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# THE INNOVATIVE WAY

Australian Friends of the Hebrew University of Jerusalem Newsletter

Issue 70 Summer 2019-2020

May the miracle of Chanukah  
continue to illuminate our lives

Chag Sameach



The Australian Friends of  
the Hebrew University

Please join us next June in Jerusalem for  
The Hebrew University 83rd  
Board of Governors Meeting and Celebrations

The annual Board of Governors Meeting showpieces the  
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Dates: Friday 12 June - Wednesday 17 June 2020

Booking: Please contact our office 02 9389 2825 or visit our  
website [www.austfhu.org.au](http://www.austfhu.org.au) for further details.

Prior to the Board of Governors, a special program for active  
innovators and entrepreneurs called NEXUS will take place  
from Wednesday 10 June - Saturday 13 June 2020.

This program is by invitation only but if you are  
interested and meet the criteria, please contact our CEO,  
Rob Schneider [ceo@austfhu.org.au](mailto:ceo@austfhu.org.au)  
to discuss possible participation.

## Israeli Chatbot Could Diagnose Early Alzheimer's Disease

By Brian Blum: ISRAEL21c

*Clara, still in testing stages, works on a new  
understanding that Alzheimer's affects the brain's  
orientation system before affecting memory.*

Hundreds of drugs have been developed to address  
Alzheimer's disease, says Dr. Shahar Arzy, Director  
of the Computational Neuropsychiatry Lab at Hadassah  
Hebrew University Medical Centre in Jerusalem. "Do you  
know how many have been found effective? Zero."

But if patients could be diagnosed in the preclinical  
stages of the disease, perhaps some of the new biological  
medications showing excellent results in other domains  
of neurology could be effective when applied early  
enough in the course of Alzheimer's disease.

Arzy and his colleagues have developed a computer-  
based system to ferret out early signs of Alzheimer's.

The system, dubbed Clara ("a hint towards 'clarity of  
mind,'" Arzy says), is an artificial intelligence-based  
chatbot that asks patients questions about themselves  
and their relationships to people, places and events.

Clara then uses machine learning to compare that  
information to a baseline in order to generate a

computer-based test tailored for the specific individual  
that can diagnose very early Alzheimer's.

Arzy's team published research results in the Proceedings  
of the National Academy of Sciences and in the American  
Psychological Association's journal *Neuropsychology*  
showing the method to be 95 percent accurate.

Arzy's work on Clara is based on a relatively recent  
understanding of how the brain works and what  
Alzheimer's does to it.

Alzheimer's affects the brain's "orientation system" that  
dictates how a person relates to the world outside. "It's



A man in Brazil tests the Israeli Clara chatbot for early Alzheimer  
diagnosis. (Photo: courtesy)

The Hebrew University - a tradition of innovation

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Dr. Shahar Arzy speaking about early diagnosis of Alzheimer's disease. (Photo: courtesy)

easy to test memory," Arzy says. "I can give you three words and ask you to retrieve them." That's very different than processing specific relationships.

For example, a patient might remember both the assassination of US President John F. Kennedy and the election of Barack Obama but be confused about which came first. Or a patient might recognize his or her spouse and doctor, but not be able to distinguish which person is standing closer.

Orientation can be measured in a functional MRI. Your brain will light up differently if you see a picture of your own daughter vs. someone else's child or a generic image of a baby.

"The overlap between how the self is oriented to the world and the brain mechanisms that are disturbed by Alzheimer's disease is astonishing," Arzy says.

In the preclinical stages of Alzheimer's, the orientation system begins to deteriorate, "but people can still compensate for this by tapping into other resources like memory," Arzy says. "They can write down a note, for example. Maybe their performance is a little off, but they come up with the same output."

It's only when both systems – orientation and memory – go under a certain threshold that the disease becomes apparent. That's when people seek help. But it's already too late to present an effective treatment.

The key to Clara is that the questions it asks are taken from a patient's personal orientation system and are not just generic questions that could draw on the brain's memory system.

### A blessing in disguise

Arzy's original idea was to skip the chatbot and get information about a patient from *Facebook* and social media. "That's what we did at the beginning," he tells ISRAEL21c. "We spent two years writing the code."

Then, just when they were done, the Cambridge Analytica scandal broke.

Cambridge Analytica was the consulting firm that mined openly available user data on *Facebook* in order to influence voting in the 2016 US elections. *Facebook* responded by disabling the functionality that allowed third parties to access user data. That threw Arzy and his team back to square one.

It was a blessing in disguise. Arzy says that "the information we were getting from *Facebook* was not perfect" and that using artificial intelligence, as Clara does now, "is a better solution."

Arzy envisions Clara to be available free as a public service, through doctors' offices and through download onto mobile devices or computers. The pilot Android and web versions support English, Hebrew, Chinese and Portuguese so far. French, Russian, Arabic and Japanese options are already under development.

Clara is not ready to make its public debut, Arzy says. "We are at the stage of proving the efficacy of the AI agent and the two-system [orientation vs. memory] theory."

Clara is now in the second year of a five-year test at Harvard to compare data generated by the system with data from Alzheimer's markers taken via amyloid PET scan, quantitative and functional MRI and other neuropsychological tests. Assuta Medical Centre in Tel Aviv has been running its own study on Clara using combined PET-fMRI over the past year.

Developing Clara has been a team effort on the part of the neuropsychiatry lab. Michael Peer headed the original study; Gregory Peters-Founshtein managed the neuroimaging of patients; and Amnon Dafni led the development of Clara with the help of Yochai Levi. Michael Yavorovsky from the Israeli software consulting firm Brainway built the AI agent. The Israel Science Foundation and the Alzheimer's Foundation of America supported the project financially.

### They all raised their hands

Israeli cybersecurity company Guardicore helped ensure the security of information in Clara. "When we approached Guardicore, we insisted on one condition: that only volunteers would work on it," Arzy recalls. "I came to the company and gave a lecture. One hundred people attended. At the end, I asked who wants to volunteer. All 100 raised their hands."

That sense of mission permeates the Clara story. Arzy once visited Brazil to demonstrate the system. While there, he met a volunteer who offered to translate the Clara chatbot into Portuguese.

The volunteer told Arzy: "I can't bring all of the patients to the best doctors, but I can buy tablets and bring them to the villages and train people to operate them."

For those living in Israel, Hadassah is now establishing a centre for preclinical Alzheimer's disease where a comprehensive exam and treatment will be available, Arzy says.

# Israeli artificial pancreas may one day cure diabetes

By Brian Blum: ISRAEL21c

Ahead of International Diabetes Day, November 14, Israeli startup *Betalin Therapeutics* (Betalin) announced that it is beginning the application process for clinical trials of its revolutionary artificial pancreas.

**B**etalin's Engineered Micro Pancreas (EMP) aims to free patients suffering from the most severe types of diabetes from constantly monitoring blood-sugar levels and injecting insulin. About 160 million people are insulin dependent.

The road to an Israeli-made artificial pancreas has been a decade in the making.

When ISRAEL21c first reported on Betalin in 2015, the company had just been founded, based on research in the laboratory of Prof. Eduardo Mitrani at the Hebrew University of Jerusalem. (Mitrani is continuing his academic work while serving on Betalin's scientific advisory board.)

In Type 1 diabetes, insulin-producing cells (known as "beta cells" – hence the name Betalin) in the pancreas don't function properly.

Doctors have tried implanting patients with islets of beta cells extracted from the pancreas of a donor. Unfortunately, the implanted cells don't survive long even with immunosuppressive drugs. Half of all transplanted patients are back on insulin injections one year later and 90% revert to insulin dependency within five years.

The relapse rate is so high because beta cells aren't naturally designed to survive on their own in the body.

"They need to be surrounded by some sort of supporting tissue – a scaffold, we call it," Betalin CEO Nikolai Kunicher tells ISRAEL21c. "The scaffold mimics the natural environment the cells are used to inside the body. It helps them function better and live longer."

The EMP is Betalin's scaffold. With a diameter of 7 millimetres and a thickness of 300 microns, the EMP is composed of lung tissue from a pig and insulin-secreting beta cells, either from a donor or created in a lab.



Israel's Betalin Therapeutics is developing an artificial pancreas that would free diabetics from having to inject insulin. (Photo: courtesy)

## Replacing the pancreas

The EMP does not jump-start a malfunctioning pancreas; it actually replaces it. The artificial pancreas "senses the body's glucose level and the beta cells secrete the optimal amount of insulin," says Kunicher, who has a PhD in microbiology.

The EMP is implanted under the skin – usually in the leg – using only local anesthesia and quickly attaches to the vascular system. The process should take less than an hour.

Betalin is expecting a price of \$50,000 per implant, although insurance should cover most of that. "The cost of complications around diabetes and the cost of insulin is so high, government and insurance companies will jump on it," Kunicher predicts.

How high? The global Type 1 diabetes market is expected to be worth \$25.52 billion by 2024. The World Health Organization estimates that nearly half a billion people worldwide suffer from Type 1 or Type 2 diabetes – some 8.8% of the adult population. Diabetes doubles the risk of early death.

## Creating beta cells

For Betalin Therapeutics, the hard part is acquiring enough beta cells to fill an EMP. The only way to get human beta cells today is from a cadaver. Up to three donors are needed for each patient to supply the 400,000 to 500,000 islets required per infusion.

That's led to a red-hot medical technology niche for companies creating beta cells in a lab.

In September, for example, Vertex Pharmaceuticals paid \$950 million to acquire Boston-based Semma Therapeutics, which derives beta cell islets from human stem cells.

Betalin can use beta cells from third parties like Semma, Kunicher says, but the company is also working on making its own. Betalin was recently awarded a binational collaboration grant by the Israel Innovation Authority and the Italian government to work with beta cell expert and transplant researcher Prof. Lorenzo Piemonti.

## Years of clinical trials ahead

Diabetes patients will have to wait a few years before the technology is fully tested. So far, Betalin has conducted only animal trials.

In preclinical studies in a mouse model of diabetes, published in the Medical Journal *PLOS ONE*, approximately 70% of the mice in which the EMP was implanted did not need further insulin injections, even for the longest period tested (90 days after implantation).

Kunicher says it will take another year – and an additional \$5 million, which the company is in the process of raising – to complete all the regulatory work required to begin testing in humans.

Betalin has set up international testing collaborations with clinics in Germany, England, the United States, Italy and China.

If all goes well, it would then be another five years before the EMP reaches the market.

Betalin's labs are located in the Jerusalem Bio Park on the campus of Hadassah-Hebrew University Medical Center. The staff of eight includes founder Joshua "Shuki" Hershovich, a serial entrepreneur who previously founded Sonovia (formerly Nanotextile).

Two past winners of the Nobel Prize in chemistry sit on the company's board of directors: Israel-born University of Southern California Prof. Arieh Warshel (2013) and Yale University Prof. Sidney Altman (1989). Altman has diabetes and his brother died from complications of the disease.

Speaking of prizes, Betalin won the top spot in the pharmaceutical category at the 2017 MIXiii Biomed Conference, Israel's largest life-science industry event.

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## Cannabis Company *Medivie* Files Patent for Toothpaste Stand-In Cannabis Gum

by Tzally Greenberg CTECH Calcalist

**According to *Medivie*, tests held so far showed that the gum cleans around 98% of mouth bacteria, removes plaque, and whitens teeth.**

This is a mouthful: Tel Aviv-listed cannabis company Medivie Therapeutic Ltd. (Medivie) is developing a toothpaste stand-in cannabis gum. A subsidiary of the company, *Mustix Ltd.*, has filed a patent request for a gum-like dental product with cannabis as one of its ingredients, Medivie announced in a stock exchange filing Sunday. Medivie owns an 85% stake in Mustix.

Mustix is set to start clinical trials soon in collaboration with the Hebrew University of Jerusalem, a partnership announced in August. Mustix committed to funding development in exchange for an exclusive international license, while the university is entitled to royalties. The trials are expected to end in April 2020.

According to Medivie, tests held so far showed that the gum cleans around 98% of mouth bacteria, removes plaque, and whitens teeth, and could even make



Photo: Shutterstock

toothpaste and mouthwash superfluous. The gum will provide the same result as brushing your teeth, or perhaps surpass it, Medivie CEO Menachem Cohen told Calcalist in an interview.



Photo: Getty Images/Stockphoto

## Bees Say 'Buzz Off' to Sleep When Caring for Young

**It's a phenomenon that most new parents can identify with: chronic exhaustion due to lack of sleep. As it turns out, humans are not alone in this: all animals, including insects, need their sleep. Or do they?**

That's the question Professor Guy Bloch and his team at Hebrew University of Jerusalem (HU)'s Department of Ecology, Evolution, & Behaviour are looking to answer in the journal *Current Biology*. They studied brood-tending bumblebee workers and found that those tending the young sleep much less than other bees do, even when caring for offspring that aren't their own.

"Our findings show that sleep is more plastic and less rigid than is commonly accepted," shared Bloch. Insect sleep looks much like sleep in people and other animals. They stop moving, take on a typical sleep posture, and become less responsive to noise or touch. When humans, rodents, or flies are sleep deprived, it compromises their health and performance. But the new study suggests there may be ways around that in some cases.

Bloch and colleagues had earlier shown that bees adjust their activities depending on their role in the colony, with foragers showing a strong circadian rhythm and "nurse" bees tending the brood around the clock. They wondered how activity around the clock affects the way they sleep. To find out, the researchers, spearheaded by postdoctoral fellow Dr. Moshe Nagari, combined video recordings, detailed behavioural analyses, sleep deprivation experiments, and response threshold assessments to characterise the sleep behaviour of bumblebee workers.

Their studies show that bumblebees tending young do indeed sleep much less. That's true even when the brood doesn't need to be fed and when the young are not their own offspring. The evidence suggests that substances produced by the pupae drive the reduction in sleep. Surprisingly, however, when the pupae and their substances were removed, those bees did not show the expected sleep rebound. It suggested that they weren't sleep deprived in the expected way.

"The fact that the nursing bees sleep so little, even when caring for pupae that do not need to be fed was the most surprising," Nagari says. "Before this study, we assumed that the main functions of activity around the clock

without circadian rhythms in nurse bees is to provide improved feeding to the developing larvae, enabling them to grow rapidly.”

The findings add to emerging evidence showing that under certain conditions, animals can give up sleep, the researchers said. For example, they noted that birds sleep less during their seasonal migrations. Some male birds and fruit flies will forgo sleep to give themselves more time to mate. And some cavefish have evolved to sleep less compared with related species of fish that live in open water habitats.

The findings in bees raise questions about whether the sleep loss comes at a cost in terms of health or cognitive performance.

In the past, sleep research focused on the need for sleep and on the damage to small laboratory animals, such as mice and rats, by a lack of sleep. “However, with bees, if there is no cost for sleep loss, it means that the brood-tending bees have a mechanism that allows them to significantly reduce sleep without a cost to their brain or other tissue,” Bloch explained. “This, of course, raises the question about what exactly are these mechanisms and what is the basic function of sleep.”

Professor Bloch says his current research is the first proof that insects change their sleep schedules to care for offspring but adds that now that the precedent has been established he would not be surprised to find similar phenomena with other social insects, such as wasps and ants.

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## Plan to create super-smart designer babies won't work, says Hebrew University study

By Kristen Houser

**In November, a company called Genomic Prediction announced that it had developed a multi-gene screening technique for embryos. This method, the company claimed, allowed it to scan an embryo for conditions or traits impacted by numerous genes, including intelligence, and give it a “polygenic score.”**

The company said this was so parents could avoid using an embryo with an abnormally low score for in-vitro fertilization. However, it quickly raised concerns about parents using the tech to have super-smart designer babies.



But now it seems that fear was premature: A new study presented at the annual meeting of the American Society of Human Genetics debunks the accuracy of the technique.

Today, having fertilized embryos undergo genetic testing prior to implantation is a fairly

common option for people using in-vitro fertilization. This can allow them to avoid using an embryo that likely wouldn't lead to a successful pregnancy, or one that would produce a child with birth defects or certain single-gene disorders, such as cystic fibrosis.

The key to that type of testing is that it focuses on individual genes – in the case of cystic fibrosis, for example, the doctor would look for mutations in the CFTR gene.

To test the viability of Genomic Prediction's multi-gene screening technique, a research team led by Hebrew University of Jerusalem statistical geneticist Shai Carmi created computer models of five hypothetical embryos by combining the DNA profiles of two people. In some cases, the researchers knew the heights of both parents and, in others, their IQs.

They then created “virtual genomes” for the embryos and gave each embryo a polygenic score predicting the height or IQ of the person that would theoretically be born from it.

The researchers found that the technique produced only slight gains – hypothetical children produced by the highest scoring embryos were approximately 2.5 centimetres taller and 2.5 IQ points smarter.

They then put the technique to the test again, this time giving polygenic height scores to all of the offspring in 28 families with an average of 10 children.

In just seven of the families was the child with the highest height score the tallest. And in five families, that child was actually the shortest of the siblings – meaning had their parents used the polygenic screening technique, they may well have ended up with a shorter child than if they'd left height up to chance.

So, while Genomic Prediction's technique could still allow parents to identify embryos likely to produce children with intellectual disabilities, it doesn't appear poised to lead to the creation of super-smart designer babies any time soon.

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## Legend Raphael Mechoulam Leads Israeli Cannabis/Cancer Study

by Tzally Greenberg CTECH Calcalist

**Tel-Aviv listed cannabis producer Cannbit Ltd. is launching a study to test a cannabis-based treatment for three aggressive types of cancer, Cannbit announced in a filing to the exchange Thursday.**

The study will be led by cannabis research pioneer Raphael Mechoulam of the Hebrew University of Jerusalem, who chairs Cannbit's Scientific Advisory Committee.

Hadassah University Hospital-Ein Kerem and Sheba Medical Center will collaborate on the study.

Mechoulam, a professor of medicinal chemistry at the Hebrew University, was the first person to identify the main psychoactive constituent in cannabis, THC. Cannbit has a first look agreement for all his research following



Mechoulam: The Father of Modern Cannabis Medicine

his appointment to the company. Cannbit will invest \$400,000 in the study, plus another \$2 million towards a commercial drug license.

In return, Cannbit will receive exclusive commercial license for the drug for the duration of the patent (25 years), and for any other intellectual property generated during the study. The rest of the partners will receive 13% of the future revenues generated from the drug or from any of the research stages, according to one person familiar with the matter who spoke to Calcalist on condition of anonymity.

The study will involve molecules found effective in fighting melanoma, neuroblastoma, and Glioblastoma. The Hebrew University's technology transfer company Yissum owns the intellectual property for the results of the preliminary study, which will later be transferred to Cannbit for the duration of the patent.

## Tomatoes could be key in tackling male infertility

By Aston Avery Gateway 978

**For the first time in history, male fertility issues are equal to women's. According to the Human Embryology and Fertilisation Authority, the body responsible for governing the IVF industry in the UK, they now account for 50% of all identified issues leading to IVF referrals.**

A further study by the Hebrew University of Jerusalem has also shown that the sperm concentration of men in Western countries has dropped by more than 50% in under 40 years

Last year a study published in Human Reproduction Update found sperm counts had halved in Western countries since 1973. The author, Hagai Levine of the Hebrew University in Jerusalem, warned that declining sperm count is the "canary in the coalmine," alerting us to an impending epidemic of male infertility. In Fertility Network UK's research on male infertility, released in 2017, 93% of men surveyed stated



their wellbeing had been impacted by fertility issues, and they reported fertility issues to be emasculating, distressing and isolating, harming their self-identity, and causing stress.

However, according to new research by the University of Sheffield, sperm quality can be improved with a simple diet supplement containing a compound found in cooked tomatoes.

## Discovery by Hebrew University Scientists Could Revolutionise Chemotherapy

**New technique targets cancer cells and leaves healthy ones alone; Patients would receive less chemo and fewer side effects**

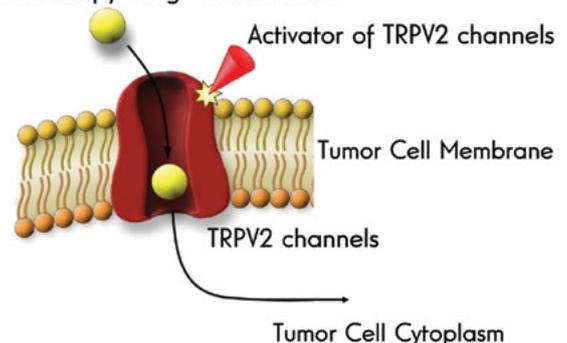
It is a feeling that many who receive a cancer diagnosis can identify with: heartbreak and fear, followed by hopes that chemotherapy will save the day. Unfortunately, for many patients, chemo's painful side effects cause them to stop treatment prematurely.

Now, a research team headed by Professor Alexander Binshtok, head of the Pain Plasticity Research Group at the Hebrew University of Jerusalem's Faculty of Medicine and Edmond & Lily Safra Center for Brain Sciences, has developed a method that delivers chemotherapy drugs directly to malignant cells and bypasses healthy ones. This discovery could allow doctors to reduce chemo doses for patients, thereby reducing the unpleasant side-effects associated with the treatment, and improve treatment compliance and overall prognoses.

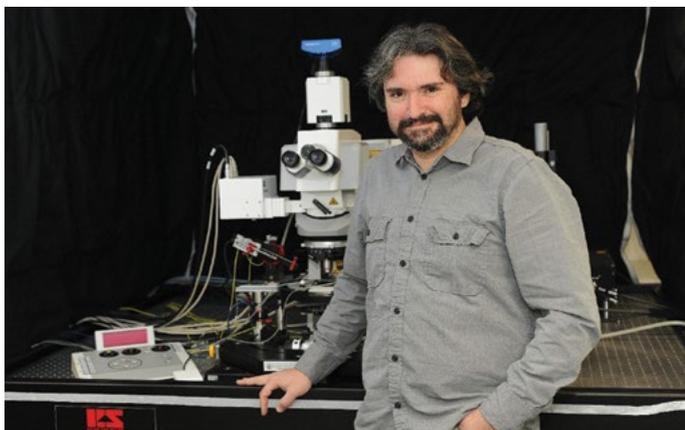
"Most anti-cancer treatments are not sufficiently specific, meaning they attack healthy cells together with the malignant ones they're trying to get rid of," explained Binshtok. "This leads to the many serious side-effects associated with chemo therapy. Eliminating cancerous cells while leaving healthy ones alone is an important step towards reduce patients' suffering."

The new findings were published in a recent issue of *Frontiers in Pharmacology*. The study focuses on the selective expression of the TRPV2 protein by cancer cells. When activated, TRPV2 protein opens a canal inside cell membranes. Binshtok and his team studied liver cancer cells and were able to successfully insert a low dose of doxorubicin, a chemotherapeutic agent, through the

### Chemotherapy Drug - Doxorubicin



TRPV2 protein in action (Photo: Dr. David Roberson & Prof. Alex Binshtok)



Hebrew University's Prof. Alexander Binshtok in his lab. (Photo: Hadas Parush/Flash90)

canal and directly into cancer cells. Not only did the new method target cancer cells without harming healthy ones. In the future, the precision of this delivery method may allow doctors to prescribe lower chemo doses and to relieve patients from some of the harsher effects of chemo.

"It's too early to make concrete predictions but we are hopeful this discovery will lead the way towards a new, more targeted delivery method for chemotherapy treatment, one that will drastically reduce patients' pain," Binshtok concluded.

## Long Lost Human Relative Unveiled

[Hebrew University Researchers Provide First Glimpse at What Ancient Denisovans May Have Looked Like, Using DNA Methylation Data](#)

If you could travel back in time to 100,000 years ago, you'd find yourself living among several different groups of humans, including Modern Humans (those anatomically similar to us), Neanderthals, and Denisovans. We know quite a bit about Neanderthals, thanks to numerous remains found across Europe and Asia. But exactly what our Denisovan relatives might have looked like had been anyone's guess for a simple reason: the entire collection of Denisovan remains includes three teeth, a pinky bone, and a lower jaw.

Now, as reported in the scientific journal *Cell*, a team led by Hebrew University of Jerusalem (HU) researchers Professor Liran Carmel and Dr. David Gokhman (currently a postdoc at Stanford) produced reconstructions of these long-lost relatives based on patterns of methylation (chemical changes) in their ancient DNA.

"We provide the first reconstruction of the skeletal anatomy of Denisovans," says lead author Carmel of HU's Institute of Life Sciences. "In many ways, Denisovans resembled Neanderthals but in some traits they resembled us and in others they were unique."

Denisovan remains were first discovered in 2008 and have fascinated human evolution researchers ever since. They lived in Siberia and Eastern Asia and went extinct approximately 50,000 years ago. While we still don't know why they went extinct, up to 6% of present-day Melanesians and Aboriginal Australians

contain Denisovan DNA. Further, Denisovan DNA likely contributed to modern Tibetans' ability to live in high altitudes and to Inuits' ability to withstand freezing temperatures.

Overall, Carmel and his team identified 56 anatomical features in which Denisovans differ from modern humans and/or Neanderthals, 34 of them in the skull. For example, the Denisovan's skull was probably wider than that of modern humans' or Neanderthals'. They likely also had a longer dental arch and no chin.

The researchers came to these conclusions after three years of intense work studying DNA methylation maps. DNA methylation refers to chemical modifications that affect a gene's activity but not its underlying DNA sequence. The researchers first compared DNA methylation patterns among the three human groups to find regions in the genome that were differentially methylated. Next, they looked for evidence about what those differences might mean for anatomical features—based on what's known about human disorders in which those same genes lose their function.

"In doing so, we got a prediction as to what skeletal parts are affected by differential regulation of each gene and in what direction that skeletal part would change—for example, a longer or shorter femur bone," Dr. Gokhman explained.

To test this groundbreaking method, the researchers applied it to two species whose anatomy is known: the Neanderthal and the chimpanzee. They found that roughly 85% of their trait reconstructions were accurate in predicting which traits diverged and in which direction they diverged. Then, they applied this method to the Denisovan and were able to produce the first reconstructed anatomical profile of the mysterious Denisovan.

As for the accuracy of their Denisovan profile, Carmel shared, "One of the most exciting moments happened a few weeks after we sent our paper to peer-review. Scientists discovered a Denisovan jawbone! We quickly compared this bone to our predictions and found that it matched perfectly. Without even planning on it, we received independent confirmation of our ability to reconstruct whole anatomical profiles using DNA that we extracted from a single fingertip."



3-D printed reconstruction of a female Denisovan. (Photo: Maayan Harel)

In their Cell paper, Carmel and his colleagues predict many Denisovan traits that resemble Neanderthals', such as a sloping forehead, long face, and large pelvis, and others that are unique among humans, for example, a large dental arch and very wide skull.

Do these traits shed light on the Denisovan lifestyle? Could they explain how Denisovans survived the extreme cold of Siberia?

"There is still a long way to go to answer these questions but our study sheds light on how Denisovans adapted to their environment and highlights traits that are unique to modern humans and which separate us from these other, now extinct, human groups," Carmel concluded.

Professors Eran Meshorer from the Hebrew University, Yoel Rak from Tel Aviv University, and Tomas Marques-Bonet from Barcelona's Institute of Evolutionary Biology (UPF-CSIC) contributed to this research.



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