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THE TAV TIMES

TAV COLLEGE
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A REPUTABLE STUDENT NEWS PUBLICATION FOR YOUR INFORMATION AND ENTERTAINMENT

COVER BY SAMMY RICH

JUST AROUND THE CORNERSTONE

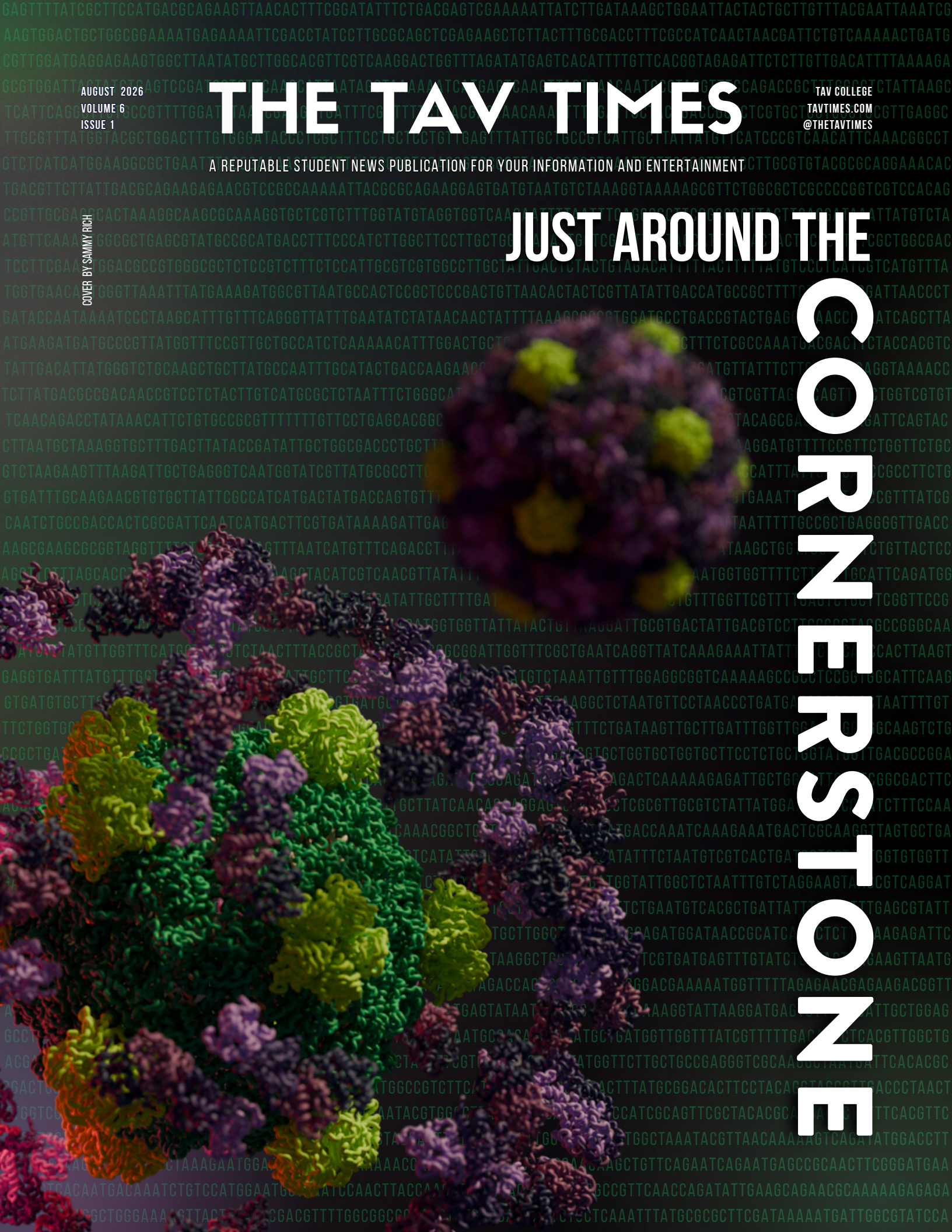


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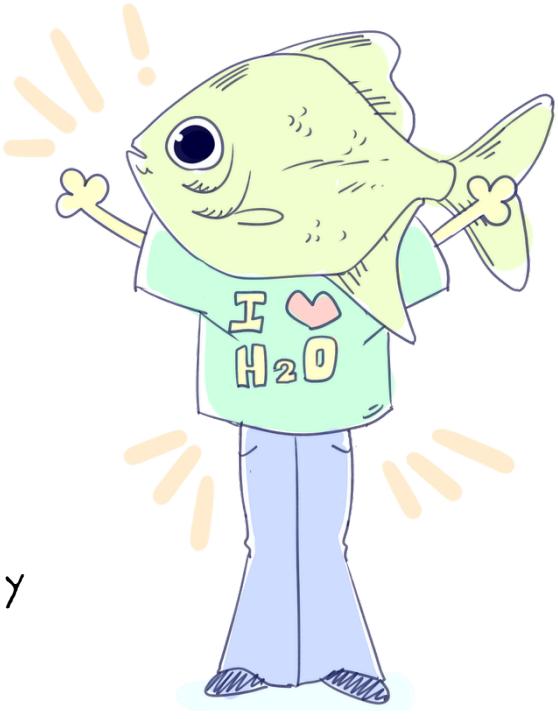
MESSAGE FROM THE EDITOR-IN-CHIEF

Howdy, thank you for picking up a copy of the TAV Times zine.

This zine is an attempt to revive the TAV Times Journalism Club.

I was in health science and am now specializing in cell and molecular biology at Concordia. My first article for the TAV Times was called “Brain Food”; it was no New Yorker feature, but I had a lot of fun making it. It’s cool to throw something you made out there.

No matter your program, writing about your field of interest will always look unique on a CV; academia and employment seem to care less about your grades and more about what else you did during schooling. With the rise of AI, having literary works that can show authentic understanding of complex topics can be a real asset and conversation piece during interviews; having extracurriculars never hurts your chances.



Being a writer shows your comprehension of topics of interest and communication skills, as well as demonstrates media literacy, which has become a paramount quality for schools and employers-

SO JOIN THE TAV TIMES!!!

I rest my case; enjoy the zine!

-Sammy

TAV + COMMUNITY

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TAV STUDENT RESEARCH

TISSUE ENGINEERING | DRUG KINETICS | BIO MATERIALS

ENGINEERING 3D-PRINTED PATCHES TO COMBAT ANTIMICROBIAL RESISTANCE

With excessive antibiotic usage, bacteria are adapting their ability to successfully evade the effects of antibiotics, limiting the tools in the toolkit necessary to treat infection.

The growing global concern about antimicrobial resistance has undermined decades of progress in preventing and treating infectious diseases. Topical infections specifically can lead to significant challenges in clinical settings due to their prevalence, potential for complications, and risk of developing nosocomial, antibiotic-resistant strains. Such infections reside and fester at the site of open wounds, abrasions, or surgical incisions, impeding the natural healing process. This not only causes excessive harm, but also multiplies the usage of resources, including **antibiotic overuse.**

Utilizing 3D printing technology has led to a plethora of innovative techniques in treating topical wounds; Not only are 3D-printed dressings fully customizable to the wound geometry, but they can also be made to hold various antimicrobial substances and be modified for different approaches of treatment, such as cell therapy or microelectronics. At TAV College, science students throughout the years have been working to develop a **3D-printed bandage that could release consistent amounts of antibiotics over days** to minimize bacterial evolution.

THE MAIN GOAL FOR THE PROJECT IS TO UNDERSTAND HOW TO CONTROL THE RELEASE KINETICS OF THESE DRUG-LOADED, 3D-PRINTED SCAFFOLDS.



HOW WE ARE DOING IT

In affiliation with the McGill Laboratory at the Montreal General Hospital, TAV is investigating materials called **LAY-FOMM and LAY-FELT**, which are stretchy, rubber-like filaments infused with a water-soluble component called polyvinyl alcohol, or **PVA**, to be used as the main material for the dressing. For the time being, small, 3D-printed disks have been used to test the material in comparison to commercial antibiotic disks. When these disks are stored in water for 3-4 days, the PVA washes out, leaving behind a **nanoporous material** that is paramount for liquid uptake.

As their names suggest, LAY-FOMM has a structure and texture similar to foam, while LAY-FELT is more analogous to felt. In the literature, both LAY-FOMM and LAY-FELT are excellent candidates for drug uptake and release, though LAY-FELT is less studied. LAY-FOMM is observed to sustainably release medicine used to treat bone loss, as well as chemotherapeutic drugs towards cancer cells. Furthermore, LAY-FOMM is biocompatible, meaning it can come in contact with both wet and dry cells without causing harm or initiating an immune reaction.

Both TAV and McGill are working on this project to bring the final product to fruition, though both focus on different aspects of the project.

TAV is more directed to decoding how the filament behaves on a physical and molecular scale. The task of student researchers is to design and execute experiments to deconstruct the diffusion kinetics between the polymer, the diffusion surface, and the antibiotic.

Under the guidance of their head of research, Nima Nateghi, and supported by the TAV laboratory supervisor, Elie Saade, the students involved get real, hands-on experience in both foundational and translational research.

Three of the first students to work on the project were featured in the scientific article, **"A Nanoporous 3D-Printed Scaffold for Local Antibiotic Delivery",** which established preliminary diffusion observations of both polymers, even though the original goal was to develop 3D-printed bone cement beads.



"HAVING RESEARCH EXPERIENCE UP YOUR SLEEVE PUTS YOU AT A HUGE ADVANTAGE WHEN YOU GET TO UNIVERSITY."
-DAVID I. (STUDENT RESEARCHER, 2024)

WHAT WE HAVE DONE

So far, the TAV laboratory has explored how different printing parameters affect diffusion, experimented with dyes as simulated antibiotics, and established multiple experimental designs and analysis protocols to reverse-engineer the diffusion kinetics of both filaments.

In 2021, the lab looked into the fundamental behaviour of both filaments by loading disks of both materials with antibiotics and placing them on bacteria. This is called a Kirby-Bauer assay, which allows us to have a visual indicator of how an antibiotic diffuses out in the shape of a ring around the disk. Their work confirmed there was **statistically no difference in the diffusion pattern between LAY-FOMM and LAY-FELT**; furthermore, while both materials diffused at the same rate as the commercial disk within the first 24 hours, they showed a slower release later on than expected, indicating it takes longer for the antibiotic to move within the 3D-printed disks than the commercial control disks.

The following years have been dedicated to explaining this phenomenon. Students from 2022 and 2024 focused attention on hydrogel comparison and dye simulations, as well as experimenting with disk surface-to-volume ratios. Within the past year, while no publishable results were collected, TAV students **solidified multiple techniques, experimental plans, and disk parameters** for the next generation of students to build upon.

"I ENJOYED LEARNING HOW TO DESIGN CONTROLLED EXPERIMENTS, ANALYZE DIFFUSION DATA, AND FEEL A PART OF SOMETHING MEANINGFUL."
-ALANA C. (STUDENT RESEARCHER, 2025/26)

WHAT COMES NEXT?

During the summer of 2026, there were multiple issues regarding the printing process. Due to the filament having such unique properties, the printers have a hard time printing the polymer at high precision as they do plastic filaments. This, in turn, caused a lack of disks to use for the different experiments planned. While the printer was being troubleshooted, the direction of the project was shifting towards experimental design involving diffusion on real human cells as well as animal wounds. While not much was set in motion, the groundwork was laid neatly in hopes of the next team of students **doing both kinetic decoupling and live tissue experiments concurrently.**

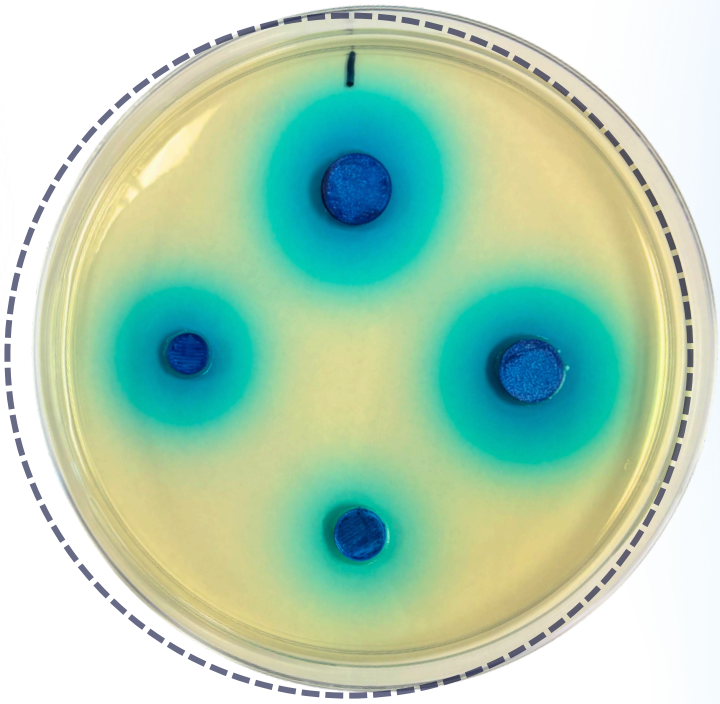


Fig 1. Diffusion plate showing how surface to volume ratio of disks affects diffusion rings

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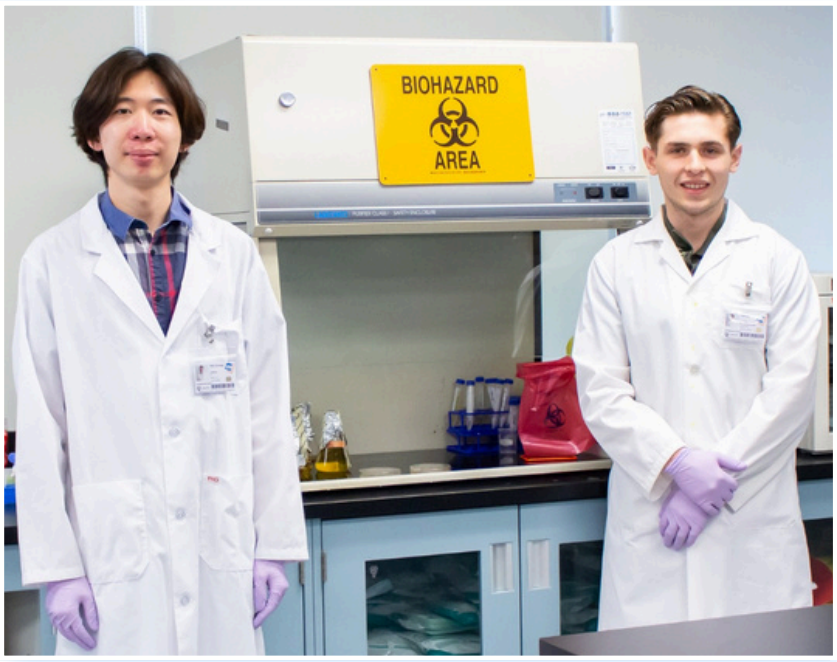
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WANT TO READ MORE? SCAN THE QR CODE TO READ THE PUBLICATION!



IMAGE FROM NASAHUBBLE

ROCKETRY | FLUID SYSTEMS | ENGINEERING

ALUMNI EXCELLENCE

THE ENGINEER BEHIND THE STARSAILOR DESPIN SYSTEM AT CONCORDIA UNIVERSITY

SPACE CONCORDIA

While Concordia University's strengths are notably in the arts and engineering, its true merit lies within its students and alumni; it is due to the monumental efforts and determination of Concordian graduates that **Space Concordia** was founded.

As an alum-led organization, Space Concordia comprises **over 250 undergraduate and graduate students** across five departments of expertise, all united by a shared goal: to **inspire, educate, and innovate** in the pursuit of reaching the stars. Amongst its branches is the Rocketry Division, which housed a TAV alumnus who contributed to the launch of the **"largest student-built rocket in the world: Starsailor".**

-Space Concordia

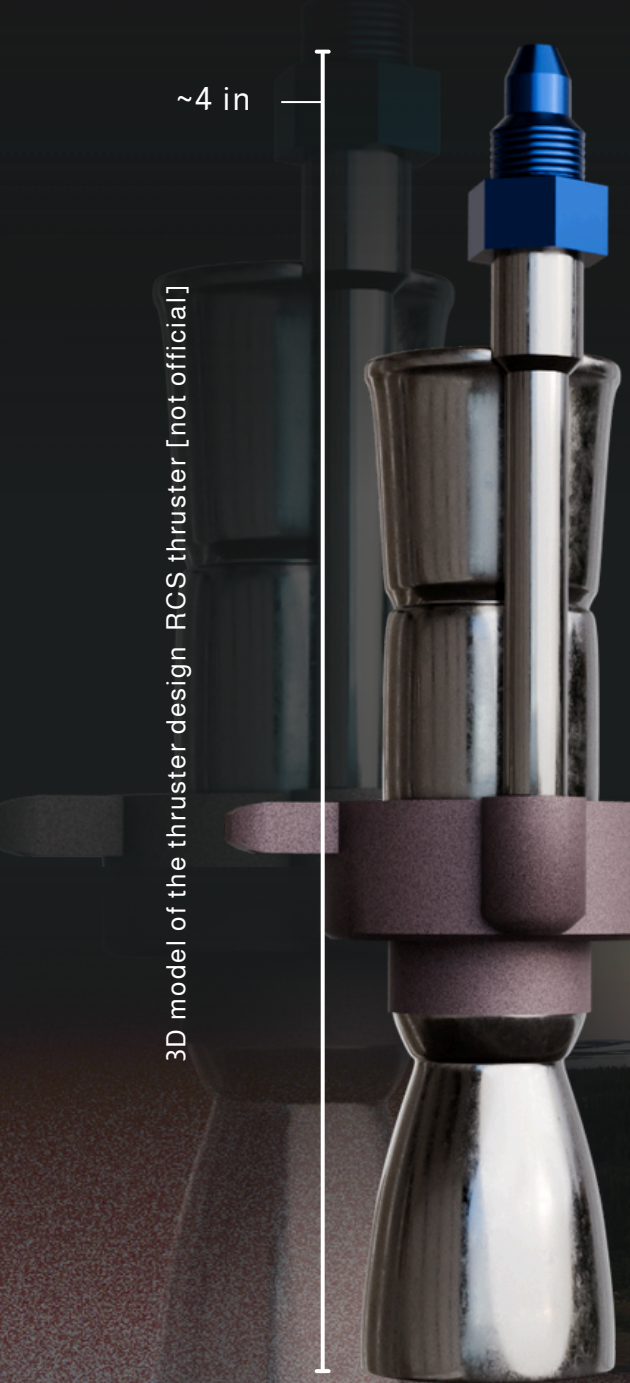
RAFAEL KALMANSON

Rafael first attended TAV College in the Springboard to DEC in 2016, graduating from Pure and Applied Sciences in 2019. He then pursued a Bachelor of Engineering at McGill University before obtaining his master's in mechanical engineering at Concordia University in 2025. He was not only a member of McGill's Rocket Team and Baja Racing Team, but also spent nearly two years at Space Concordia working on one of Concordia's most pivotal projects, Starsailor, where he had the opportunity to fine-tune his talent for **propulsion and thermal engineering and design**.



AD ASTRA STARSAILOR AND RAFAEL'S COLD GAS REACTION CONTROL SYSTEM

The most recent feat of Space Concordia was the launch of **Starsailor**, a single-stage sub-orbital rocket, on August 15, 2025. The rocket measured in at approximately 42 feet and 1750 pounds, which is as tall as a **brachiosaurus**, yet as heavy as a **1967 Volkswagen Beetle.** Its size isn't the only thing that is record-breaking; its engine, the Stewart engine, generates **35,000 newtons of force**, securing it as the most powerful student-engineered engine to date. The rocket's ambition was to break through Earth's atmosphere, enter the realm of space, and descend along a calculated path.



3D model of the thruster design RCS thruster [not official]

A crucial component of successful spacecraft flights is precise control of axial rotation and translational motion, which is modulated by the rocket's **Reaction Control System (RCS).**

Rafael's primary contribution to the project was designing Starsailor's RCS thrusters to control the rocket's trajectory; These thrusters expel short bursts of gas, generating forces to reorient and guide the rocket throughout its course. While most RCSs expel hot gas or use chemical combustion, Rafael utilized cold gas as his system's propellant; it relies solely on the release of highly pressurized gas, eliminating the risk of fuel ignition as well as the need for intensive thermoregulation.

As the thrusters are quite small, being able to fit in the palm of a hand, the rocket was decorated with 8 of them, each **propelling a force of 100 newtons!**



GROUND CONTROL

Later on, Rafael shifted his attention to leading the development of the video-capturing hardware and ground operations. This entailed configuring stable and secure camera housing on the rocket as well as on the ground, ensuring that all cameras were well integrated and protected from harsh disturbances to provide quality recordings of the launch at various angles to be featured on both live broadcasts and on a CBC News report. Furthermore, he aided in the mechanical assembly of Starsailor pre-launch, solidified real-time countdown procedures, and assisted in the final flight analysis and diagnostics of the rocket.

WISE WORDS

Success isn't born from talent or convenience; it is forged through relentless effort and **the courage to ask questions** when you don't have the answers.

High-stakes achievements don't happen because you feel like working on a given day, they happen because you push through years of friction, failure, and iteration without backing down. True accomplishment requires a relentless work ethic, an unyielding willingness to learn, and **the grit to keep grinding** long after the initial excitement wears off until the mission is complete.

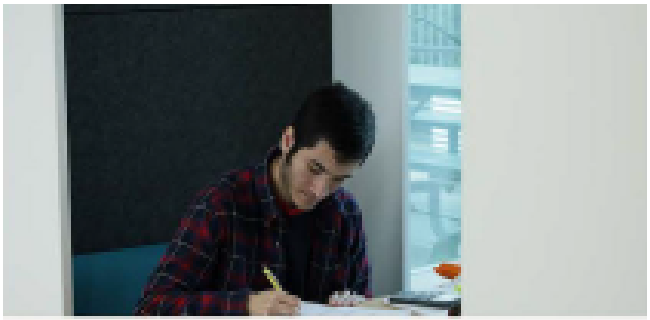
-Rafael Kalmanson

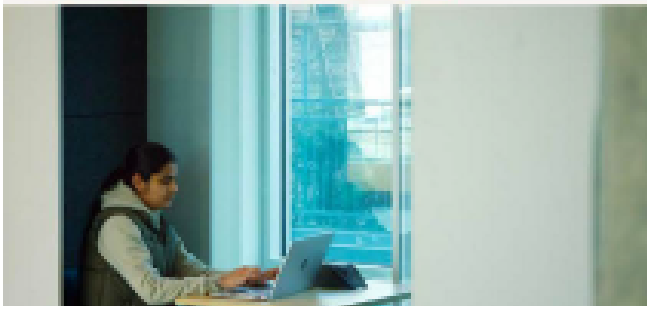


CHECK OUT THE NEWS BROADCAST MADE POSSIBLE BY RAFAEL AND HIS TEAM

SEE MORE ABOUT THE STARSAILOR AT HTTPS://SPACECONCORDIA.CA/STARSAILOR

THE HEART OF LEARNING





By Andre Nguyen

In quiet corners of the building, at sunlit tables near the windows, and even on the steps outside between classes, students at TAV College are often seen deep in focus.

Open textbooks, glowing laptop screens, and scribbled notebooks tell stories of determination and ambition. Some study in groups, discussing ideas with quiet intensity; others sit alone, headphones in, completely immersed in their work.

There's a kind of calm energy in these moments; proof that learning isn't just happening in the classroom, but all around the campus. Each page turned and every note taken is a step closer to a goal. These scenes capture more than just study sessions-they reflect the drive, discipline, and dreams that make up the spirit of TAV.

At the front of the room, the teacher speaks with energy and purpose, their voice rising and falling with passion as they bring the lesson to life. Eyes follow them as they move across the board, explaining complex ideas with clarity and ease. The classroom isn't silent-but engaged. Students nod, take notes, ask questions, and lean in a little closer.

Every explanation is more than just information-it's a connection. The teacher doesn't just teach facts; they spark curiosity, challenge thinking, and encourage confidence. There's a rhythm to the room, a flow between teacher and students that turns learning into something dynamic and alive.





In the classroom at TAV College, the atmosphere is one of focused learning and active engagement. The teacher stands at the front, guiding the lesson, while students remain attentive and involved, contributing to the flow of discussion.

The interaction between the instructor and students creates a dynamic learning environment where ideas are exchanged, and critical thinking is encouraged. At TAV, the classroom is not just a place for lectures, but a space where learning is a shared, evolving process.

ZINE COVER CONTEST

WANT YOUR WORK ON A ZINE COVER?

ENTER THE COVER PAGE CONTEST AND DESIGN OUR NEXT COVER FOR THE WINTER 2027 ISSUE!

USE ANY MEDIUM YOU DESIRE; CREATE AN IMAGE THAT RADIATES THE THEME:

MIRACULOUS MACHINES



RULES

- NO GENERATIVE AI IMAGES
- MUST BE ORIGINAL WORK

TARGET

All TAV STUDENTS CAN SUBMIT

SUBMISSION

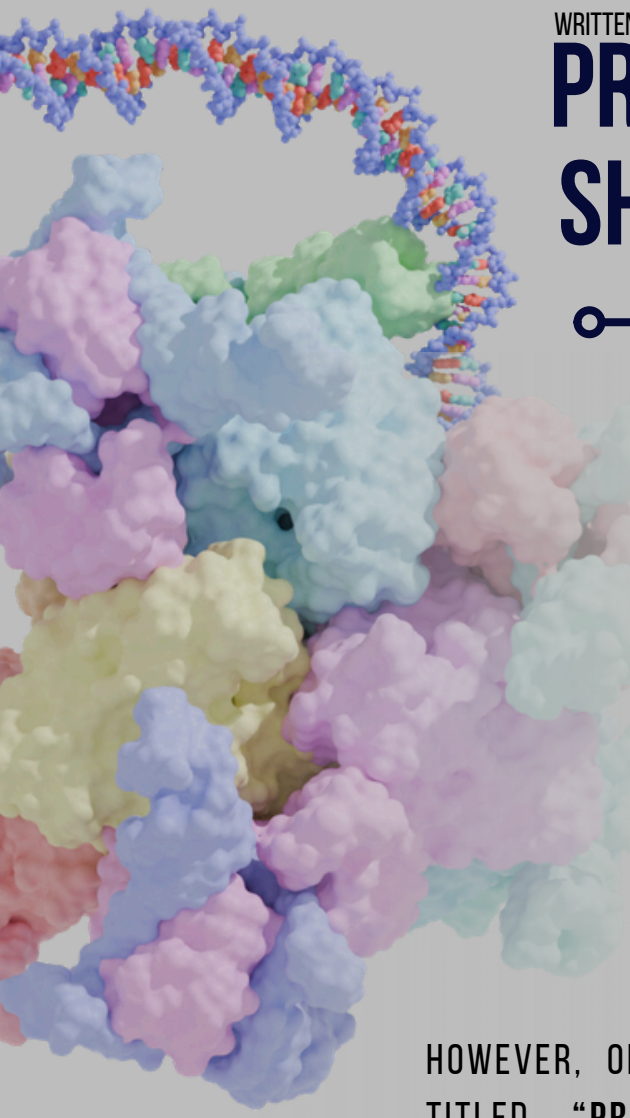
EMAIL US AT THETAVTIMES@TAV.CA A COPY OF YOUR WORK IN JPEG FORMAT. MENTION YOUR NAME AND STUDENT ID NUMBER.

DEADLINE TO SUBMIT IS DECEMBER 1

FOR INQUIRIES OR QUESTIONS ABOUT THE CONTEST, CONTACT US VIA EMAIL OR WEBSITE.

SCIENCE

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WRITTEN AND ILLUSTRATED BY SAMMY RICH

PROTEIN-SYNTHESIZED DNA SHATTERS CENTRAL DOGMA

IN A CONTINUOUSLY EXPANDING FIELD, A SINGLE PRINCIPLE HAS REMAINED CONSISTENT TO DATE: ALL GENETIC INFORMATION ORIGINATES FROM **DNA***, A CONCEPT KNOWN AS THE **CENTRAL DOGMA**.

FUNDAMENTALLY, THE ENTIRETY OF THE READER'S BEING IS DEFINED BY APPROXIMATELY 3 BILLION SEQUENCES OF ONLY **4 GENETIC BUILDING BLOCKS***, WHICH WE CALL DNA. IN FACT, ALL LIVING THINGS ARE UNITED BY THIS SYSTEM OF GENETIC CODING.

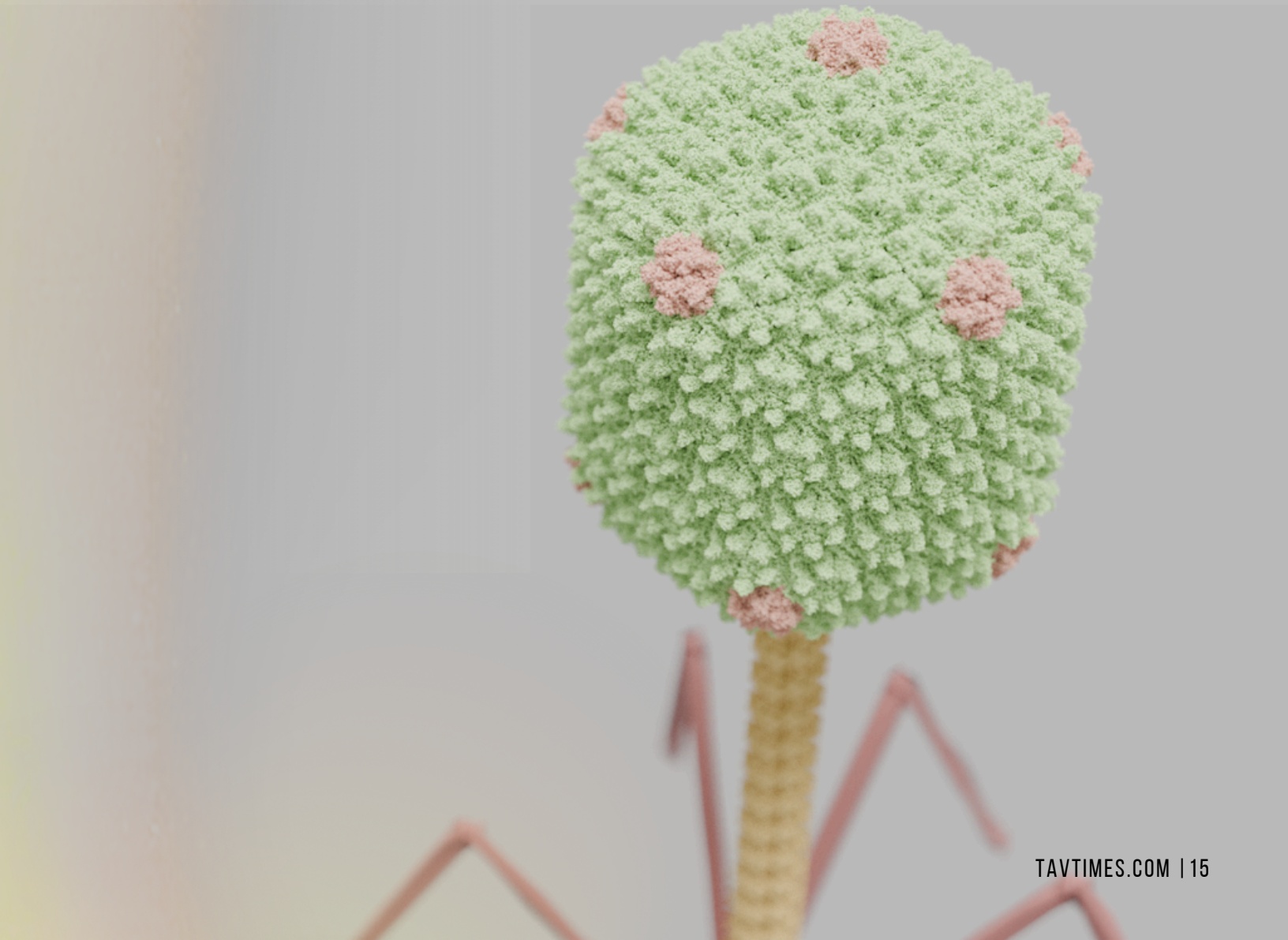
HOWEVER, ON APRIL 16TH OF 2026, A REVOLUTIONARY PAPER TITLED **"PROTEIN-TEMPLATED SYNTHESIS OF DINUCLEOTIDE REPEAT DNA BY AN ANTIPHAGE REVERSE TRANSCRIPTASE"** PLACED THE CENTRAL DOGMA INTO QUESTION WITH ITS DISCOVERY OF A PROTEIN WITH THE ABILITY TO MAKE DNA FROM SCRATCH. THIS PROTEIN WAS FOUND IN OVER 20 DIFFERENT BACTERIAL SPECIES AND WAS OBSERVED IN **E. COLI***, A COMMON **MODEL BACTERIUM***.

THE RESEARCH WAS LED BY **ALEX GAO** AND HIS TEAM AT GAO LABS; THEY DETERMINED THAT THE PROTEIN IS A **DEFENCE-ASSOCIATED REVERSE TRANSCRIPTASE (DRT)***, A **MOLECULAR MACHINE*** ONLY FOUND IN **PROKARYOTIC CELLS***.

WHAT ARE DRTS AND WHAT DO THEY DO?

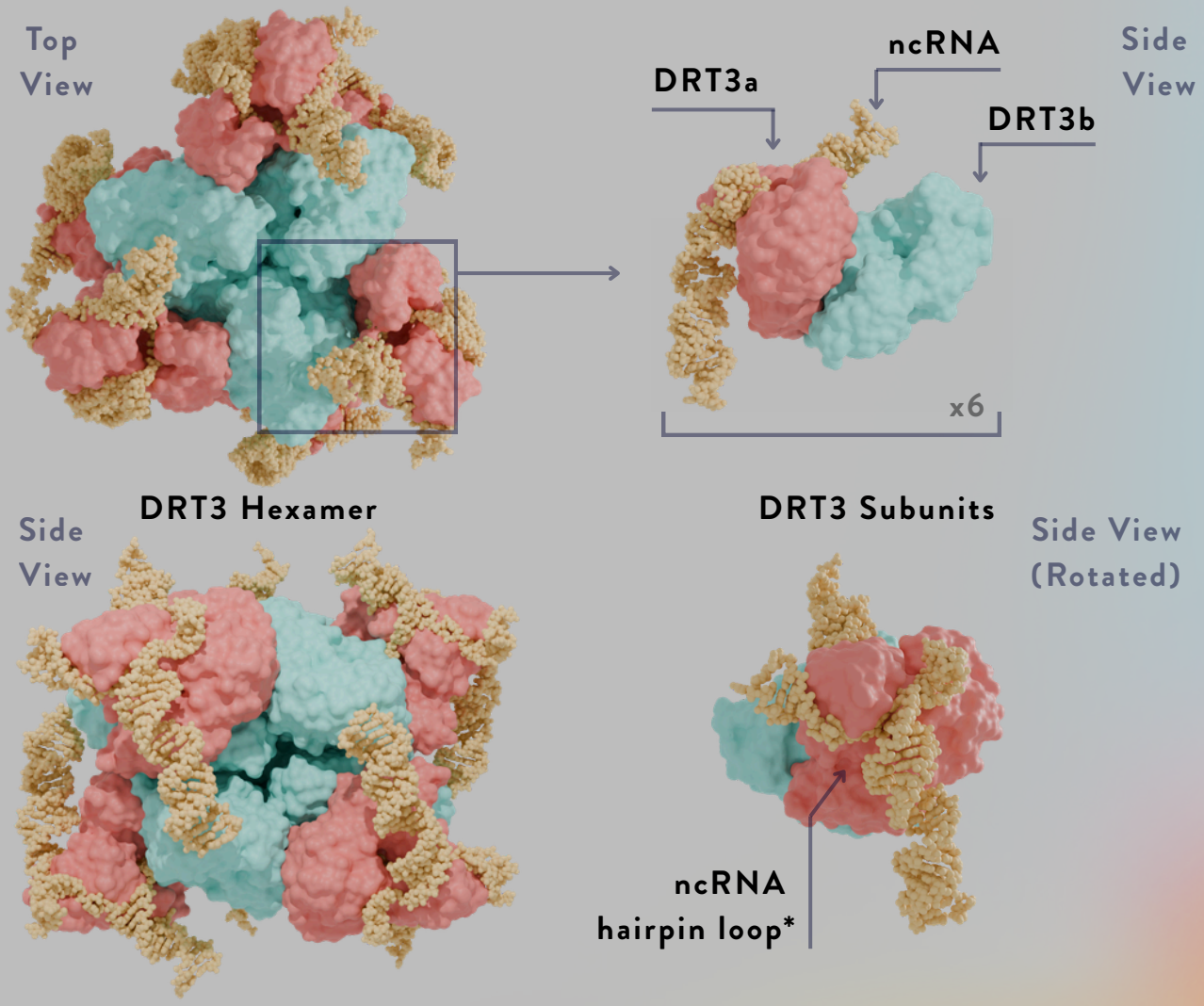
REVERSE TRANSCRIPTASES ARE THE **ENZYMES*** USED TO SYNTHESIZE COMPLEMENTARY STRANDS OF DNA FROM **RNA*** STRANDS AND ARE FOUND ACROSS ALL KINGDOMS OF LIFE. DEFENSE-ASSOCIATED REVERSE TRANSCRIPTASES (DRTS), HOWEVER, ARE A SPECIFIC CLASS OF REVERSE TRANSCRIPTASES USED ONLY BY PROKARYOTIC CELLS AS A DEFENSE MECHANISM AGAINST **BACTERIOPHAGES***.

ONLY 9 TYPES OF DRTS HAVE BEEN ESTABLISHED, WHICH ALL ACT AS ALARMS OR WEAPONS, YET ALL HAVE UNIQUE MECHANISMS OF DEFENDING AGAINST PHAGES. THE NEWLY DISCOVERED DRT3, HOWEVER, IS THE SOLE ENZYME IN THE FAMILY TO SHOW **DNA SYNTHESIS "IN THE COMPLETE ABSENCE OF A NUCLEIC ACID TEMPLATE"** DENG, ET AL.·



WHAT IS DRT3 AND WHAT DOES IT LOOK LIKE?

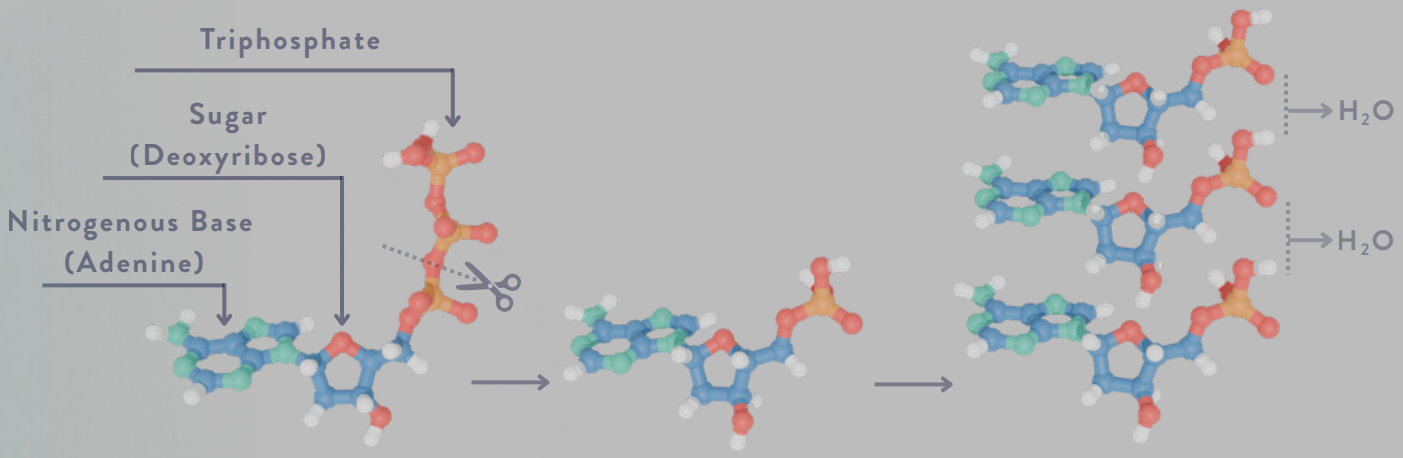
DRT3 IS ASSEMBLED FROM 3 DIFFERENT UNITS: $DRT3_A$, $DRT3_B$, AND **NON-CODING RNA ($_{NC}$RNA)***. $DRT3_A$ AND $DRT3_B$ ARE ACTUALLY TWO DISTINCT TYPES OF REVERSE TRANSCRIPTASES, WORKING TOGETHER. THE DRT3 **HEXAMER*** COMPLEX IS COMPOSED OF SIX $DRT3_A$ UNITS, SIX $DRT3_B$ UNITS, AND SIX STRANDS OF $_{NC}$RNA.



IT IS A BEAUTIFULLY SYMMETRIC MOLECULAR MACHINE WHERE BOTH SUBUNITS WORK SIMULTANEOUSLY, YET DIFFERENTLY FROM ONE ANOTHER, TO FORM DNA. THE CLAIM IS THAT DRT3 SYNTHESIZES DNA WITHOUT A BASE COPY; HOWEVER, THE ENZYME STILL UTILIZES $_{NC}$RNA. BOTH $DTR3_A$ AND $DTR3_B$ FORM THEIR OWN STRAND OF DNA, EXCEPT THAT ONLY ONE HAS ITS OWN UNIQUE WAY OF MAKING DNA NEVER OBSERVED BEFORE.

HOW DRT3A AND DRT3B WORK

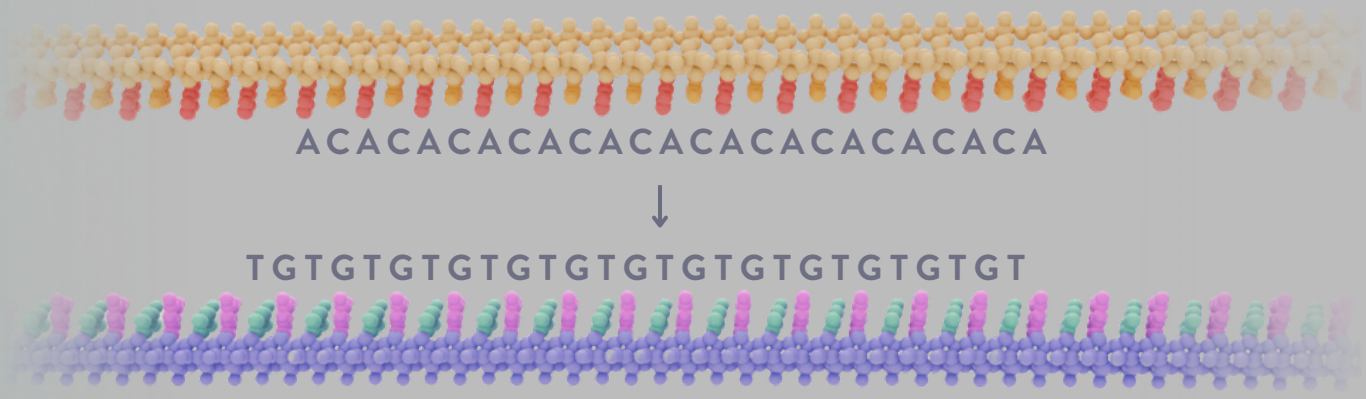
WITHIN THE BACTERIA'S **CYTOPLASM*** ARE MOLECULES CALLED **DATP*** AND **DCTP***, WHICH ARE RAW MATERIALS USED FOR **NUCLEOTIDES***. DRT3 CAPTURES THESE FLOATING MOLECULES AND CUTS OFF TWO OF THE THREE PHOSPHATES, LEAVING **A SUGAR***, **A PHOSPHATE GROUP***, **AND A NITROGENOUS BASE***; THE REMAINING PRODUCT IS EXACTLY WHAT IS REQUIRED FOR DNA SYNTHESIS.



dATP **dAMP*** **Single strand of DNA (AAA)**

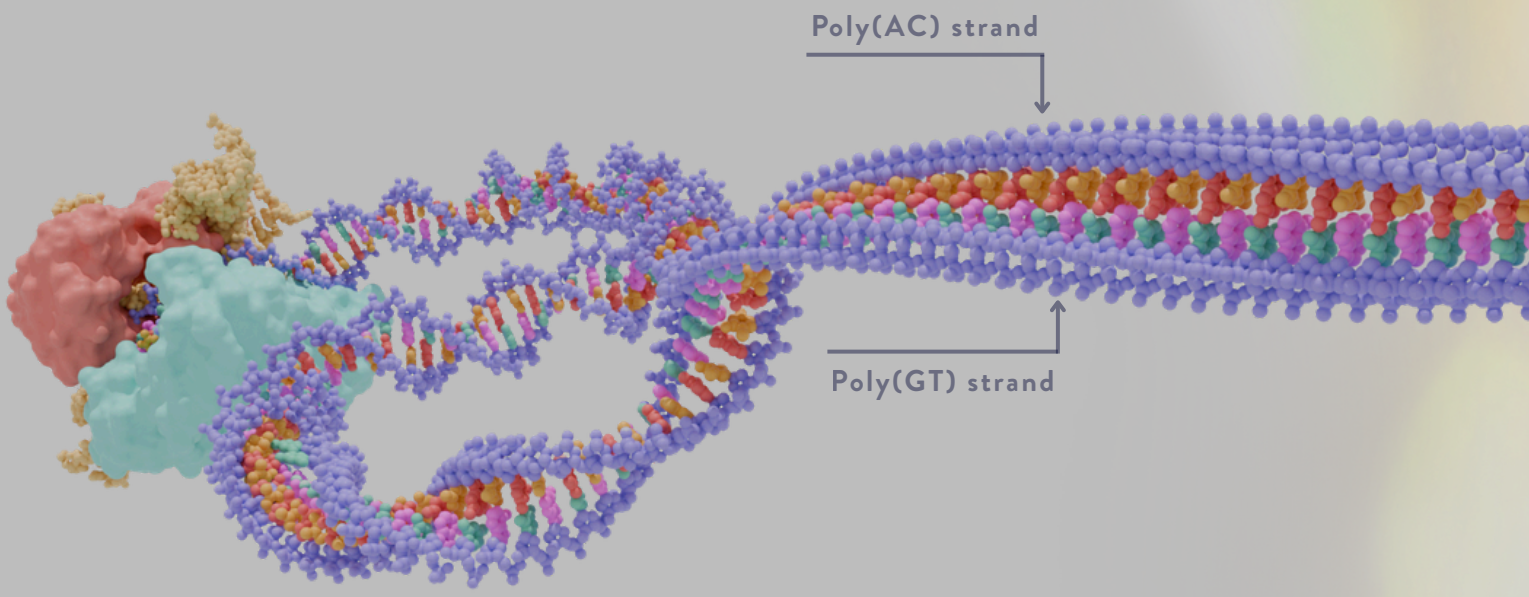
BOTH STRANDS OF DNA ARE MADE INDEPENDENTLY OF EACH OTHER. $DRT3_A$ FOLLOWS THE FAMILIAR PROCEDURE; IT USES THE $_{NC}$RNA CONSISTING OF AN **ACACAC** MOTIF AS A BASE, PRODUCING A REPEATING **TGTGTG** PATTERN CALLED A **POLY(GT)** STRAND.

ncRNA



Poly(GT) DNA strand

DRT3$_B$, ON THE OTHER HAND, USES ITS OWN MOLECULAR GEOMETRY TO FORM A REPEATING ACACAC STRAND, POLY(AC), TO COMPLEMENT THE POLY(GT) STRAND. DRT3$_B$ PRIMARILY USES TWO AMINO ACIDS IN ITS STRUCTURE TO BIND: **GLUTAMINE (GLU^{26})*** AND **ARGININE (ARG^{253})***, WHICH ACT AS GATES THAT ALTERNATELY ALLOW **DAMP*** AND **DCMP*** TO BIND TOGETHER AS A STRAND.

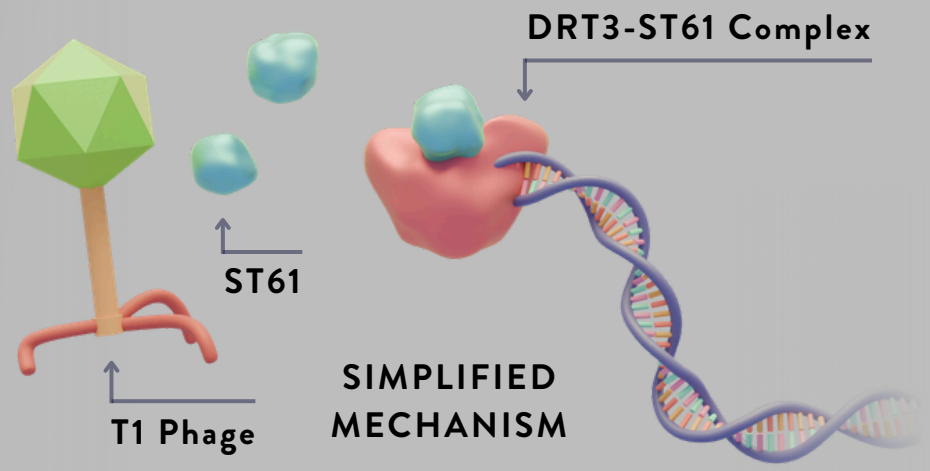


WHEN DATP IS WITHIN THE **ACTIVE SITE*** OF DRT3$_B$, GLU^{26} BINDS TO THE INCOMING MOLECULE, APPENDING DAMP TO START THE DNA STRAND. SUBSEQUENTLY, THIS ALTERS THE SHAPE OF THE ACTIVE SITE AS THE DNA CHAIN MOVES FORWARD, MOVING GLU^{26} **OUT OF THE SITE** AND ARG^{253} IN, ALLOWING CAPTURE OF DCTP TO FOLLOW. THIS, IN TURN, PUSHES ARG^{253} BACK AND GLU^{26} FORWARD, RESULTING IN THE ALTERNATING ACACAC STRAND.

AS BOTH STRANDS ARE PUSHED OUT OF THE HEXAMER, THEY BOTH SPONTANEOUSLY ZIP TOGETHER, RESULTING IN A BRAND NEW STRAND OF DNA CONSISTING OF COMPLEMENTARY POLY(AC) AND POLY(GT) STRANDS. AT FIRST GLANCE, THE GENERATED DNA SEQUENCE SEEMS OVERLY SIMPLE FOR SUCH A NOVEL DISCOVERY; HOWEVER, THE UNIQUE MECHANISM MAY BE LINKED TO THE STRAND'S SPECULATED FUNCTION.

WHY ALL THE FUSS FOR A SIMPLE SEQUENCE?

DRT3 HAS BEEN SHOWN TO PRODUCE THESE REPETITIVE STRANDS OF DNA IN THE PRESENCE OF A PARTICULAR PROTEIN RELEASED BY PHAGES, CALLED **ST61***. THE PRESENCE OF THIS PROTEIN IS AN APPARENT SIGN OF A PHAGE INVASION, AS IT IS EXCLUSIVELY PRODUCED BY VIRAL BACTERIOPHAGES, SUCH AS **T1 PHAGES***, WHICH WERE USED TO OBSERVE DRT3 BEHAVIOR. ST61 WAS SEEN TO BIND TO THE DRT3 HEXAMER, KICKSTARTING THE ENZYME INTO PRODUCING DNA.



THE EXISTENCE OF DRT3 HIGHLIGHTS THE COMPLEXITY OF BACTERIA TO PERSEVERE AGAINST VIRUSES, DEMONSTRATING A DORMANT MOLECULAR MACHINE CAPABLE OF FENDING AGAINST BACTERIOPHAGE INFECTION ONCE INITIATED. WHILE THE EXACT FUNCTION OF THE REPETITIVE DNA IS STILL UNDER INVESTIGATION, ITS NECESSITY TO BYPASS CANONICAL DNA SYNTHESIS FOR IMMEDIATE PRODUCTION MAY SUGGEST THAT THE STRANDS ACT AS DETERRENTS TO PHAGE REPLICATION. IT IS DESCRIBED AS POTENTIALLY HAVING A FUNCTION SIMILAR TO THAT PROPOSED FOR DRT9: **PRODUCING DECOY DNA TO BIND TO THE DNA-BINDING PROTEINS RELEASED BY BACTERIOPHAGES, WHICH THEY USE TO HIJACK THE BACTERIA'S GENETIC CODE TO MAKE COPIES**.

INDEX

DNA: Deoxyribonucleic acid, molecules that store all genetic information.

4 genetic building blocks: referencing the 4 bases that are the coding sequences in DNA: adenine(A), cytosine(C), thymine(T), and guanine(G).

E.coli: Escherichia coli; it's a common bacterium that is frequently harmless and aids with digestion.

Model bacterium: Bacteria used by labs to study cellular phenomena, usually picked for being simple to grow, having high reproduction rates, and a well-studied genome.

DRT: Defense-associated reverse transcriptases; enzymes that make DNA and are specifically used to defend the cell against viral infections.

Molecular machine: An atomic or molecular assembly that uses energy to perform mechanical functions.

Prokaryotic cells: The kingdom of life comprising single-celled organisms, such as bacteria and archaea.

Enzymes: A type of protein specializing in catalyzing chemical reactions.

RNA: Ribonucleic acid, molecules that translate DNA instructions into proteins. It has various types according to their function, such as mRNA, and instead of thymine(T), it contains Uracil(U) as its pair to adenine(A).

Bacteriophage/phages: A virus that infects bacteria, replicating by hijacking the cell's DNA to instruct its machinery to make more copies of itself.

ncRNA: non-coding RNA, RNA that does not get translated into protein; common types include tRNA and rRNA.

Hexamer: A Structure consisting of 6 identical subunits.

ncRNA hairpin loop: A common secondary structure of ncRNA where a single strand of ncRNA loops back onto itself and looks like a hairpin.

Cytoplasm: The gelatinous filling of all cells, holds the cell's organelles together.

INDEX

dATP/dCTP: deoxyribose adenosine/cytosine triphosphate

Nucleotide: Core building blocks of DNA/RNA; they are also used in energy transport; they consist of a sugar, phosphate group, and a nitrogenous base.

Sugar: Used as part of the DNA backbone, either deoxyribose for DNA or ribose for RNA.

Phosphate group: A chain of phosphates; comes in groups of 1 (mono-), 2 (di-), or 3 (tri-) in this context.

Nitrogenous base: either adenine(A), cytosine(C), thymine(T), guanine(G), or Uracil(U) in this context.

Glu26/Arg253: Molecules called amino acids; the numbers indicate their positions in the protein chain.

dAMP/dCMP: deoxyribose adenosine/cytosine monophosphate.

Active site: The location of the enzyme to which the signaling molecule (substrate) binds.

T1 phages: Viral bacteriophages that target E.coli.

ALL DETAILED MODELS WERE EXTRACTED FROM THE RCSB PROTEIN DATA BANK (PDB).
CHEMICAL MODELS WERE EXTRACTED USING AVOGADRO2.

PROTEIN DATA BANK MODELS:

- **DRT3 (9Z6Y)**: DENG, P., GAO, A.
- **DNA (1BNA)**: DREW, H.R., WING, R.M., TAKANO, T., BROKA, C., TANAKA, S., ITAKURA, K., DICKERSON, R.E.
- **HEAD STRUCTURE OF PHAGE T4 (7VS5)**: FANG, Q., TANG, W., FOKINE, A., MAHALINGAM, M., SHAO, Q., ROSSMANN, M.G., RAO, V.B.
- **BACTERIOPHAGE T4 TAIL SHEATH PROTEIN (3F08)**: AKSYUK, A.A., LEIMAN, P.G., KUROCHKINA, L.P., SHNEIDER, M.M., KOSTYUCHENKO, V.A., MESYANZHINOV, V.V., ROSSMANN, M.G.

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MESTRE, M. R., GAO, L. A., SHAH, S. A., LÓPEZ-BELTRÁN, A., GONZÁLEZ-DELGADO, A., MARTÍNEZ-ABARCA, F., IRANZO, J., REDREJO-RODRÍGUEZ, M., ZHANG, F., & TORO, N. (2022). UG/ABI: A HIGHLY DIVERSE FAMILY OF PROKARYOTIC REVERSE TRANSCRIPTASES ASSOCIATED WITH DEFENSE FUNCTIONS. NUCLEIC ACIDS RESEARCH, 50(11), 6084–6101. HTTPS://DOI.ORG/10.1093/NAR/GKAC467

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BACTERIAL DEFENSE SYSTEM BUILDS DNA IN UNEXPECTED NEW WAY TO STOP VIRUSES. (N.D.). RETRIEVED JULY 16, 2026, FROM HTTPS://PHYS.ORG/NEWS/2026-04-BACTERIAL-DEFENSE-DNA-UNEXPECTED-VIRUSES.HTML

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Our brains are composed of approximately

86 billion neurons...

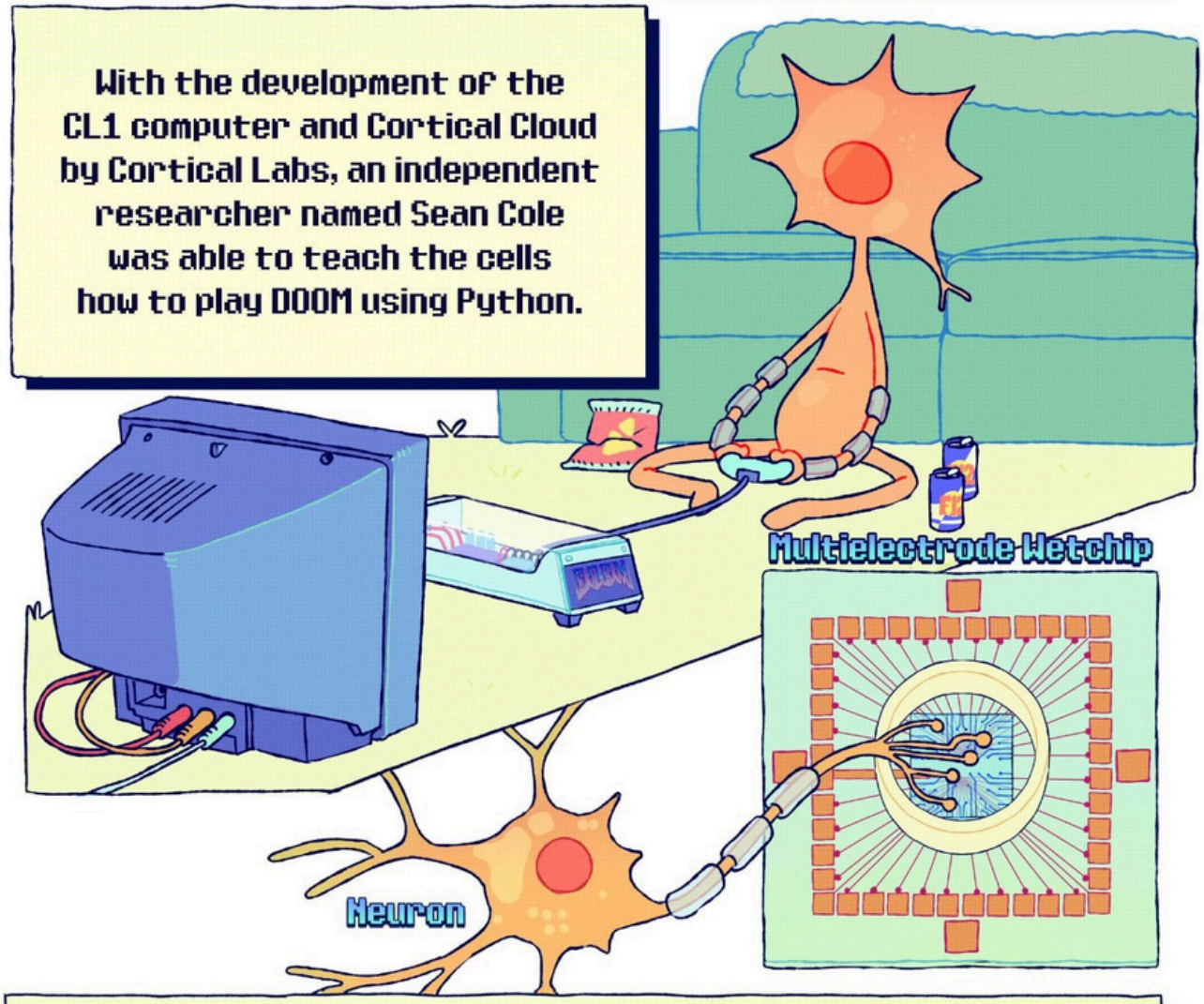
but can you play DOOM 1993
better than 200,000 brain cells?

Written and Illustrated by Sammy Rich

Researchers at Cortical Labs, an Australia-based startup lab, have taught a colony of approximately 200,000 human brain cells to play DOOM, the 1993 first-person shooter.

In 2022, the lab had taught 800,000 neurons to play Pong in 18 months; however, the transition from 2D to 3D was more complex.

With the development of the CL1 computer and Cortical Cloud by Cortical Labs, an independent researcher named Sean Cole was able to teach the cells how to play DOOM using Python.



The CL1 computer is what Cortical Labs calls a biological computer; human neurons are grown from stem cells inside a nutrient solution across a silicon chip, which integrates electrical impulses to and from the cells.

The environment the cells experience is created by the Biological Intelligence Operating System, biOS, which runs simulations that the neurons can interact with through their impulses.

The CL-1 Biological Computer



Cortical Labs integrates the neurons into the biOS using multiple CL-1 computers to create the Cortical Cloud, a collection of neurocomputers ready to accept uploaded code directly into neurons.

To program the cells to play DOOM, the first step was to translate the game into a neuron's biological language: electricity.

The Chief Technology Officer, David Hogan, explains that "specific electrodes stimulate the sensory area of the neural culture[...] The neurons react to that stimulation."[1] The neural activity spikes are then interpreted manually into "motor commands" within the game.

By translating electronic patterns produced by neurons into in-game commands, the cells learned to play DOOM in less than a week.

Dr. Brett Kagan, Chief Scientific/Operations Officer, states that "the cells play a lot like a beginner who's never seen a computer[...], and while they die a lot, they are learning."[1]





picture by Cortical Labs [edited]

This is only the beginning; the cells have shown evidence of being able to "seek out enemies and shoot", and the next step is to provide performance feedback and begin training the cells into pro gamers.

Why DOOM 1993?

"Can it run DOOM?" has been an eternally lingering question over decades.

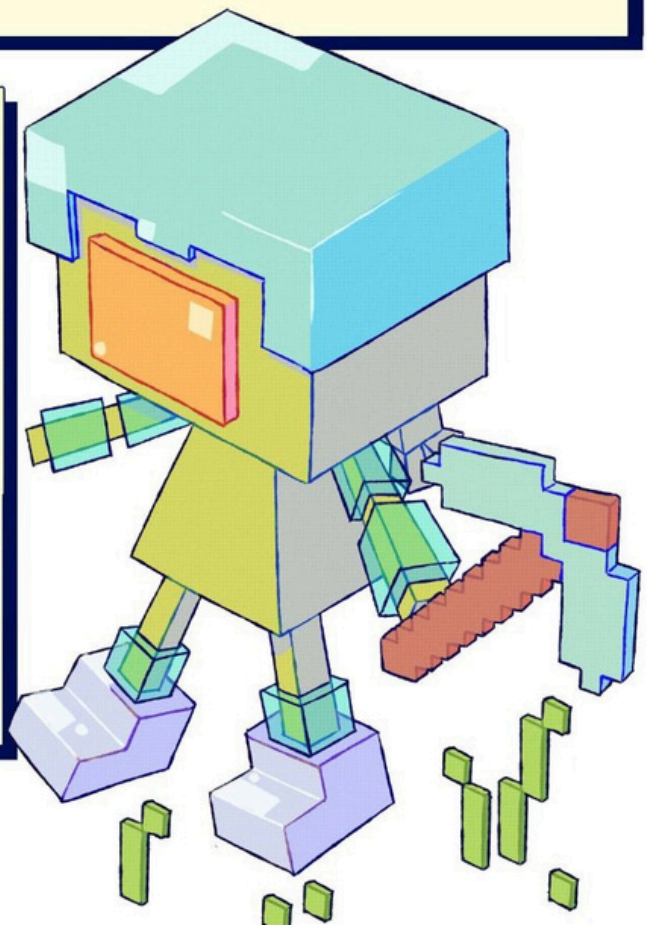
In 1997, the company that made DOOM released the game's source code, allowing anyone to port the game onto a variety of devices. The spread of questioning of a device can play DOOM was kickstarted by YouTubers who managed to port the game onto a Scope monitor, iPod 5, and even a graphing calculator.

Cortical Labs was also approached with the question, "Can it play DOOM?" when they released their experiment in which neurons played Pong, prompting the company to accept the challenge.

Why Neurons?

Cortical Labs didn't grow neurons just to play games.

The main application of studying programmable neurons is to "study brain function [...] through biological computing that captures neural adapt ability and learning in real-time, revealing disease mechanisms and compound effects on cognition."[2]



Using the CL1 provides a more ethical and accurate alternative to animal testing, as well as producing data more relevant and applicable to humans.

Currently, Cortical Labs has challenged developers and researchers to experiment with biological computing using the Cortical Cloud.

If you could teach cells to play a game, what would they play?

Index

Neuron: Brain cells, a specialized cell that makes up our nervous system

Stem cell: Unspecialized master cells before it is assigned specific functions.

Python: A coding language

Wetware: A new term created to describe human brain cells being used as a computing system.

Multielectrode Wetchip: A small grid of electrodes in the form of a chip that is used for non-invasive, long-term, and high-throughput monitoring of the electrical activity of cells. It is called a "wetchip" because a "wet" cell culture is used [7].

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THROWBACK

HOW MRNA VACCINES WORK...2021

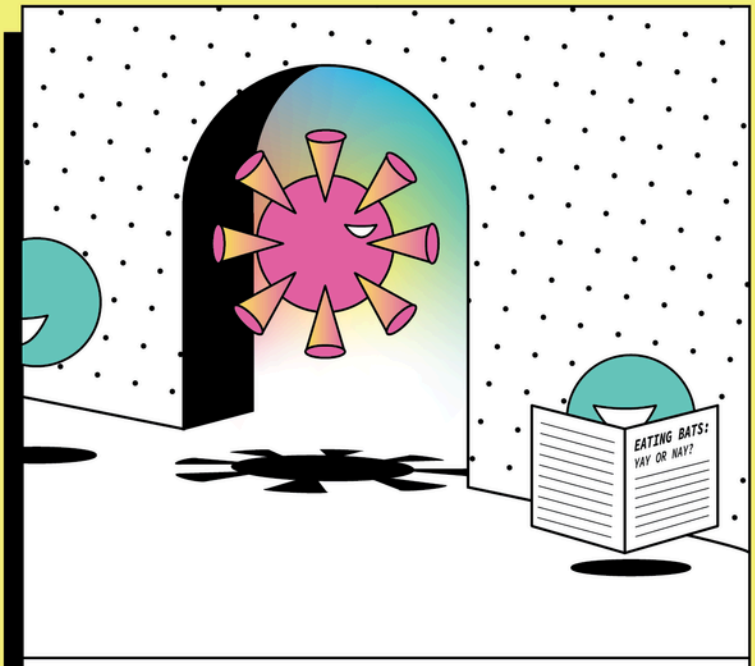
HELICOPTERS ON MARS?.....2021

IMPOSTERDOM.....2020

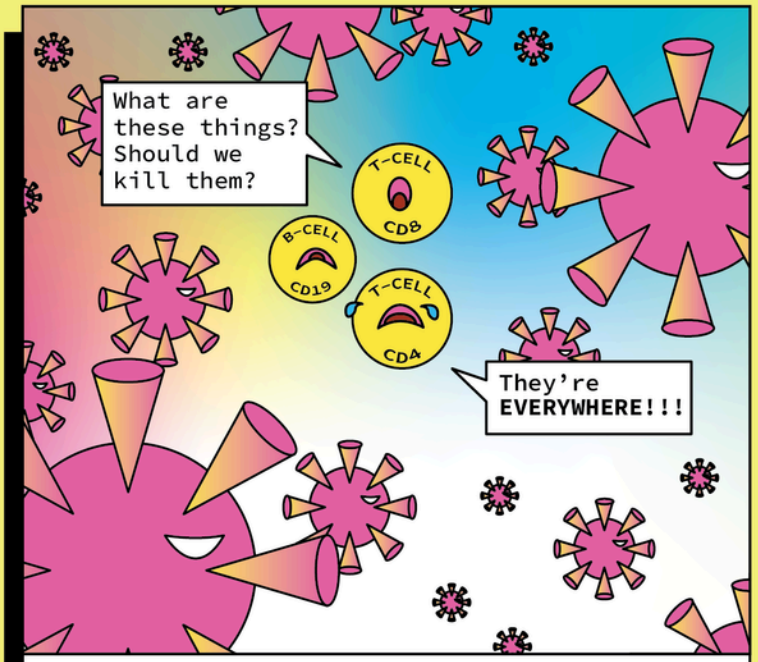
HOW mRNA VACCINES WORK

EDITOR'S CHOICE
TA
VT

by Ita Sonnenschein



If you haven't vaccinated, it's very easy to gt infected with covid-19. For example, imagine that someone has just coughed on you, and now the SARS-CoV-2 virus has entered your body.



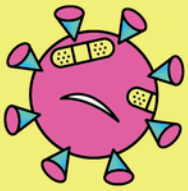
It takes your immune system a few days to recognize SARS-CoV-2 as a threat and retaliate. By that time, the virus has broken into the your cells and created copies of itself, so you can become infected with covid-19.

Most people who get infected with the virus will recover as their immune system learns to fight it off. For some people, symptoms like fatigue, shortness of breath, loss of smell and chest pain will last for weeks or months. In rarer cases, covid-19 is fatal. As of February 2021, the virus has taken the lives of 2.3 million people worldwide.

What if you could train your immune system to recognize threats in advance, so it could fight off intruders before they gain the upper hand? That's what vaccines do. While the concept of inoculation has been around since the 1100's, the first vaccine was developed in the late 1790's by Edward Jenner to combat smallpox. Here are some common ones.

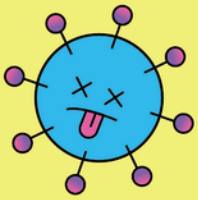
SOME EXAMPLES OF VACCINES

MEASLES



This is a **live-attenuated vaccine.** A live version of a virus or germ is injected. Other examples: mumps, rubella, chickenpox.

INFLUENZA (THE FLU)



This is an **inactivated** vaccine. It uses a strain of the virus or bacteria that has been killed by chemicals or heat. Other examples: polio, rabies, hepatitis A.

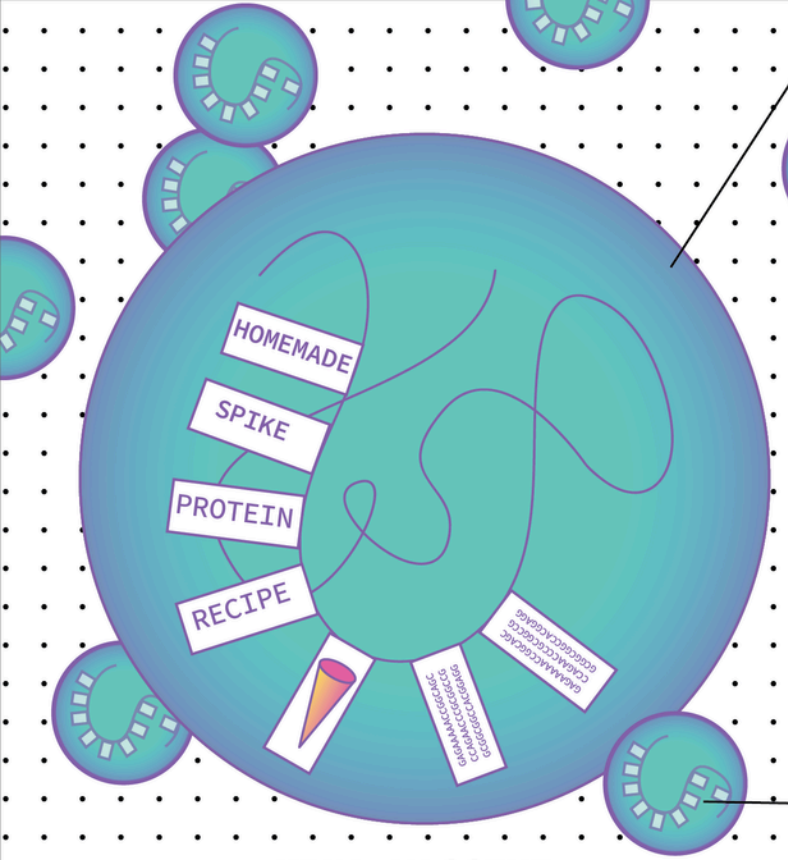
PERTUSSIS (WHOOPING COUGH)



This is an **acellular** vaccine. This type uses a piece of the germ or virus, called a toxoid.

We'll be focusing on a newer type of vaccine called an mRNA vaccine, such as the ones made by Pfizer and Moderna.

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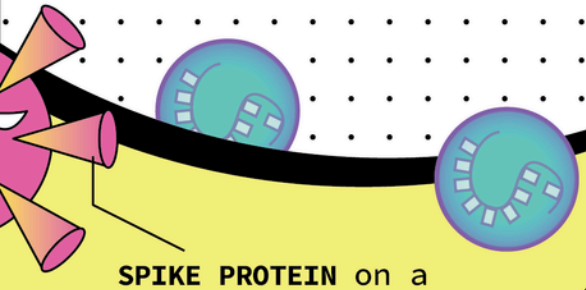


LIPID NANOPARTICLE
fat bubble that protects the mRNA

The radical thing about an mRNA vaccine is that it doesn't contain a piece of the virus. Rather, it contains instructions in the form of messenger RNA for making just the spike protein that surrounds the real covid virus.

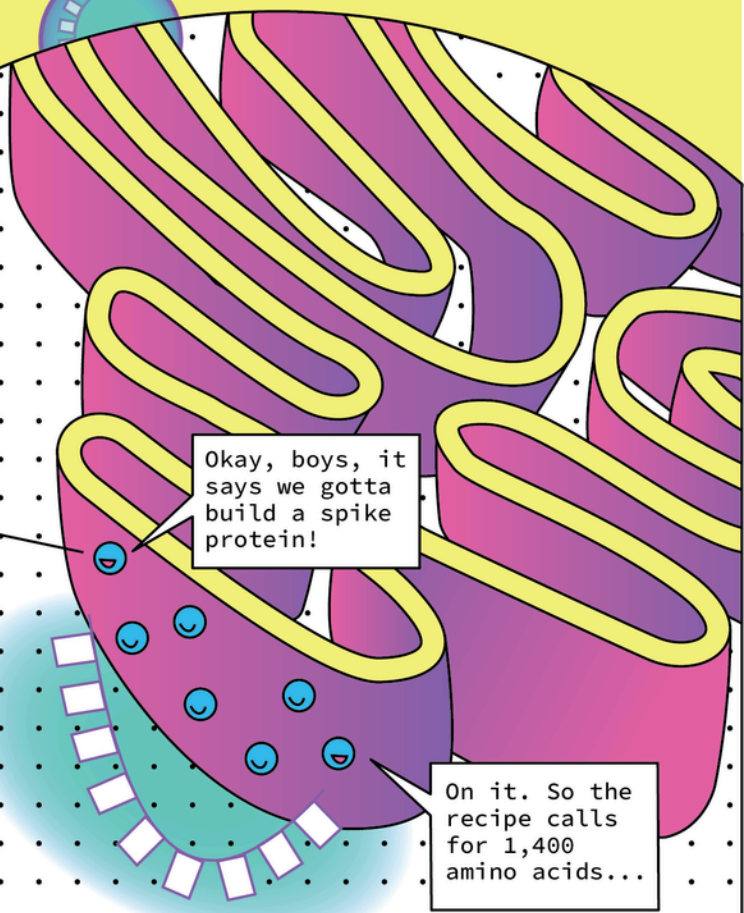
MRNA VACCINE

MESSENGER RNA
a single-stranded molecule that is complementary to one of the DNA strands of a gene

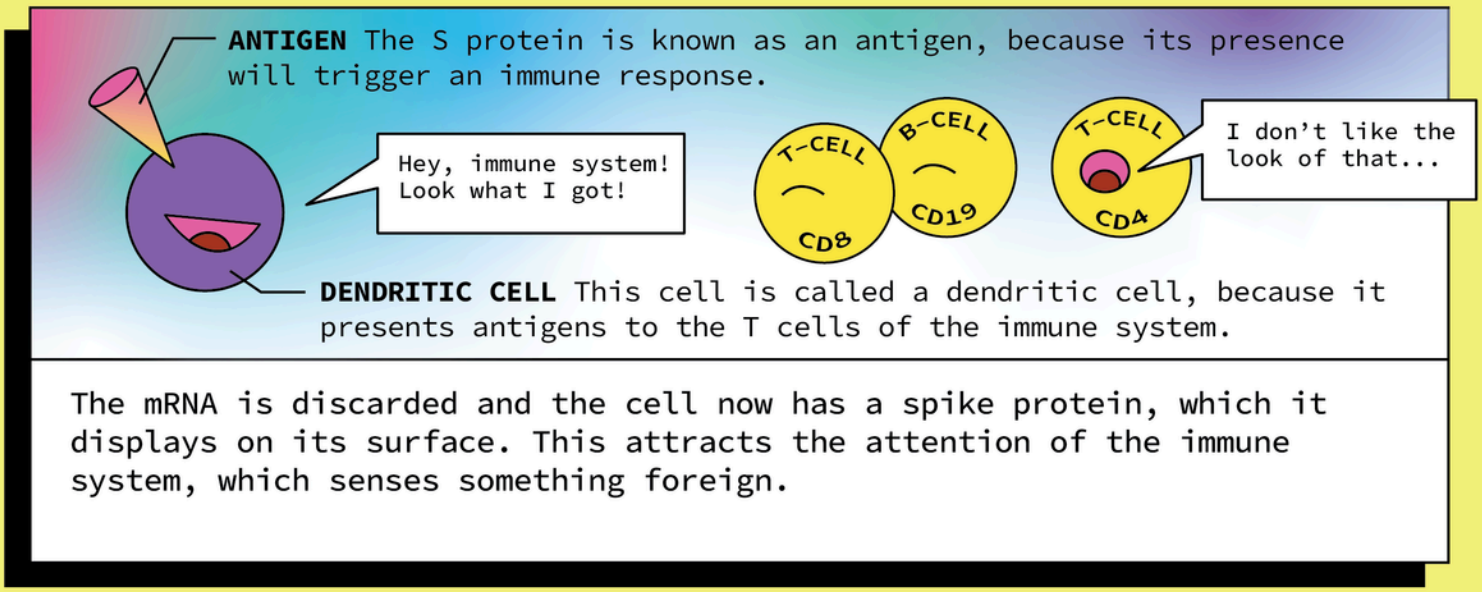


SPIKE PROTEIN on a coronavirus fuses to a host cell and allows the virus to enter it

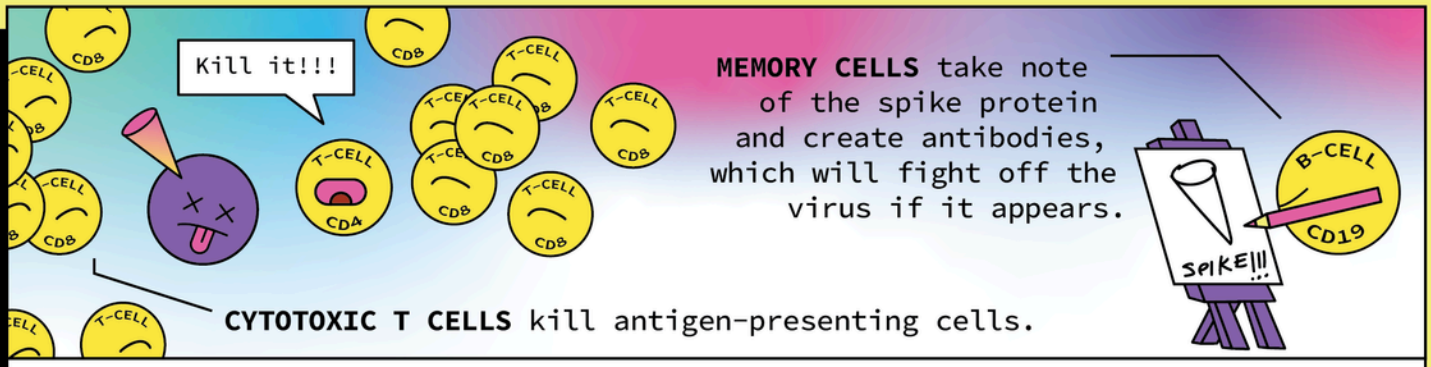
RIBOSOMES
the protein factory of the cell



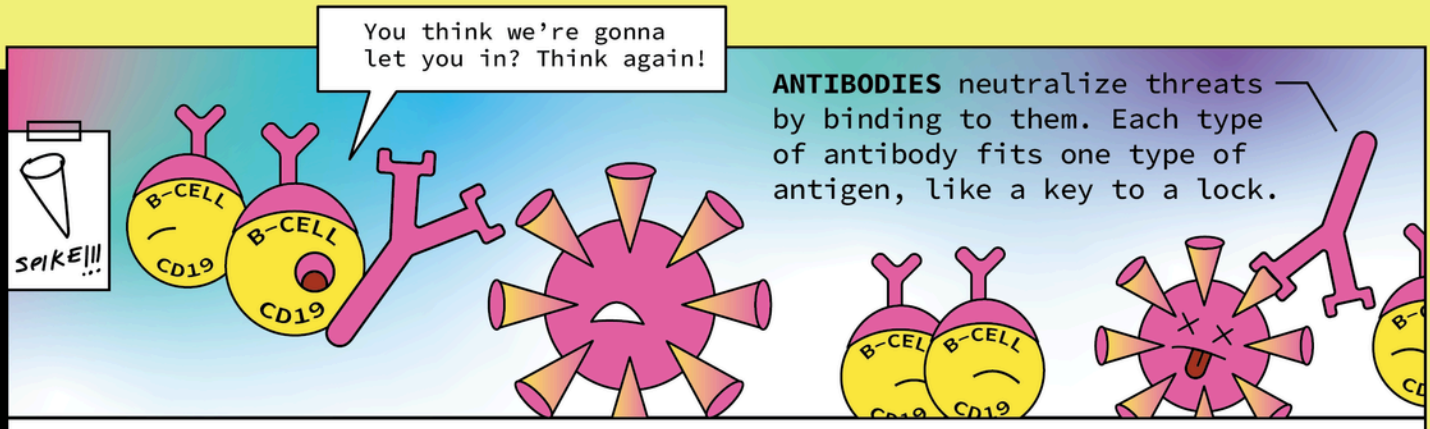
The vaccine is injected into the upper arm. The lipids dissolve, leaving the spike protein mRNA (the instructions) in the cell. Each cell's ribosomes read the instructions and make the spike protein.



The mRNA is discarded and the cell now has a spike protein, which it displays on its surface. This attracts the attention of the immune system, which senses something foreign.



Your immune system starts an attack to get rid of the invader. This is why people have symptoms like chills, fever, or muscle soreness after getting vaccinated.



Now, your immune system has successfully created antibodies, which will recognize the spike proteins. Your body is properly equipped to fight off covid-19, thanks to the mRNA vaccine.

HELICOPTERS ON MARS? FROM ROLLING ROVERS TO FLYING DRONES

By Elizabeth Vykhodtsev
April 2021

Photo: A martian rover. Source: canva.com
Image for reference only; this is not NASA's Perserverence.

Since the 1960s, dozens of missions and spacecraft launchings have been carried out by NASA with the intention of exploring the Martian surfaces to discover if the red planet was once habitable, and perhaps if it is a candidate environment for the future of our human species.

A great amount of information that is known about the red planet, that we call Mars, due to the successful wheeled rovers that have been used to obtain such information, ranging from the planet's geology all the way to its atmospheric characteristics.

However, with increasing ambition to further expand discoveries, these slow-moving rovers simply aren't fast enough. So, what may be the solution to increase rover movement and maximize exploration? A fast-flying rover perhaps! And, believe it or not, NASA has already got that covered.



MEET THE 'SOL' SISTERS: PERSEVERANCE AND INGENUITY

Ingenuity is an autonomous technological experiment that was built by NASA to show the possibility of powered flight on a planet that is not our own, just like the very first Mars rover, Sojourner, which rolled on Mars' soil in 1997.

This helicopter's name was not originally given by NASA, but by a student who won the, "Name The Rover" contest in 2020. "Ingenuity is what allows people to accomplish amazing things, and it allows us to expand our horizons to the edges of the Universe," wrote Vaneeza Rupani, winner of the contest.

The goal of this helicopter is to simply be a successful (experimental) project, which can help future flights such as the Dragonfly—a drone that is planned to launch on Saturn's moon in the coming years.

Helicopter launches are actually quite difficult. The reason being, Mars' atmosphere is 99% less dense than Earth's, making it quite thin, resulting in difficulty to lift any spacecraft off of its surface.

So, how exactly is Ingenuity going to be any different? Well, Ingenuity was built with a light anatomy, weighing only 4 pounds, with carbon-fiber blades that spin at 2,400 rpm, 6 times faster than the ones on Earth, making Ingenuity's flight off of the Martian soils possible, which was tested on April 14th, 2021.

The helicopter has also shown success just by surviving the journey to Mars, and no, it did not fly itself there. The small drone was transported in a large six-wheeled rover known as Perseverance, which made its landing on the planet in February 2021. Two months later, the small helicopter was sent free from Perseverance by finally being dropped onto Mars' surface.

Evidence of success kept on rising as the helicopter, now independent from Perseverance, survived Mars' below-freezing temperatures, of minus ninety degrees Celsius, thanks to the heating systems that were built in to keep Ingenutiy's electronics properly functioning in below-freezing temperatures.

The two spacecraft will continue to work hand-in-hand as Ingenuity takes its first flight, capturing 30 pictures a second that is then analyzed to assess its location using a tracking-like software, all of which is then going to be sent back to Earth through Perseverance.

The innovation doesn't just stop here! Make sure to follow along with Ingenuity's journey through the red planet's atmosphere, and the many more discoveries that this helicopter is going to make on NASA's website, or you can follow NASA's Jet Propulsion Laboratory on Facebook and Instagram.

"Ingenuity was built with a light anatomy, weighing only 4 pounds, with carbon-fiber blades that spin at 2,400 rpm"



IMPOSTERDOM

COMBATING FRAUDULENT FEELINGS

BY ESTY ROSENFELD

PHOTO SOURCE | ESTY ROSENFELD

We are social creatures. We often rely on others to help keep us going and motivated. For some, these extended months of social distancing may have posed an extra challenge on them, their motivation and work performance. These people don't only rely on social support but need it.

FEELING LIKE A PHONY

The Imposter Phenomenon was first coined by two psychologists Pauline Clance and Suzanne Imes. It is a term used to describe people who feel they are not rightfully deserving of their position. These people often feel like their cover will be blown and people will know that they are incompetent and a complete fraud.

In the article "Great Pretenders" written for the Scientific American, Birgit Spinath talks about the three main components of this phenomenon: feeling like a fraud, having the inability to accept praise and attributing your successes to luck instead of to your hard work.

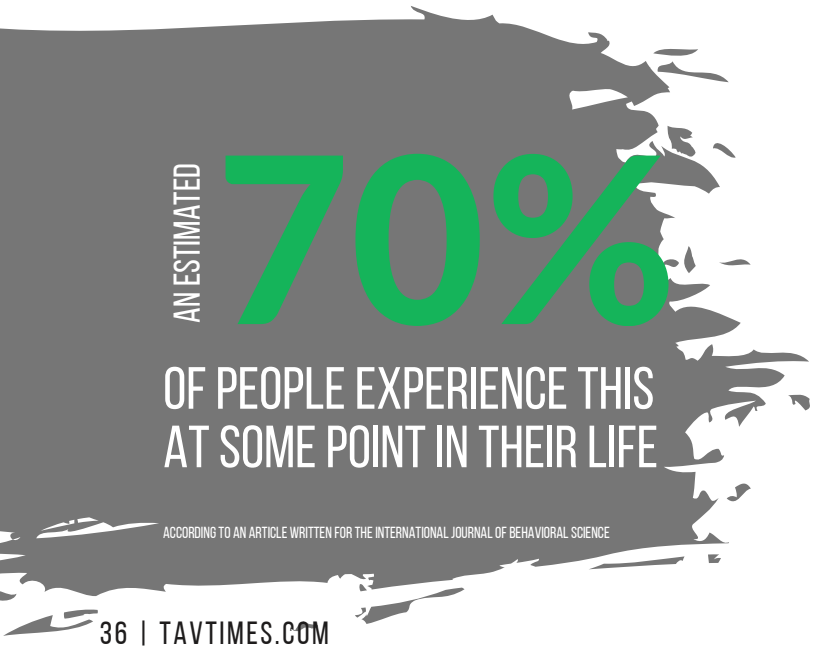
There are two ways in which this can play out. There's the over-doer who prepares and reviews material even once they have already mastered it. This causes them to become stressed knowing that they

won't always be able to perform at such a high level. They have essentially raised their own bar too high. The under-doer will beat around the bush and fail to prepare. This person will procrastinate or do other meaningless tasks to avoid the true task at hand. If they nonetheless succeed at the task, they attribute it to luck.

According to an article written for the Journal of Business and Psychology, the social environment can, to some extent, act as a buffer to help reduce these feelings.

SAY IT LOUDER

The first step to overcome this challenge is to recognize that you are experiencing it. Saying it out loud may take away some of its power. Tell someone who you trust that you've been experiencing this so that they can offer some support, even if it's virtual.



MAKE YOURSELF A MANTRA

Aibileen Clark was onto something when she made the sad little girl repeat the affirmation "You is kind. You is smart. You is important." in the movie "The Help". Write yourself an affirmation to read to yourself listing your positive virtues and capabilities. You may not believe all of it but repeating it over and over will help internalize it. Reminding yourself why you want or need to do a certain task and the benefits you'll gain will make you want to do it more.

PRACTICE MAKES PERMANENT

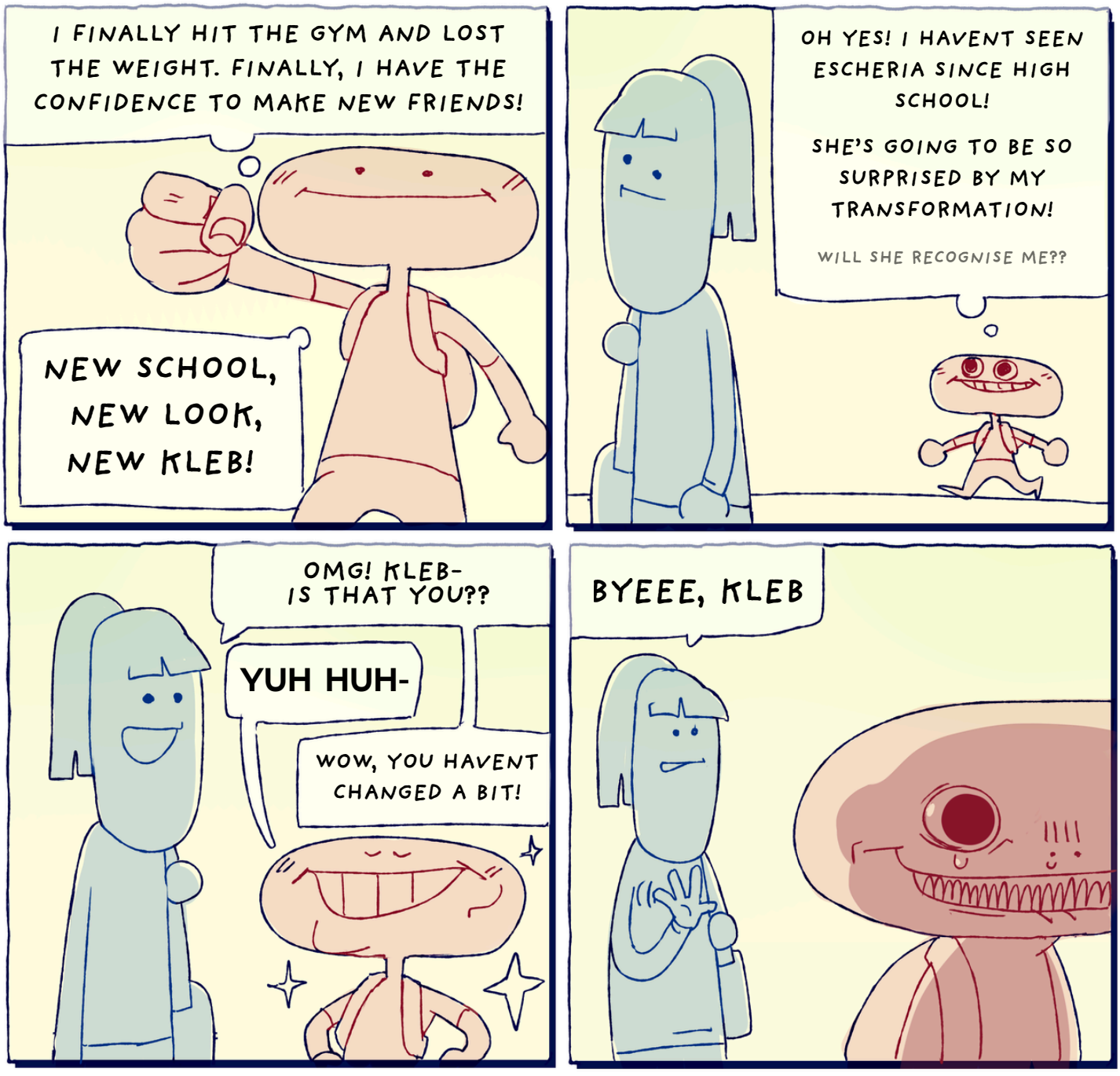
Maxwell Maltz wrongfully assumed that one can fully integrate a habit in twenty-one days back in the 1960's. Fifty years later, researcher Phillippa Lally and her colleagues finally put the hypothesis to the test. They found that it can take anywhere from 18 to 254 days for a habit to become routine, depending on its complexity. Although missing one day here or there won't do much damage, avoid skipping days to ensure that you keep up the momentum. Habits are hard to change, but with some work, you can start feeling like you are worthy of your position.

And finally, you are where you are meant to be, whether you feel deserving of it or not. You may as well take the plunge and do something great!

CREATIVE

COMICS.....38
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THE "GLOW UP"


I FINALLY HIT THE GYM AND LOST THE WEIGHT. FINALLY, I HAVE THE CONFIDENCE TO MAKE NEW FRIENDS!
NEW SCHOOL, NEW LOOK, NEW KLEB!
OH YES! I HAVENT SEEN ESCHERIA SINCE HIGH SCHOOL!
SHE'S GOING TO BE SO SURPRISED BY MY TRANSFORMATION!
WILL SHE RECOGNISE ME??
OMG! KLEB- IS THAT YOU??
YUH HUH-
WOW, YOU HAVENT CHANGED A BIT!
BYEEE, KLEB

SUDOKU

	5						4	1
	8		3					
6	9		4		7		5	3
2	1		6					9
						5		
8						3	1	2
	6	8	7		1	2	9	4
1				5			3	
7	3	4	9				8	5

HIDATO

	26		18	13	14
28	25	17			12
		21		9	
				36	10
2	4				35
	1			34	33

Fill the grid with numbers in such a way that each number connects to its consecutive neighbors either horizontally, vertically, or diagonally. The finished puzzle will have a completely connected path leading from the smallest number to the largest.



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