. With around 300 peer-reviewed scientific papers, the project demonstrated that these digital brain models closely mirror real brain structure and function—enabling experiments that would otherwise be technically or ethically impossible.

OBI takes this legacy further, hosting virtual neuroscience laboratories where researchers can access:

- Open Data, data made available on AWS Open Data Registry under the [Blue Brain Open Data](#).
- Open Software with 18 million lines of code to explore, build and simulate digital brains.
- Global brain databases curated by the project and the neuroscience community.
- An AI companion to guide exploration, modeling, and simulation.

Simulation neuroscience now joins experimental, theoretical, and clinical neuroscience as the fourth pillar to tackle the brain's complexity. "The Blue Brain Project gave us the proof that the brain can be reconstructed in a computer from limited experimental data," says Professor Henry Markram, Founder of OBI, who presented this breakthrough at this year's World Economic Forum. "Today, the OBI brings the recipe to build and simulate the brain to empower researchers to explore the brain in unprecedented detail, and at a scale and speed never before imagined."

Sparking a Global Collaboration

OBI's Virtual Labs allow researchers from any discipline, anywhere in the world, to construct digital brain models at multiple scales—from molecular pathways and individual neurons to entire brain regions and whole-brain simulations, in principle of any species, at any age, and in any disease state.

- Disease modeling: Study neurological and psychiatric disorders in digital brains.
- AI and cognition research: Use digital brains to inspire new forms of artificial intelligence.
- Brain-computer interface and neuroprosthetics: Prototype and test neural implants virtually.

Researchers can invite unlimited collaborators into their Virtual Labs, fostering global, interdisciplinary teamwork in ways never before possible.

Visionary Funding

The Blue Brain Project was established at EPFL in 2005, when Professor Patrick Aebischer, then President of EPFL, outbid several prestigious institutions to host and fund the project. His visionary leadership led to 300 million Swiss francs in Swiss Federal Government funding over 20 years. "We recognized that if scientists can replicate the brain in computers, we can explore its functions and diseases in completely new ways" says Professor Patrick Aebischer. "The Open Brain Institute takes our work at EPFL and extends it into an open, global resource. It is exactly what the community needs to accelerate progress and spark new discoveries."

An EPFL Legacy

As one of the world's leading research institutions, EPFL continues to drive science into innovation and impact. "EPFL is delighted to support this transition from a long-term audacious internal project to a non-profit platform serving the international neuroscience community," says EPFL President, Professor Anna Fontcuberta i Morral. "The extensive work accomplished within the EPFL Blue Brain Project will continue to have impact under the Open Brain Institute, providing researchers worldwide with access to cutting-edge virtual laboratories."

Over 22'000 students have already taken Blue Brain's on-line courses on simulation neuroscience, preparing for the age of digital brains.

A Catalyst for Neuroscience Breakthroughs

The OBI enables rapid brain research, therapeutic development, and next-generation AI, helping to tackle some of humanity's greatest challenges:

- The brain's complexity: Understanding perception, learning and action to adapt and thrive, as well as developmental changes, species-specific adaptations, and the origins of disease.
- The economic burden: Exploring treatments for brain disorders that cost the global economy trillions annually, yet drug development remains slow, expensive, and inefficient.
- Neurotechnology innovation: Rapid virtual prototyping on digital brains to accelerate brain-computer interface, neuromodulation, and neuroprosthetic research and development.

- AI beyond machine learning: Studying biological intelligence could unlock new AI architectures and strategies to interact with the world in real time.

“The brain is the only known system that exhibits true generalized intelligence,” says Markram. “OBI’s virtual labs can be used to study how the brain’s natural architecture—evolved over millions of years—creates intelligence, offering radical new directions for AI.”

Join the Digital Brain Revolution

- The OBI opens its doors to the Virtual Labs on March 28, 2025.
- Researchers, clinicians, industry R&D teams, and AI innovators are all invited.
- Virtual Labs accommodate principal investigators, small research teams, and global consortia.

Reserve Your Virtual Lab Today

Visit <https://openbraininstitute.org> or contact the OBI Communications Office at info@openbraininstitute.org

Conclusion: The Dawn

of Digital Brains

The Open Brain Institute marks a historic moment in neuroscience—transitioning decades of pioneering research into an open, global platform.

For researchers, OBI means faster and cheaper breakthroughs.

For clinicians, it means deep access to the latest findings on brain diseases.

For AI innovators, it means working with the only system capable of generalized intelligence.

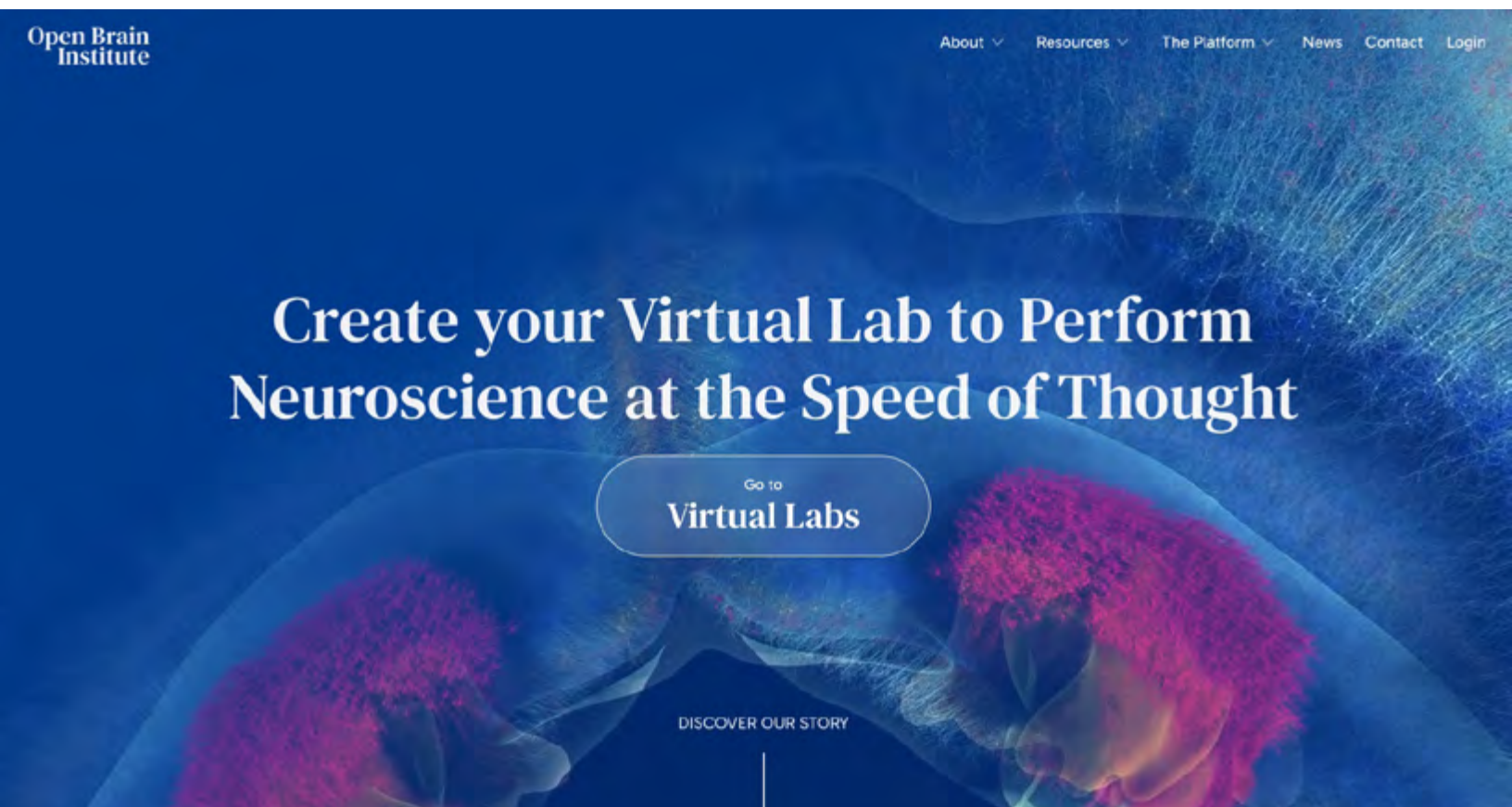
The next generation of brain science and technology begins now. Be part of it. Register for a Virtual Lab today.

<https://openbraininstitute.org>

contact: info@openbraininstitute.org

<https://bbp.epfl.ch/bbp/research/domains/bluebrain/index.html>

<https://www.epfl.ch/en/>

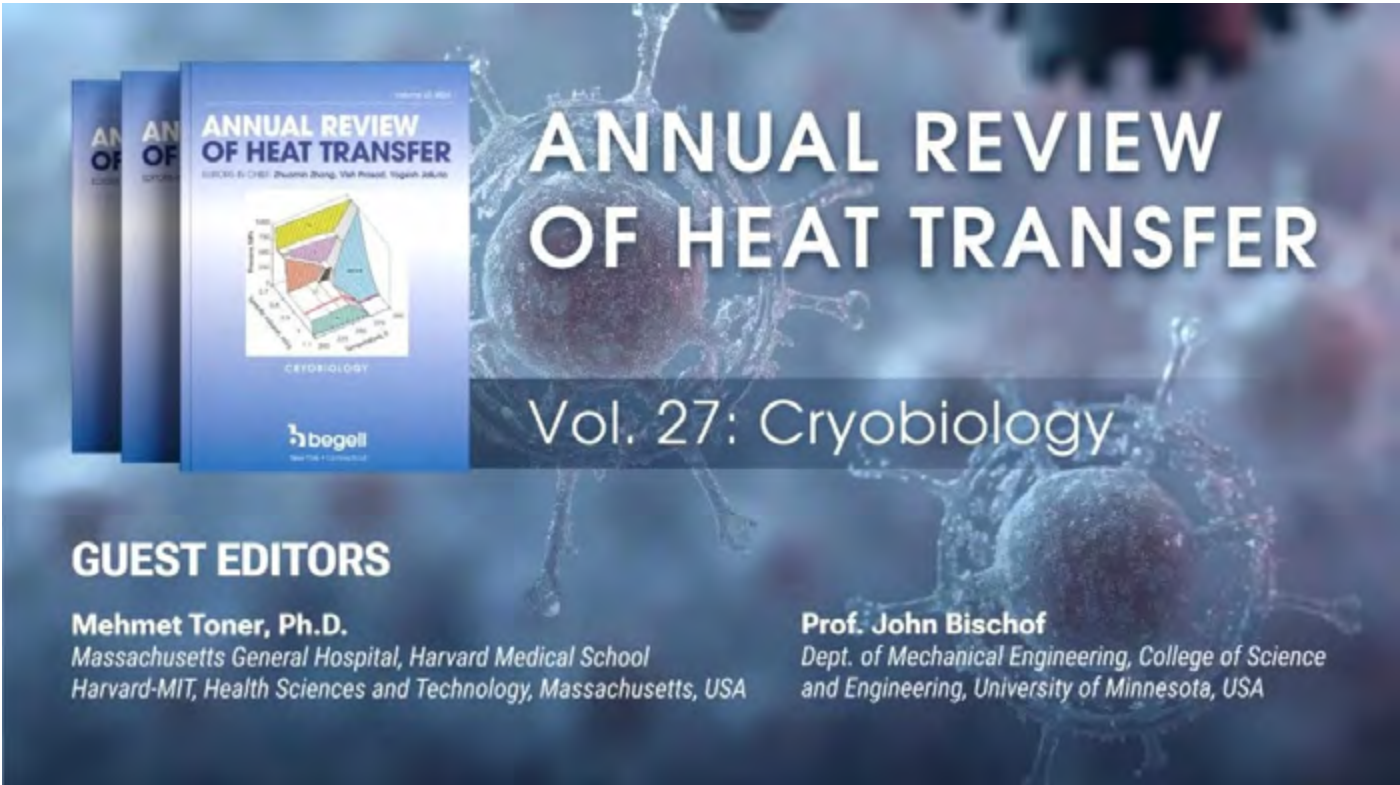




from ATP-BIO.ORG

New-advances-in-organ-preservation-every-biomedical-engineer-should-know

March 28, 2025



ANNUAL REVIEW OF HEAT TRANSFER
Vol. 27: Cryobiology

GUEST EDITORS

Mehmet Toner, Ph.D.
*Massachusetts General Hospital, Harvard Medical School
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Prof. John Bischof
Dept. of Mechanical Engineering, College of Science and Engineering, University of Minnesota, USA

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Innovative instrumentation – including ultrafast cooling systems and cryogenic freezing technologies.

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About Annual Review of Heat Transfer

Annual Review of Heat Transfer (ARHT) has been a cornerstone of heat transfer research since its founding in 1987 by the esteemed Professor Chang-Lin Tien. Each volume is curated by a distinguished guest editor and focuses on a specific aspect of heat transfer, featuring invited contributions from leading experts at top global engineering institutions.

With an extensive archive dating back nearly four decades, ARHT continues to be an invaluable resource for those seeking to stay at the forefront of heat transfer research and innovation. [[Browse Archives](#)]

Summary Table of Contents

Summary page can be found [here](#).

PREFACE: MACHINE LEARNING AND ADDITIVE MANUFACTURING

Zhuomin M. Zhang

pages v-viii

DOI: 10.1615/AnnualRevHeatTransfer.2025062129

CHAPTER 1

MACHINE LEARNING ENHANCEMENT OF HEAT TRANSFER RESEARCH AND TECHNOLOGY DEVELOPMENT

Van P. Carey

pages 1-89

DOI: 10.1615/AnnualRevHeatTransfer.2025059986

ABSTRACT

This review has two main threads of discussion. The first describes key underlying foundational concepts of the machine learning (ML) tools considered. This is included for two reasons. First, these concepts often dictate how the data science strategy interacts with the physics of the system, which is key to creating robust, high-fidelity physics-inspired models, and key to adapting ML tools to different systems and objectives. In addition, the discussion of the fundamental data science principles behind ML tools is included to make this review useful to a graduate student in engineering with little prior experience who is interested in using ML in their heat transfer research. The second main discussion thread summarizes recent research (as of 2025) exploring the use of ML tools in heat transfer and energy conversion research and development. This discussion focuses on studies involving physics-inspired ML tools that have been most widely used in heat transfer-related applications: artificial neural networks, genetic algorithms, convolution neural networks, and physics-inspired neural networks. Research on methods that modify conventional ML tools in innovative ways are also examined. Some of these studies have explored the use of one or more ML tools for a specific application, whereas others have explored how to improve the ML strategy by fundamentally altering it or combining it with one or more other ML tools. Bigger picture evolutionary trends in the use of ML and supporting hardware and software are also discussed.

CHAPTER 2

MACHINE LEARNING FOR DATA ASSIMILATION/ INVERSE MODELING IN THERMAL PROBLEMS

Yadu Krishnan Sukumarapillai, Michelle Baxter, Perumal Nithiarasu

pages 91-132

DOI: 10.1615/AnnualRevHeatTransfer.2025060593

ABSTRACT

This study aims to systematically examine various methods leveraging machine learning (ML) to assimilate data for investigating thermal systems. These measured or observed data may include temperature or thermal material properties and could be synthetically (computationally) generated or experimentally obtained. The goal of these ML-augmented methods is to derive the unknown material properties and/or reconstruct the full temperature field by integrating such measured data into physics-based computational models, such as finite-element (FE) models. The present work continues the previously conducted review of ML in heat transfer with a strong focus on inverse modeling techniques. It also attempts to integrate ML closely into the FE workflow. Data assimilation and inverse modeling are closely linked tasks. While inverse modeling typically focuses on recovering unknown parameters or inputs from given observational data, data assimilation incorporates observations into dynamic models in a sequential manner, often with the goal of improving forecasting performance. In this review, we use the terms interchangeably for simplicity, though they arise from distinct methodological traditions.

CHAPTER 3

MACHINE LEARNING FOR THERMAL PROPERTIES OF INORGANIC CRYSTALS

Ogheneyoma Aghoghovbia, Joshua Ojih, Ming Hu

pages 133-172

DOI: 10.1615/AnnualRevHeatTransfer.2025059587

ABSTRACT

This article reviews artificial intelligence (AI) and machine learning (ML) approaches for predicting transport behaviors of thermal energy carriers, mainly lattice vibrations (phonons), in inorganic crystals. Traditional first principles approaches, namely density

functional theory (DFT) combined with the Boltzmann transport equation (BTE) (DFT+BTE), provide accurate predictions but are computationally expensive and not feasible for handling large-scale screening of unknown materials. State-of-the-art AI/ML methodologies provide computationally efficient solutions by learning intricate structure-property relations, allowing for fast calculations of phonon-related thermal properties at minimal computational expense. We classify AI/ML methodologies into two groups: direct method, which directly predicts properties like lattice thermal conductivity from structural descriptors or graphs, and indirect method, which substitutes computationally demanding force evaluations in DFT calculations with ML-predicted forces or interatomic force constants, thus retaining physical interpretability. The recent developments in graph neural networks, machine learning interatomic potentials, and data-driven feature engineering are discussed, highlighting their scalability, accuracy, and applicability to a wide chemical space. The article also outlines current challenges, including dataset quality, transferability, and integration with high-throughput computational frameworks, and identifies future directions for AI/ML accelerated thermal materials discovery.

CHAPTER 4

MACHINE LEARNING IN NANOSCALE THERMAL TRANSPORT

Yuhan Liu, Sobin Alosious, Jiahang Zhou, Meng Jiang, Tengfei Luo

pages 173-214

DOI: 10.1615/AnnualRevHeatTransfer.2025060156

ABSTRACT

Thermal transport is a fundamental process underpinning a wide range of applications. Traditional experimental and computational methods have substantially advanced our understanding of nanoscale thermal transport. However, they continue to face challenges, such as the cost and speed associated with the experimental and computational methods, limiting their effectiveness for investigating complex nanoscale systems. Machine learning (ML) has emerged as a powerful approach in this domain, offering unique capabilities for processing extensive datasets, identifying intricate patterns, and designing novel materials. In this article, we provide an overview

of recent advancements and applications of ML in nanoscale thermal transport, emphasizing polymeric systems along with interfaces and inorganic materials. Specifically, we review recent progress in property prediction, material design, atomistic simulations, and data analysis. We also highlight promising ML methods, including transfer learning, active learning, and physics-informed neural networks, which effectively address data scarcity and improve model accuracy. Finally, we present our perspective on emerging trends and future research directions, emphasizing their potential to guide the discovery and design of next-generation thermal materials and to unravel complex thermal phenomena.

CHAPTER 5 APPLICATION OF MACHINE LEARNING IN RADIATIVE HEAT TRANSFER

Wei Chen, Tao Ren

pages 215-276

DOI: 10.1615/AnnualRevHeatTransfer.2025059506

ABSTRACT

The integration of machine learning (ML) into radiative heat transfer has transformed traditional methods, offering new perspectives and capabilities in addressing complex radiative transfer phenomena. This review provides a comprehensive overview of recent advancements in ML applications within the field of radiative heat transfer (RHT). The present study explores the development and implementation of ML models to enhance the accuracy and efficiency of radiative transfer simulations, spectral property predictions, and inverse problems solving. In this chapter, we discuss various ML techniques, including data-driven and physics-informed approaches, highlighting their roles in overcoming challenges such as high-dimensional data, nonlinearity, and computational cost. Case studies demonstrating successful ML applications in RHT, including combustion systems and atmospheric science, are presented. This chapter concludes by identifying current limitations, potential future research directions, and the transformative impact of ML on the field of RHT.

CHAPTER 7 COMPUTATIONAL, DATA-DRIVEN, AND PHYSICS- INFORMED MACHINE LEARNING APPROACHES

FOR MICROSTRUCTURE MODELING IN METAL ADDITIVE MANUFACTURING

D. Patel, R. Sharma, Y. B. Guo

pages 339-378

DOI: 10.1615/AnnualRevHeatTransfer.2025059621

ABSTRACT

Metal additive manufacturing (AM) enables unprecedented design freedom and the production of customized, complex components. However, the rapid melting and solidification dynamics inherent to metal AM processes generate heterogeneous, nonequilibrium microstructures that significantly impact mechanical properties and subsequent functionality. Predicting microstructure and its evolution across spatial and temporal scales remains a central challenge for process optimization and defect mitigation. Although conventional experimental techniques and physics-based simulations provide a physical foundation and valuable insights, they face critical limitations such as high computational cost, limited scalability, and difficulty bridging across scales. In contrast, data-driven machine learning (ML) offers an alternative prediction approach and powerful pattern recognition but often operates as a “black box,” lacking generalizability and physical consistency, particularly in data-scarce scenarios. To overcome these limitations, physics-informed ML (PIML), including physics-informed neural networks (PINNs), has emerged as a promising paradigm by embedding governing physical laws into NN architectures, thereby enhancing accuracy, transparency, data efficiency, and extrapolation capabilities. This work presents a comprehensive evaluation of modeling strategies for microstructure prediction in metal AM. The strengths and limitations of experimental, computational, and data-driven methods are analyzed in depth and highlight recent advances in hybrid PIML frameworks that integrate physical knowledge with ML. Key challenges, such as data scarcity, multi-scale coupling, and uncertainty quantification, are discussed alongside future directions. Ultimately, this assessment underscores the importance of PIML-based hybrid approaches in enabling predictive, scalable, and physically consistent microstructure modeling for site-specific, microstructure-aware process control and the reliable production of high-performance AM components.

CHAPTER 8

PROGRESS IN HIGH-PERFORMANCE HEAT-TRANSFER TECHNOLOGY ENABLED BY ADDITIVE MANUFACTURING

Karen A. Thole, Alexander S. Rattner

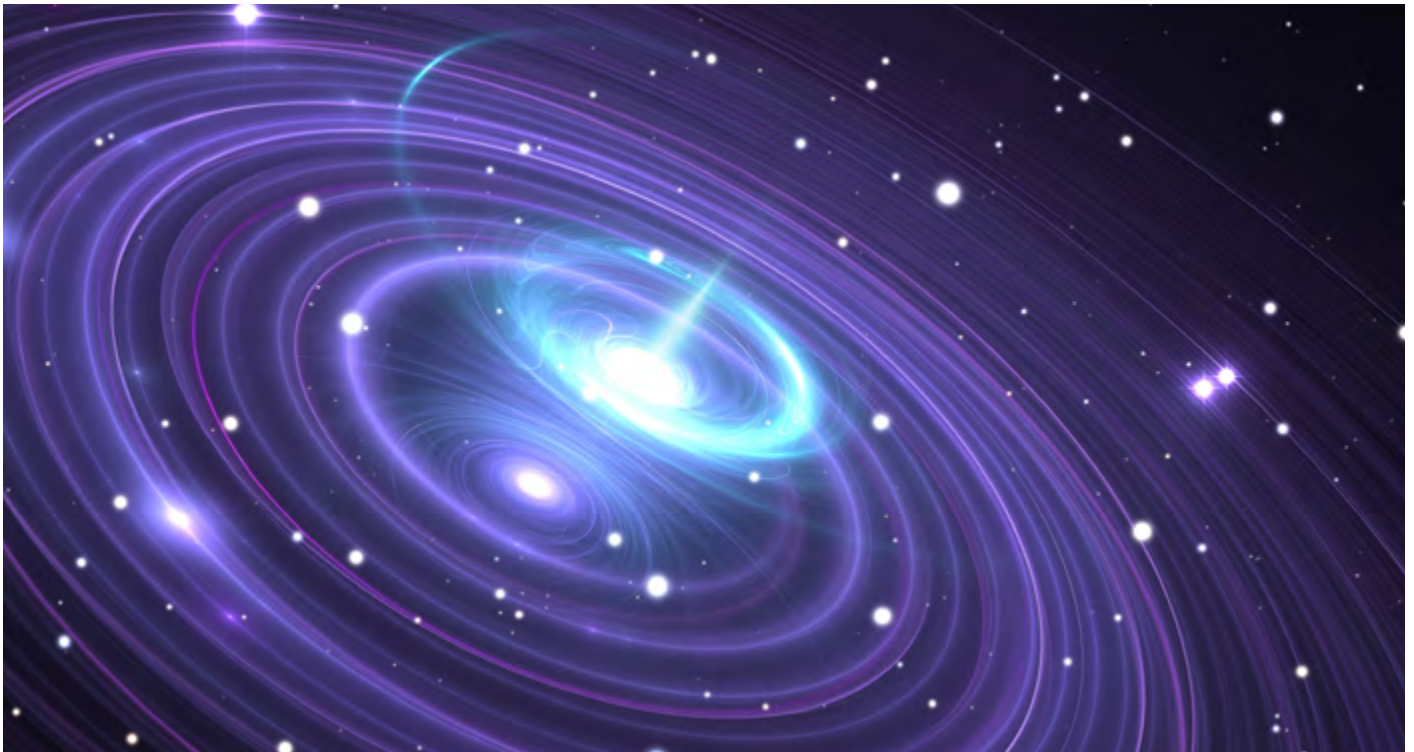
pages 379-414

DOI: 10.1615/AnnualRevHeatTransfer.2025060710

ABSTRACT

Advancements in metal additive manufacturing (AM) are yielding design concepts in diverse fields that reduce discrete part counts, consolidate processing steps, and raise technical performance. AM is enabling novel high-performance convective heat-transfer geometries with applications in turbomachinery, electronics thermal management, building energy systems, power generation cycles, and actively cooled manufacturing tooling. This review traces progress of metal AM heat transfer technology over the past decade. At the feature-scale, findings are summarized for heat-transfer enhancement geometries enabled by AM including complex internal passages, surface modifications, pin fins, and lattice structures. Emphasis is placed on practical manufacturing considerations, such as the impacts of wall thickness and orientation. Performance trends for the AM-enabled geometries are compiled and compared with metrics that

capture competing augmentations for heat-transfer enhancement and frictional loss, providing a mapping for different design applications. At the device-scale, this review presents progress toward practical-scale (~1–100 kW) fluid-to-fluid heat exchangers (HXs) and potential commercialization. Different design approaches are surveyed, including reproduction of conventional HX geometries, application of AM-enabled lattice structures, and topology/shape optimization. While AM convective heat-transfer technology offers technical benefits and enables rapid customization, there are significant barriers to broader adoption. Key challenges are reviewed including support-structure requirements, minimum feature size limitations, difficulty in removing unsintered powder, limitation to single material construction, maximum build-volume limits, and the lack of standards for AM design software interoperability. Additionally, there are open questions including whether AM can become repeatable or “turnkey,” whether the complex mechanics of metal AM can be captured at the design stage, and the ultimate economics of AM for heat-transfer applications. The extent to which these challenges can be addressed and outcomes for these questions will determine the prospects for AM heat-transfer technology and translation from specialty applications to mainstream commercialization.



10 Worst Mistakes in Cryonics

Don't ruin your chance for a successful suspension

1) Not signing up ahead of time

Becoming a member, having contracts in place, and having paperwork in order should not be a last minute decision. Waiting until the last minute or after death results in an unnecessary delay of care or worse- No suspension at all! Don't wait. Sign up here and be prepared.

<https://www.cryonics.org/membership/>

2) Not providing proof of funding

Some people believe that they can worry about funding later or if they have funding, they have put off providing proof of funding to CI. This should be done annually. Failing to provide this can result in a delay of care while the funding clears, which can take weeks. Send your proof of funding to CI now to be prepared.

3) Not telling anyone your plans

Being reclusive or not telling family or friends your wishes is not recommended. You should not be afraid to tell those around you what your wishes are, especially your next of kin. Wearing a bracelet, necklace or having identification or other items in view can speak to your wishes. This is all you have when you can't speak for yourself. Disasters have resulted in the past from not sharing. Talk with your family, close friends and your estate attorney, so you can be prepared.

4) Not planning

Many think cryonics is a turnkey service where you can just sign up and let fate take over. No matter how much you pay for cryonics, you are the only one who can make sure that you will have the best chance by planning. CI has provided a lot of information on our website and in our standby manuals. Those who plan succeed those who don't fail.

For more information visit: <https://cryonics.org/category/members/standby/>

5) Not notifying CI of Emergencies

There is no way that your cryonics provider can help you if they do not know of your emergency. Your family, friends, standby group or next of kin must immediately contact CI when you are having health issues or worse. It is also important for CI to know if you have up and coming surgeries or procedures, including terminal illness. Patients with a diagnosed terminal illness could enter hospice care, which might help your cryonics situation vastly. Any delay in notifying us directly could result in a poor suspension. Those helping you must have simple and clear instructions.

6) Committing suicide

Anyone who commits suicide who is not terminally ill or breaks a local law in doing so is potentially putting both themselves and our organization at great risk. CI will not risk itself for people who engage in behavior that goes against our mission to preserve life. Such activity will likely lead to an autopsy and long delays, rendering the suspension process substandard or impossible to carry out.

Do not consider cryonics as a way out of your problems. You are likely to not get suspended under those circumstances. If you do not have a terminal illness and are considering suicide, you should seek mental health advice and treatment as soon as possible. <https://www.mentalhelp.net/articles/depression-hotline/>

7) Engaging in Risky or illegal activities

Risky behaviors or associations that lead to the patient dying around suspicious circumstances will also likely lead to mandated autopsies that will also stand in the way of your cryonics wishes. It is best to use common sense and not put yourself in harm's way. Not only could your life be ended, so too could your chances of cryonics suspension or future reanimation. Use common sense and stay safe.

10 Worst Mistakes in Cryonics

8) Providing financial or legal incentives that encourage your **not** being suspended.

Leaving all of your insurance or cryonics money to family if you are not suspended is certainly an option at CI, but ironically it does provide financial incentive for hostile family members to block your suspension. As often is the case, people will make sure you are not suspended to get a hold of your money.

One suggestion is to leave family and next of kin some separate money from cryonics funding while suggesting that Cryonics funding go to cryonics as a donation no matter if you are buried or suspended. In addition, family or next of kin can be further compelled to cooperate if they will actually lose the money that is allocated to them for not cooperating. It is also suggested that your family be made fully aware of your wishes and stipulations, so they know what the results of their actions will be. You want to make sure you put incentives and disincentives in the correct place, so that your wishes are honored. It is suggested that your will and cryonics documentation reflect this and get reviewed by an attorney. See <https://cryonics.org/members/protect-yourself-from-legal-threats/>

9) Not removing a hostile next of kin from rights to your remains and finances

In many states and areas you can legally remove a hostile family member or next of kin from your estate. You can reassign someone who is sympathetic to cryonics and who has the legal authority to disposition of your remains, as well as your assets. In some states and locations there are disposition of remains reassignment documents, as well as powers of attorney, both in regards to financial as well as medical decisions. The executor of your will or anyone involved with making decisions should

be sympathetic to your cryonics wishes. It is your responsibility to make your wishes very clear and to remove any doubt or potential legal resistance from family or next of kin.

We suggest seeking legal advice to help you in this regard. Some members have even made a video statement of their wishes and given it to both their cryonics organization as well as their attorneys. Not being careful could mean that you don't get suspended, despite your wishes. Many are surprised to learn that they lose their rights upon legal death. See an attorney and prepare.

10) Dying under less than favorable conditions

This seems harder to control than the other situations, but there are some things you can do to make your situation more favorable. You can diet, exercise and follow the latest official medical advice to stay healthy longer. The longer you are alive, the better the technology will probably be for suspending you and the closer we will be to a future that may be able to reverse your condition.

You can also avoid travel to remote or hostile places where such travel is risky. Some overseas travel can result in long delays both logistically and bureaucratically. In general, dying near your cryonics provider or cryonics standby group helps your chances. Living a healthy lifestyle and staying sociable, while surrounding yourself with people who will act on your behalf is paramount. Building solid, positive relationships with good people is probably one of the most important things you can do to have your wishes honored. Take care of yourself and maintain social connectivity.

