

Survival Mode in a Tiny Worm's Brain

LORI DAJOSE
Caltech Strategic Communications

This article is adapted from a story that was originally published online at caltech.edu.

How the minuscule roundworm *C. elegans* rewires its brain in times of stress.

Caenorhabditis elegans, or *C. elegans*, are tiny worms with tiny brains—their whole bodies are the width of a pencil tip and contain only 302 neurons. These nematodes live out their two-week-long lifespans in rotting vegetation, eating bacteria, and avoiding predators. However, *C. elegans* does not always live such a simplistic lifestyle. Under environmental stress—such as when overcrowding leads to lack of food—these creatures can switch into survival mode, halting aging for months and attempting to hitch a ride to a new location by attaching to other animals.

Caltech researchers have now discovered how this worm, with such a limited neurological system, can so drastically change its behaviors. The findings may have implications for understanding how parasitic nematodes find and infect hosts.

The work was done in the laboratory of Paul Sternberg, Bren Professor of Biology. The research is described in a paper that recently appeared in *Proceedings of the National Academy of Sciences*.

When a *C. elegans* worm realizes that its environment is overcrowded and food is running low, it shifts into what is known as the dauer state. These dauer worms are able to halt development and feeding and can survive in this state for six to eight months.

Meanwhile, these worms cannot last forever in this survival mode and must relocate to a better location. However, *C. elegans* can generally only wriggle around without moving very far, meaning that they cannot escape the poor conditions that triggered the dauer state in the first place. Thus, they need to hitch a ride on other animals, like snails or flies. To do this, a worm will nictate, a process in which the worm stands straight up on its tail and waves vigorously as if trying to hail a taxi. Normally, *C. elegans* worms do not nictate. But when dauer worms do, they are more likely to latch onto a

passing animal. Additionally, while *C. elegans* is normally repelled by carbon dioxide (because the gas is likely to have been emitted by a nearby predator), dauer worms are attracted to carbon dioxide—likely because the gas could indicate that a potential carrier animal is nearby.

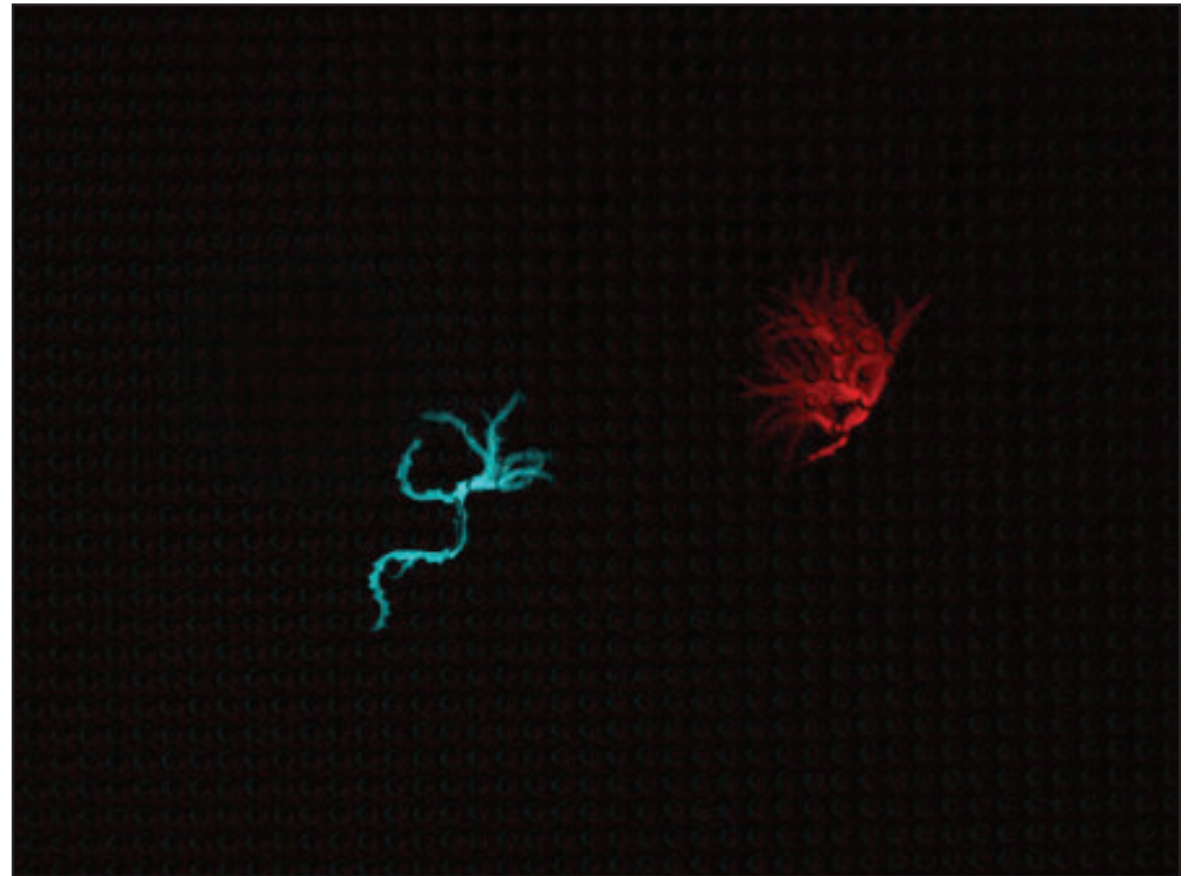
These drastic behavioral changes have been known for some years, but the question still remained: How can a worm with such a tiny nervous system acquire behaviors that are so different from their normal states?

“We decided to build upon previous work by a former graduate student, Oren Schaedel [PhD '10], who measured the expression levels of all 20,000 genes within *C. elegans*,” says graduate student and co-first author James Siho Lee. “Looking at how gene expression changed as the worms went into dauer mode, we found that 8,000 genes were affected—a big percentage! In particular, we noted that genes encoding for certain types of neural signaling molecules called neuropeptides were strikingly up-regulated, or increased. We chose to focus on neuropeptides to see if we could discover more about how the worm's limited neural system can implement such drastic behavioral changes.”

Neurons are physically wired together to form circuits with structures called synapses. The neurons send chemical and electrical signals to other connected neurons through these synapses, like speaking directly to a select group of people. However, a neuron can also send a mass message—like shouting to a crowd—by releasing chemicals called neuropeptides, which flood through intercellular space and signal to neurons that may not be connected through synapses.

The Caltech team found that as *C. elegans* goes into the dauer state, more than half of the genes that encode for neuropeptides are activated more strongly, indicating that the worms are sending many more mass messages.

“We wondered if this increase in neuropeptides was responsible for the transition into dauer. To test this, we used a mutant strain of *C. elegans* that is defective in the gene *sbt-1*, which controls a large fraction of neuropeptides,” says graduate student and co-first author Pei-Yin Shih. “We found



Time-lapsed recordings of dauer worm movement during nictation, a process by which a worm stands on its tail and waves its body in an attempt to latch on to a nearby carrier animal. Mutants that are deficient for neuropeptides (red) exhibit much weaker nictation in the dauer state than normal worms (blue).

Image courtesy of the Sternberg Laboratory

that overall reduced levels of neuropeptides made it much less likely that an animal under stress would go into the dauer state.”

The *sbt-1* mutants did not exhibit any attraction to carbon dioxide and their nictation was feeble, suggesting that the increase in neuropeptides is a critical requirement for *C. elegans* to truly enter the dauer survival mode and gain access to carrier-seeking behaviors.

“These animals are not just hibernating—they are actually triggered by their environments to rewire their own brains,” says Shih.

One particular subset of neuropeptides that increases during the dauer stage is an evolutionarily ancient group called the FMRFamides. Many species of parasitic nematodes, which are responsible for disease in millions of people across the world, also contain FMRFamides.

“Parasitic nematodes only have one stage within their life cycle where they are truly infective and must find a host,” says Lee. “During this stage, they don't feed, they shrink down, and they're very dauer-like. Thus, we're now interested if what we've learned about neuropeptides in *C. elegans* can be carried over into parasitic

worms. Because the FMRFamide family seems to enable access to new, carrier-seeking behaviors in *C. elegans*, we think that studying FMRFamides may reveal strategies for disrupting the host-seeking behaviors of parasitic nematodes, and will shed light on how nervous systems can load up different functions and behaviors under different circumstances.”

The paper is titled “FMRFamide-like peptides expand the behavioral repertoire of a densely connected nervous system.” In addition to Lee, Shih, Schaedel, and Sternberg, other co-authors are Caltech graduate students Porfirio Quintero-Cadena and Alicia Rogers. Funding was provided by the Howard Hughes Medical Institute and the National Institutes of Health.

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Caltech Y Column

CALTECH Y

The Caltech Y Column serves to inform students of upcoming events and volunteer opportunities. The list is compiled by Katherine Guo from information given by the Caltech Y and its student leaders.

Founded by students in 1916, the Y was organized to provide extracurricular activities planned and implemented by students as an opportunity to learn leadership skills and discover themselves. The mission of today's Y remains the same—to provide opportunities that will prepare students to become engaged, responsible citizens of the world. The Y seeks to broaden students' worldviews, raise social, ethical, and cultural awareness through teamwork, community engagement, activism, and leadership. More information about the Caltech Y and its programs can be found at <https://caltechy.org>. The office is located at 505 S. Wilson Avenue.

Upcoming Events

Costa Rica Alternative Spring Break Trip

Saturday, March 17th through Sunday, March 25th (9 days) | Cost: \$950

Applications Due: by Noon on November, 22nd

The Caltech Y is excited to seek applicants for our 2017 Alternative Spring Break trip to Costa Rica. Join other Caltech students for a conservation focused spring break trip this year. On the Costa Rica trip we will be working with a host organization OSA Conservation www.osaconservation.org – which is dedicated to protecting the globally significant biodiversity of Costa Rica's Osa Peninsula. Don't miss out on this fantastic opportunity to explore another part of our planet and make a tangible difference in the world.

Trips fees include transportation, lodging, and most food. The Costa Rica Alternative Spring Break trip is coordinated by the Caltech Y and has been made possible thanks to generous funding from the Frank and Elsie Stefanko Fund, the George Housner Fund, Caltech Student Affairs, and the Caltech Y. Spaces are limited.

Visit http://caltechy.org/programs_services/areas/asb/ for applications and more information.

The Caltech Y Social Activism Speaker Series presents:

Solving Climate Change: From Policy to Personal

Thursday | November 30th | 4:00 to 6:00 PM | Location: TBD

The Caltech Y Social Activism Speaker Series is hosting a panel with members of the Citizens' Climate Lobby, a non-partisan volunteer organization dedicated to national policy to address climate change.

Climate change is one of the most pressing issues facing humanity. While the impacts of emissions up to now will be felt potentially for decades, significant policy changes are required in the immediate future to address greenhouse gas emissions and reverse the warming

trend in the long term. Passing legislation to deal with this pressing issue however, remains a problem. CCL campaigns for the passage of a Carbon Fee and Dividend bill designed to tax carbon emissions and return carbon dioxide to its pre-1990s levels. This discussion will feature a panel of CCL members from a variety of backgrounds each of whom will bring their perspective to this issue. Each panel member will talk about their views and then take questions from the audience.

Presentations are intended to introduce one perspective in order to stimulate thought and to provide a forum for respectful dialogue and examination. The views expressed by speakers are solely those of the speakers. Presentations do not necessarily reflect the opinion of the California Institute of Technology or the Caltech Y and should not be taken as an endorsement of the ideas, speakers or groups.

Decompression 2.0

Friday | December 1st | 3:00 to 5:00 PM | Center for Student Services

We made the move... Decompression is now an end of the week stress reliever with activities, snacks and entertainment. Don't go into finals week stressed out. Join us at the end of class week for a little break before studying. A variety of drinks and snacks, entertainment and activities will be provided.

Caltech Y Explore LA Series The Broad Museum

Sunday | December 3rd | 2:30 PM | Cost: \$5 | Transportation Included

Sign-up starting Thursday, 11/16 at the Caltech Y

Join us on a visit to The Broad with the Caltech Y! The Broad is a contemporary art museum founded by philanthropists Eli and Edythe Broad. Designed by Diller Scofidio + Renfro in collaboration with Gensler, the museum is home to 2,000 works of art from the Broad collection, which is among the most prominent holdings of postwar and contemporary art worldwide, and presents an active program of rotating temporary exhibitions and innovative audience engagement. The 120,000-square-foot building features two floors of gallery space and is the headquarters of The Broad Art Foundation's worldwide lending library, which has actively loaned collection works to museums around the world since 1984. With in-depth representations of influential contemporary artists like Jean-Michel Basquiat, Barbara Kruger, Cy Twombly, Ed Ruscha, Kara Walker, Christopher Wool, Jeff Koons, Joseph Beuys, Jasper Johns, Cindy Sherman, Robert Rauschenberg, and more, plus an ever-growing representation of younger artists, The Broad enriches, provokes, inspires, and fosters appreciation of art of our time. This offer is for students only; however, students purchasing tickets are permitted to purchase tickets for up to one guest each – and that guest can be a non-student. Explore LA is coordinated by the Caltech Y. The Caltech Y is located in the Tyson House 505 South Wilson (Bldg. 128).

Caltechlive!

EARNEST C. WATSON
LECTURE SERIES

WEDNESDAY, FEBRUARY 14, 2018 • 8 PM

USING THE BRAIN OF A MODERN FLY TO RECONSTRUCT THE BEHAVIORS OF AN ANCIENT WORLD



Michael H. Dickinson, Esther M. and Abe M. Zarem Professor of Bioengineering and Aeronautics, Caltech Division of Biology and Biological Engineering

Using an assortment of modern techniques from different fields such as neuroscience, biomechanics, and engineering, Dr. Dickinson is attempting to reconstruct the behavior and ecology of the ancestral insects through his investigations of the common fruit fly. His research provides a fascinating window into the past, providing new insight into the evolution of our planet's most diverse group of organisms.

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* Participants will need to meet at the Caltech Y at 2:30 pm to pick up tickets and coordinate rides. We have a timed entry of 3:30 pm. We will be staying for two hours, then uber'ing back to the Caltech Y. Although tickets are free, we are offering transportation for \$5.

Pasadena LEARNS

Every Friday | 3:00 - 5:00 PM | Pasadena

Come volunteer at Washington Middle and Elementary STEAM School! We are partnered with the Pasadena LEARNS program and work with their Science Olympiad team or do regular tutoring along with occasional hands-on science experiments. Transportation is provided.

For more information and to RSVP, contact azhai@caltech.edu. Eligible for Federal Work Study.

Hathaway Sycamores

Every Monday | 5:45 - 8:00 PM | Highland Park

Volunteer at Hathaway Sycamores, a group that supports local underprivileged but motivated high school students. There are a variety of ages and subjects being tutored. The service trip includes about 40 minutes of travel time and 1.5 hours of tutoring. Transportation is included.

For more info and to RSVP email Elisabeth at egallmei@caltech.edu. Eligible for Federal Work Study.

Mentors for L.I.F.E

Volunteer times: 2:45 - 5:00 PM at various locations in Pasadena

Stressed out by school? Step outside the Caltech bubble and mentor tweens who've yet to even consider college. Things you could do: Build a baking soda and vinegar volcano, read a book aloud, play sports or board games, teach the alphabet of another language, do a craft. Having a mentor makes an at-risk student 55% more likely to attend college, 78% more likely to volunteer regularly, and 130% more likely to hold a leadership position. Interested? If you have 180 seconds, you can watch this video and be inspired. If you have an hour a week, you can mentor someone and be their inspiration. If you feel unqualified, don't worry. Ultimately, mentoring is about being a consistent, dependable friend—not a surrogate parent or psychiatrist.

To get started, contact noelle@caltech.edu.

Explorer 1: The Beginning of American Space Science

PRESTON DYCHES
JPL Media Relations

This article is adapted from a story that was originally published online at caltech.edu.

Sixty years ago this week, the hopes of Cold War America soared into the night sky as a rocket lofted skyward above Cape Canaveral, a soon-to-be-famous barrier island off the Florida coast.

United States and the Soviet Union were proceeding toward the capability to put a spacecraft in orbit. Yet great uncertainty hung over the pursuit. As the Cold War between the two countries deepened, it had not yet been determined whether the sovereignty of a nation's borders extended upward into space. Accordingly, then-President Eisenhower sought to ensure that the first American satellites were not perceived to be military

against Britain during the war.

JPL's role was to prepare the three upper stages for the launch vehicle, which included the satellite itself. These used solid rocket motors the laboratory had developed for the Army's Sergeant guided missile. JPL would also be responsible for receiving and transmitting the orbiting spacecraft's communications. In addition to JPL's involvement in the Orbiter program, the laboratory's then-director, William Pickering, chaired the science committee on satellite tracking for the U.S. launch effort overall.

The Navy's entry, called Vanguard, had a competitive edge in that it was not derived from a ballistic missile program -- its rocket was designed, from the ground up, for civilian scientific purposes. The Army's Jupiter-C rocket had made its first successful suborbital flight in 1956, so Army commanders were confident they could be ready to launch a satellite fairly quickly. Nevertheless, the Navy's program was chosen to launch a satellite for the IGY.

University of Iowa physicist James Van Allen, whose instrument proposal had been chosen for the Vanguard satellite, was concerned about development issues on the project. Thus, he made sure his scientific instrument payload -- a cosmic ray detector -- would fit either launch vehicle. Meanwhile, although their project was officially mothballed,

JPL engineers used a pre-existing rocket casing to quietly build a flight-worthy satellite, just in case it might be needed.

The world changed on Oct. 4, 1957, when the Soviet Union launched a 23-inch (58-centimeter) metal sphere called Sputnik. With that singular event, the space age had begun. The launch resolved a key diplomatic uncertainty about the future of spaceflight, establishing the right to orbit above any territory on the globe. The Russians quickly followed up their first launch with a second Sputnik just a month later. Under pressure to mount a U.S. response, the Eisenhower administration decided a scheduled test flight of the Vanguard rocket, already being planned in support of the IGY, would fit the bill. But when the Vanguard rocket was, embarrassingly, destroyed during the launch attempt on Dec. 6, the administration turned to the Army's program to save the country's reputation as a technological leader.

Unbeknownst to JPL, von Braun and his team had also been developing their own satellite, but after some consideration, the Army decided that JPL would still provide the spacecraft. The result of that fateful decision was that JPL's focus shifted permanently -- from rockets to what sits on top of them.

The Army team had its orders to be ready for launch within 90 days. Thanks to its advance preparation, 84 days later, its satellite stood on the launch pad at Cape Canaveral Air Force Station in Florida.

The spacecraft was launched at 10:48 p.m. EST on Friday, Jan. 31, 1958. An hour and a half later, a JPL tracking station in California picked up its signal transmitted from orbit. In keeping with the desire to portray the launch as the fulfillment of the

U.S. commitment under the International Geophysical Year, the announcement of its success was made early the next morning at the National Academy of Sciences in Washington, with Pickering, Van Allen and von Braun on hand to answer questions from the media.

Following the launch, the spacecraft was given its official name, Explorer 1. (In the following decades, nearly a hundred spacecraft would be given the designation "Explorer.") The satellite continued to transmit data for about four months, until its batteries were exhausted, and it ceased operating on May 23, 1958.

Later that year, when the National Aeronautics and Space Administration (NASA) was established by Congress, Pickering and Caltech worked to shift JPL away from its defense work to become part of the new agency. JPL remains a division of Caltech, which manages the laboratory for NASA.

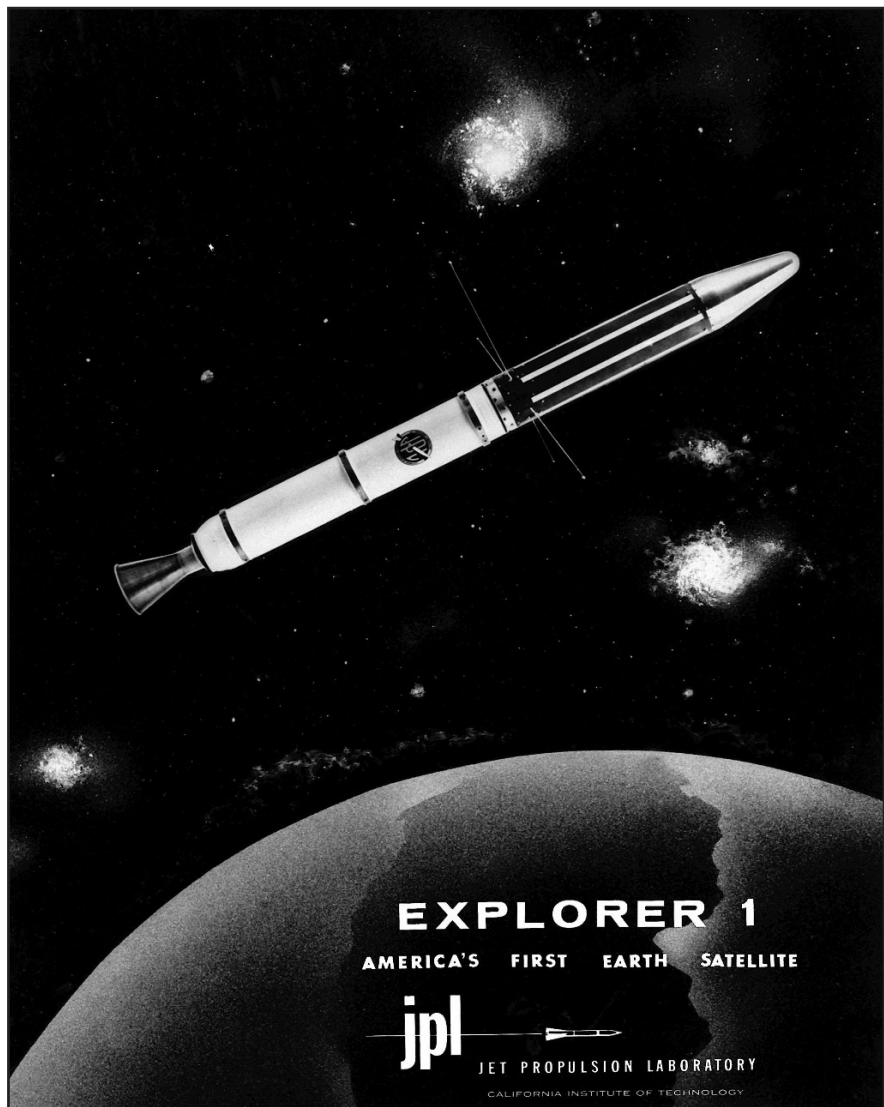
The beginnings of U.S. space exploration were not without setbacks -- of the first five Explorer satellites, two failed to reach orbit. But the three that made it gave the world the first scientific discovery in space -- the Van Allen radiation belts. These doughnut-shaped regions of high-energy particles, held in place by Earth's magnetic field, may have been important in making Earth habitable for life. Explorer 1, with Van Allen's cosmic ray detector on board, was the first to detect this phenomenon, which is still being studied today.

In advocating for a civilian space agency before Congress after the launch of Explorer 1, Pickering drew on Van Allen's discovery, stating, "Dr. Van Allen has given us some completely new information about the radiation present in outer space.... This is a rather dramatic example of a quite simple scientific experiment which was our first step out into space."

Explorer 1 re-entered Earth's atmosphere and burned up on March 31, 1970, after more than 58,000 orbits.

For more information about Explorer 1 and the 60 years of U.S. space exploration that have followed it, visit:

<https://explorer1.jpl.nasa.gov>



America's First Satellite. America joined the space race with the launch of this small, but important spacecraft.

Image courtesy of NASA/JPL-Caltech

or national security assets.

In 1954, an international council of scientists called for artificial satellites to be orbited as part of a worldwide science program called the International Geophysical Year (IGY), set to take place from July 1957 to December 1958. Both the American and Soviet governments seized on the idea, announcing they would launch spacecraft as part of the effort. Soon, a competition began between the Army, Air Force and Navy to develop a U.S. satellite and launch vehicle capable of reaching orbit.

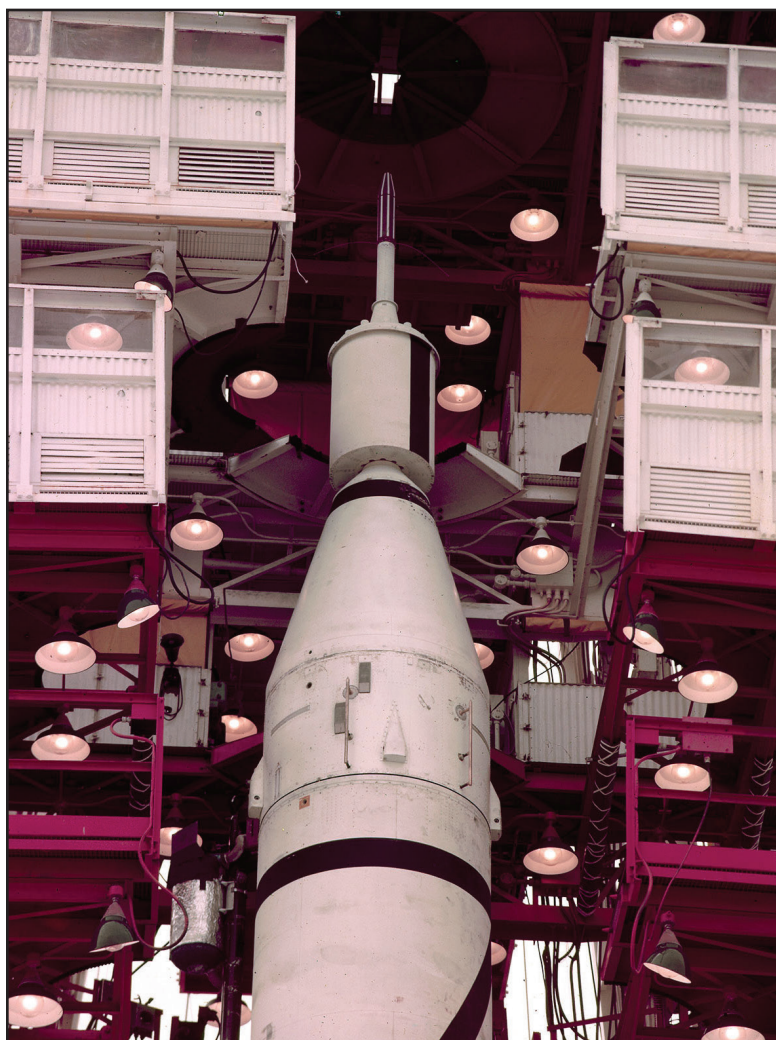
At that time, JPL, which was part of the California Institute of Technology in Pasadena, primarily performed defense work for the Army. (The "jet" in JPL's name traces back to rocket motors used to provide "jet assisted" takeoff for Army planes during World War II.) In 1954, the laboratory's engineers began working with the Army Ballistic Missile Agency in Alabama on a project called "Orbiter." The Army team included Wernher von Braun (who would later design NASA's Saturn V rocket) and his team of engineers. Their work centered around the Redstone Jupiter-C rocket, which was derived from the V-2 missile Germany had used

The date was Jan. 31, 1958. NASA had yet to be formed, and the honor of this first flight belonged to the U.S. Army. The rocket's sole payload was a javelin-shaped satellite built by the Jet Propulsion Laboratory in Pasadena, California. Explorer 1, as it would soon come to be called, was America's first satellite.

Against the backdrop of the 1950s Cold War, after the Soviet Union successfully launched Sputnik, Americans were determined to launch their own Earth-orbiting satellite. Flash back to events leading up to the successful launch of America's Explorer 1, and the beginnings of America's Space Age, as told through newsreel and documentary clips of the time.

"The launch of Explorer 1 marked the beginning of U.S. spaceflight, as well as the scientific exploration of space, which led to a series of bold missions that have opened humanity's eyes to new wonders of the solar system," said Michael Watkins, current director of JPL. "It was a watershed moment for the nation that also defined who we are at JPL."

In the mid-1950s, both the



Explorer 1 sits atop the Jupiter-C rocket (designated "Juno-1") in the gantry as its launch date nears.

Image courtesy of NASA

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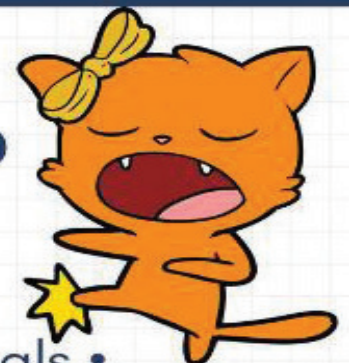
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Gallup named SCIAC Athlete of the Week

GOALTECH.COM
Actual Sports Content Editor

LAGUNA NIGUEL, Calif. (Jan. 22, 2018) – Sophomore swimmer Thomas Gallup has been named SCIAC Athlete of the Week per the conference's Monday release.

The second-year swimmer becomes the first male Beaver to earn the honor this year. The reigning SCIAC Newcomer of the Year, Gallup set an Axelrod Aquatics Center pool

record Saturday at Claremont-Mudd-Scripps College when he defeated both the Stags and Occidental College in the 100 breast (56.99) in dominant fashion, outpacing the field by over one second over multiple heats. He also finished nearly two seconds off the Caltech record time of 55.06, a record which he owns and set at last year's NCAA Division III Championships. Earlier in the day, he helped the men's 200 medley relay team to a second-place finish and victory over Oxy.



"Bruh...I'm stoked. I shredded some gnarly (pool) waves."

-goaltech.com

Haleftiras solid from deep at Whittier



That awkward moment when you forget how to dribble and the ball runs away.

-goaltech.com

GOALTECH.COM
Actual Sports Content Editor

WHITTIER, Calif. (Jan. 24, 2018) – Junior guard Nika Haleftiras of the Caltech women's basketball team picked up the offense with a greater emphasis on three-point shooting at Whittier College on Wednesday evening.

Haleftiras attempted a personal-high 10 three-pointers and connected on three of them to help her to 11 points while playing nearly the entire game. Sophomore guard Samantha D'Costa supported Haleftiras with a team-high 16 points and did half of

her damage from the free throw line with an 8-for-10 shooting line. She also came up with six rebounds, all of which came on the defensive side and added three assists and two steals. Sophomore guard Grace Peng also hit double-figures with 10 points, all of which came from the field. Caltech put together its best all-around 10 minutes in the fourth quarter, where they outscored Whittier, 17-14. Six different players scored in the quarter and the team defense held the Poets to their fewest points since the opening frame.

Men's basketball Pressures Whittier late, breaks Season Three's record

GOALTECH.COM
Actual Sports Content Editor

PASADENA (Jan. 24, 2018) – The Caltech men's basketball team came to life in the second half, and in doing so broke the program's single-season three-point record against visiting Whittier College Wednesday evening. The Beavers entered the game needing three triples to tie the record and four to break it.

Six of the team's three-point field goals came in the second half, which they entered trailing the visiting Poets, 41-24. Much like the team's last home game against California Lutheran University, however Caltech was not to be counted out. The Beavers stuck to the three in the latter half and eventually put themselves in a position to tie the game. While he did not contribute to his team's three-point sum, senior David Kawashima led all scorers with 22 points on 7-of-10 shooting and 8-of-10 shooting from the free throw



The ref yells at DK for breaking Dua Lipa's new rules.

-goaltech.com

line. He also pulled down nine rebounds, needing one more for a double-double and stole the ball three times. Freshman Gokul

Srinivasaragavan led the charge from deep with all nine of his points coming on the heels of three three-pointers while fellow freshman

Marcus Gee connected from deep twice to help him to 17 points.

Trailing the Poets by 20 points with just over 10 minutes to go, the Beavers got in gear and hung a 32-14 run on the Poets late capped by a Gee three-pointer with 32 seconds to go to put the home team down by just two points. Tensions mounted when following two Whittier free throws, freshman forward Spencer Schneider came back down the court and knocked down a three-pointer of his own to cut the deficit to one point. After the visitors made just one of their two free throws on the ensuing foul, Kawashima took a desperation drive to the rim with just five seconds to go, drew contact but did not get the call he and his teammates and coaches were looking for. The Beavers' proven resiliency, however should make them a tall order for the rest of the conference going forward in the stretch run.

ANNOUNCEMENT:

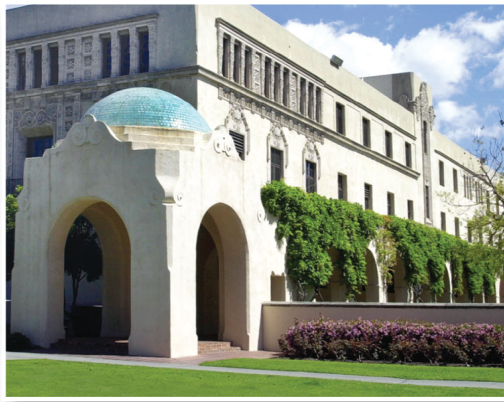
VICE PROVOST, CHIEF DIVERSITY OFFICER, AND PROFESSOR OF ENGLISH CINDY WEINSTEIN HOLDS REGULAR OFFICE HOURS AS AN OPPORTUNITY FOR UNDERGRADUATE STUDENTS, GRADUATE STUDENTS, AND POSTDOCS TO MEET FOR DISCUSSIONS PERTAINING TO THE COUNCIL ON UNDERGRADUATE EDUCATION; CALTECH ACCREDITATION; THE STAFF AND FACULTY CONSULTATION CENTER; STUDENT-FACULTY PROGRAMS; THE CENTER FOR TEACHING, LEARNING, AND OUTREACH; THE CALTECH DIVERSITY CENTER; AND THE CALTECH LIBRARIES.

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STUDENT OFFICE HOURS FOR WINTER TERM 2018:

2/15/18 THURSDAY 9:00-10:00 A.M.
 2/21/18 WEDNESDAY 11:00 A.M.-12:00 P.M.
 2/27/18 TUESDAY 10:00-11:00 A.M.
 3/8/18 THURSDAY 11:00 A.M.-12:00 P.M.
 3/12/18 MONDAY 10:00-11:00 A.M.
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ASCIT Minutes

Meetings are every week in SAC 13

No Minutes Submitted for Week of January 29th

ASCIT Board of Directors Meeting: VPSA

Minutes for January 18, 2017. Taken by Dana He.

Officers Present: Sakthi Vetrivel, Kavya Sreedhar, Rachael Morton, Sarah Crucilla, Alice Zhai, Dana He

Guests: Kevin Gilmartin, Joe Shepherd, Tom Mannion

Call to Order: 12:11 pm

President's Report (Sakthi):

- Nothing to report.

Officer's Reports:

V.P. of Academic Affairs (Kavya):

- Thinking of introducing course complements to recognize the good in courses. Students can submit recommendations for courses and could possibly tie this to Take a Prof. out to Lunch. Thinking of starting this on a monthly basis to try it out.
- Course capture has begun. Trying it on CS 21.
- Software seminar will be soon to teach Mathematica.
- Trying to bring back research list for professors looking for students during the school year.
- Looking to introduce undergraduate and graduate student research seminars.
- Math 13 course created to teach students multi-variable calculus for Physics 1b analytical. 50 students enrolled. Positive feedback.
- Creating committee for core curriculum revision.

V.P. of Non-Academic Affairs (Rachael):

- COUCH met with Joes last night about Polaris report. Will meet with faculty and staff groups soon.

Director of Operations (Sara):

- Not in attendance.

Treasurer (Sarah):

- Nothing to report.

Social Director (Alice):

- Saturday is a Six Flags Magic Mountain Trip. Used Marsh fund to subsidize tickets for 75 students. Sign-ups filled up in under 5 minutes. Tickets were \$40 each for group tickets. Buses will take students at 10 am and leave at 6 pm. Could talk to Dean's Office to try to get more tickets.
- Would like to use Marsh fund to subsidize tickets for Cirque du Soleil.
- Be a Kid Again Day will be Sunday, February 25.
- ASCIT formal will be at Hotel Alexandria in downtown LA.

Secretary (Dana):

- Nothing to report.

If anyone has any questions or concerns about a section of the minutes please email the appropriate officer. We are happy to answer any questions.

Meeting Adjourned: 12:38 pm

ARC Minutes 1.28.2018

Present: Kavya Sreedhar, Vibha Vijayakumar, Michael Yao, Matthew Zeitlin, Shreya Ramachandran, Arushi Gupta, Camilla Ora, Alice Jin, Alejandro Lopez, Allison Tang, Timothy Liu

Minutes submitted by: Allison Tang and Shreya Ramachandran

1. Programming

- Student Faculty Lunches (SFLs): likely week 8, send prof invitations this week.
- Course Compliments: choose winning prof/TA and arrange lunch every 2 weeks
- Software Seminars: around 20 people came
- UG+Grad Student Research Seminars: talk to GSC Academics Chair to start organizing
- Ombuds Training: probably don't need second ombuds training
- Course Concerns: rotation for ARC members on course concerns
- Option Fair: before registration for next term, hold fair on Olive Walk

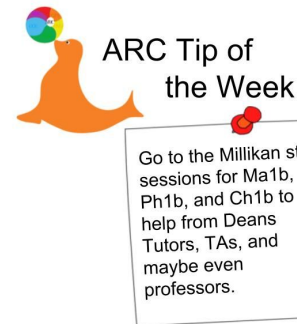
2. Projects

- TQFR Improvement: discuss TQFR guide with Jenn from CTLO this Thursday
- Core Connections: CS141 project to research how core classes are connected to other classes; open source tool for crowdsourcing data.

3. Miscellaneous

- ARC turnover: new members joining
- CS2: talk to Deans Tutors about holding Millikan study session, maybe Saturday

The ARC website at arc.caltech.edu has more information about what the ARC does if you are interested. We meet every Sunday at 11am in SAC13 and our meetings are open to everyone! If you have any questions, please feel free to email ksreedha@caltech.edu.



Crossword

Across

- Stage
- Yawn
- Pace
- Consumed
- Examination by word of mouth
- Story
- Decelerates
- Pay back
- Peak
- Relating to the nose
- Go in
- Female horse
- Floor covering
- Go on board
- Chinese currency
- Any high mountain
- Elk
- Taxonomic group
- Armed conflict
- Partiality
- Terrestrial gastropod mollusk
- Finishing line of a foot race
- Make a mistake
- Visual communication
- Pocketbook
- Arm of the Indian ocean, ___ Sea
- Angry disputes
- Onus
- Surface excavation
- Ego

- Magical spell
- Part of a jacket
- Pole
- Open to arguments, ideas or change
- Mental representation
- Weapons
- Graphic symbol
- Mother-of-pearl
- Departs
- Semiaquatic salamander
- Avarice

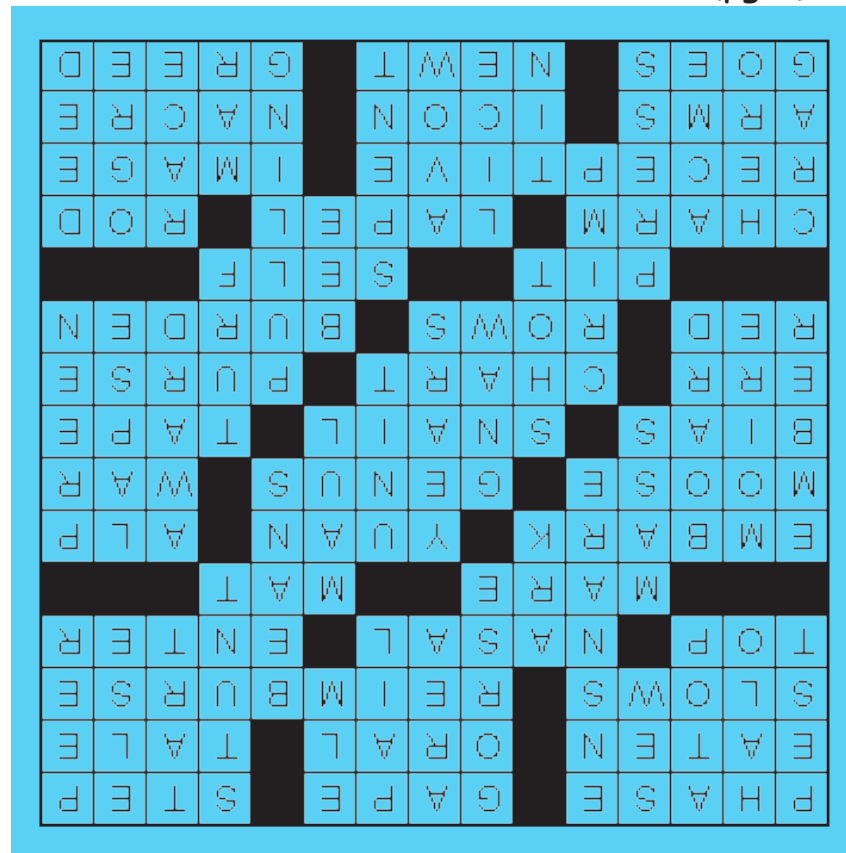
Down

- Persistently annoying person
- Aura
- At the summit
- Darn
- Trammel
- Spiny evergreen shrub
- Region
- Bucket
- Type of tree
- Unusual or dangerous feat
- Open pastry
- Other than what is under consideration
- Look searchingly
- Leguminous plants
- Biblical boat
- Join or gather together to form a whole
- Sledgehammer

- Hot fragment of wood or coal
- Silk fabric with a wavy pattern
- Committee with supervisory powers
- A prolonged period of time
- Division of quantity
- Accolade
- Oversight
- Clean with a bill
- Eat at
- Informal photograph
- Surface layer of grass and roots
- Curl tightly
- Drawing
- Drone
- Printing machine
- Drained of energy
- Steep rugged rock or cliff
- Champion
- Highest level attainable
- Parasitic insects
- Aver
- Speed competition
- Fiend
- Legal document of title
- Metallic element
- Spoil

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Answers to current crossword (pg 7)



-<http://puzzlechoice.com>

The California Tech

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