A new helper in the fight against cancer and other diseases of the gut may be genetically altered bacteria that release medicines to tumors or the gut.

Now, a new study performed using mice demonstrates how doctors might one day better regulate those therapeutic microbes by engineering them to respond to temperature. For instance, if engineered bacteria were administered to a patient with a disease, doctors could, in theory, instruct the bacteria to release medicine to just the site of interest, and nowhere else in the body, by using ultrasound to gently heat up the tissue.

“Bacteria can be designed to act like special agents fighting disease in our bodies,” says Caltech’s Mikhail Shapiro, assistant professor of chemical engineering and Heritage Principal Investigator, whose overall research goal is to create new ways to both visualize and control cells—bacterial cells and human cells—for medicinal purposes. “We’re building walkie-talkies for the cells so we can both listen and talk to them.” Shapiro is principal investigator on a paper about the new research published November 14 in the journal Nature Chemical Biology. The colead authors are Dan Piraner and Mohamad Abedi, graduate students in Shapiro’s lab.

The research demonstrates how the bacteria could be designed to destroy themselves once they leave a patient’s body through defecation. The lower temperature outside of a host’s body would signal the engineered bacteria to activate a genetic kill switch, thereby alleviating concerns about the genetically altered microbes spreading to the environment. “We can use these thermal switches in bacteria to control a variety of behaviors,” says Shapiro.

The glowing images in this animation were drawn on petri-dish plates with bacteria. The bacteria were engineered to respond to temperature changes. The bacteria seen in the sun express green fluorescent protein at temperatures above 36 degrees Celsius. Bacteria seen in the sun express a red fluorescent protein above 40 degrees Celsius. Bacteria in the lawn have both the green and red thermal switches, and thus turn yellow at the higher temperatures. (Image credit: Shapiro Lab/Caltech)

The glowing images in this animation were drawn on petri-dish plates with bacteria. The bacteria were engineered to respond to temperature changes. The bacteria seen in the tree express green fluorescent protein at temperatures above 35 degrees Celsius. Bacteria seen in the tree express a red fluorescent protein above 40 degrees Celsius. Bacteria in the lawn have both the green and red thermal switches, and thus turn yellow at the higher temperatures. (Image credit: Shapiro Lab/Caltech)

The method developed by Shapiro’s lab solves this problem by providing a mechanism through which bacteria can be instructed to direct drugs only to a specific anatomical site. The idea is that the genetically engineered bacteria would activate their therapeutic program at a certain temperature interval induced via ultrasound tools, which

Continued on page 3
Caltech Y Column

Saturday | November 19th | 5:30 AM - 12:30 PM | Boys and Girls Club Pasadena

The Boys and Girls Club of Pasadena promotes the health, social emotional, social vocational, and character development of young boys and girls. Volunteers will help spread clean up and do other gardening tasks to improve the front of the Pasadena center.

Transportation and lunch are provided. Please RSVP here: https://goo.gl/forms/uSQQaXYgKKseregk2

3. Union Station Adult Center
Saturday | November 19th | 5:00 - 9:15 PM | Pasadena

Prepare and serve dinner to the residents at Union Station Adult Center in Pasadena. Food and materials are provided. The Adult Center provides shelter, meals and support services to more than 150 homeless men and women each year.

For more info and to RSVP email rslva@caltech.edu.

4. HathaYav Samcayore
Every Monday | 5:30 - 7:00 PM | Highland Park

Volunteer at HathaYav Samcayore, 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 an hour of travel time and 1.5 hours of tutoring. Transportation is included. For more info and to RSVP email email Marshall and Richdard at sripir.caltech.edu. Eligible for Federal Work Study.

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

Come volunteer at 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 aha@caltech.edu. Eligible for Federal Work Study.

6. Caltech Y Decompression
Saturday | December 3rd | 9:00 PM | Winnett Lounge

Stressed during finals week? Join us to decompress with free food - burgers, hot dogs, cookies, fruit and vegetables, ice cream, chips and drinks; entertainment - movies; and just hanging out with your friends. It is a great way to relax a little before the first finals of the school year!

7. The Patrick Hummel and Harry Gray Travel Fund
Applications due January 10th, 2017

The Patrick Hummel and Harry Gray Travel Fund was established as a joint gift from Carla and Paul Hummel, Patrick Hummel, and Shirley and Harry Gray, Arnold O. Beckman Professor of Chemistry and Founding Director of the Beckman Institute. The endowed fund supports undergraduate travel opportunities that promote professional and leadership development and broadens students’ perspective as engaged, responsible citizens of the world.

To apply and for more information, please visit http://caltechy.org/. circuits/services/resources/PHHGTF.php

Beyond the Y

1. Tutors needed for Aspires West
Tutors are desperately needed for the Aspires West after-school program: math (general math, geometry, algebra 1 and 2) and English for elementary, middle and high school students.

Tutor schedules are Monday through Thursday, 4 - 7 p.m.; Saturday, 8:30-12:30 p.m. Aspires West, Pasadena (AWP) provides low-income students and parents with services and opportunities that provide the knowledge and fundamental skills for student success. Interested volunteers should contact: inbox@fostercareproject.org.

2. Mentors needed for Hathaway - Samcayore
Hathaway - Samcayore, Child and Family Service, is seeking mentors for their El Nido (Altadena) Residential Campus. The Hathaway - Samcayore mission is to help cultivate hope and resilience in children, adults, families and communities. Interested volunteers should contact: inbox@fostercareproject.org

Support the Y
everytime you shop on AmazonSmile!

Black Friday is fast approaching and you can support the Caltech Y while you do your holiday shopping! If you shop at AmazonSmile, Amazon donates 0.5% of the purchase price to Caltech Y. Bookmark this link: http://smile.amazon.com/ch/95-1684790 and support us every time you shop.

If you’d like to volunteer to help out, please fill out the form here: https://goo.gl/forms/ezSDGIzGK7uxyc12

Volunteers get a free gift card!
Turning Back the Aging Clock

LORI DAJOSE
Caltech Media Relations

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

Researchers from Caltech and UCLA have developed a new approach to removing cellular damage that accumulates with age. The technique could potentially help slow or reverse an important cause of aging.

Led by Nikolay Kandul, senior postdoctoral scholar in biology and biological engineering in the laboratory of Professor of Biology Bruce Hay, the team developed a technique to remove mutated DNA from mitochondria, the small organelles that produce most of the chemical energy within a cell. A paper describing the research appeared in the November 14 issue of Nature Communications.

There are hundreds to thousands of mitochondria per cell, each of which carries its own small circular DNA genome, called mtDNA, the products of which are required for energy production. Because mtDNA has limited repair abilities, normal and mutant versions of mtDNA are often found in the same cell, a condition known as heteroplasmy. Most people start off life with some level of heteroplasmy, and the levels of mutant mtDNA increase throughout life. When a critical threshold level of mutant mtDNA is passed, cells become nonfunctional or die.

The accumulation of mutant mtDNA over a lifetime is thought to contribute to aging and degenerative diseases of aging such as Alzheimer’s, Parkinson’s, and sarcopenia—age-related muscle loss and frailty. Inherited defects in mtDNA are also linked to a number of conditions found in children, including autism.

“We know that increased rates of mtDNA mutation cause premature aging,” says Hay, Caltech professor of biology and biological engineering. “This, coupled with the fact that mutant mtDNA accumulates in key tissues such as neurons and muscle that lose function as we age, suggests that if we could reduce the amount of mutant mtDNA, we could slow or reverse important aspects of aging.”

The team—in collaboration with Ming Guo, the P. Gene and Elaine Smith Chair in Alzheimer’s Disease Research and professor of biology and neurodegenerative disease at UCLA, and UCLA graduate student Ting Zhang—genetically engineered Drosophila, the common fruit fly, so that about 75 percent of the mtDNA in muscles required for flight, one of the most energy-demanding tissues in the animal kingdom, undergoes age-dependent mutation in early adulthood. This model recapitulates aging in young animals. Drosophila grow quickly and most human disease genes have counterparts in the fly, making it an important model in which to study the molecular mechanisms of aging-related processes. The researchers chose to focus on muscle because this tissue undergoes age-dependent decline in all animals, including humans, and it is easy to see the consequences of loss of function.

Unlike mutations in the nucleus, which can be corrected through cellular repair mechanisms, mutations in mtDNA are often not repaired. However, cells can break down and remove dysfunctional mitochondria through a process called mitophagy, a form of cellular quality control. What was unclear prior to this work was whether this process could also promote the selective elimination of mutant mtDNA.

The team found that when they artificially increased the activity of genes that promote mitophagy, including that of several genes implicated in familial forms of Parkinson’s disease, the fraction of mutated mtDNA in the fly muscle cells was dramatically reduced. For example, overexpressing the gene parkin, which is known to specifically promote the removal of dysfunctional mitochondria and is mutated in familial forms of Parkinson’s disease, reduced the fraction of mutated mtDNA by 76 percent to 5 percent, while the overexpression of the gene Atgs4 reduced the fraction to 4 percent.

“Such a decrease would completely eliminate any metabolic deficits in these cells, essentially restoring them to a more youthful, energy-producing state,” notes Hay. “The experiments serve as a clear demonstration that the level of mutant mtDNA can be reduced in cells by gently tweaking normal cellular processes.”

“Now that we know mtDNA quality control exists and can be enhanced, our goal is to work with Dr. Guo’s lab to search for drugs that can achieve the same effects,” Hay adds. “Our goal is to create a future in which we can periodically undergo a cellular housecleaning to remove damaged mtDNA from the brain, muscle, and other tissues. This will help us maintain our intellectual abilities, mobility, and support healthy aging more generally.”

The study is entitled “Selective removal of deletion-bearing mitochondrial DNA in heteroplasmic Drosophila.” The work was supported by grants to Guo from the National Institutes of Health, the Kenneth Glenn Family Foundation, and the Natalie K. and Eugene S. Jones Fund in Aging and Neurodegenerative Disease Research; and to Hay and Guo from the Ellison Medical Foundation.

Findings have novel applications generated versions with activation temperatures between 36 and 39 degrees Celsius. When these genetic switches are used to control the expression of therapeutic proteins, they can act like thermal controls to turn the therapy on or off at a given temperature.

“Now that we were thinking about how to get bacteria to sense temperature, we looked at nature and found a few systems where bacteria can do this,” says Piraner. “We tested the performance, found the ones that had the best switching performance. From there, we went on to find that they could be tuned and amplified. It all started with what nature gave us, and engineering took us the rest of the way.”

The study, titled, “Tunable Thermal Bioswitches for In Vivo Control of Microbial Therapeutics,” was funded by the Defense Advanced Research Projects Agency, the Weston Havens Foundation, and the Burroughs Wellcome Career Awards at the Scientific Interface, and the Heritage Medical Research Institute as well as through graduate fellowships from the National Science Foundation and the Paul and Daisy Soros Fellowship for New Americans. Other Caltech coauthors are Brittany Moser, now a student at UC Irvine, and research technician Audrey Lee Gosalin.

MITCHONDRIAL DNA IS THE SMALL CIRCULAR CHROMOSOME FOUND INSIDE MITOCHONDRIA. THE MITOCHONDRIA ARE ORGANELLES FOUND IN CELLS THAT ARE THE SITES OF ENERGY PRODUCTION.

-http://www.genome.gov/ (CC0)
Mindfully Resilient

Mindfulness-based cognitive therapy is an 8-week structured program designed to reduce future depressive relapse. If you’ve ever dealt with depression before, and are not currently dealing with a depressive episode, you are invited to schedule a 30-minute screening interview for the Winter group. It will meet Thursdays from 4:00 – 6:00 beginning the second week of the term.

Mindfully Resilient is open to all currently enrolled Caltech graduate and undergraduate students. Call the counseling center at (626) 395-8331, or visit counseling.caltech.edu for more information.

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Must qualify for CEFCU membership to join. Minimum $5 deposit and one-time $5 membership fee due upon opening any CEFCU account. Federally insured by NCUA.

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626/395-6300 • 800/592-3328 • www.cefcu.org
Galliani to give the Beavers an early boost

He drained the game's first shot, a three against a larger Titans squad by making to get to them, the Beavers started strong. Involved in.

They allow us to really look at every detail we don't have much info on the opponents. Oliver Eslinger said. “They provide great is to help us prep in the best manner possible to opponent.

game in program history against a Division I opponent.

The reason we play these Division I games is to help us prep in the best manner possible for the rest of the season,” Head Coach Dr. Oliver Edlinger said. “They provide great challenges since they are on the road and we don’t have much info on the opponents. They allow us to really look at every detail of the game. Plus, they are really fun to be involved in.”

Determined not to allow the road nerves to get to them, the Beavers started strong. Senior big man Nasser Al-Rayes held his own against a larger Titans squad by making plays both in the paint and on the perimeter. He drained the game’s first shot, a three-pointer on a pass from fellow senior Ricky Galliani to give the Beavers an early boost and finished the game 3-for-9 from beyond the arc. The versatile center was an especially big part of the Beavers’ game plan early on, as he logged 13 of the team’s 18 first-half points, while Galliani finished the contest with four points of his own.

As the Titans began to find their rhythm offensively, the Beavers responded with a more aggressive defensive approach in the second half. Al-Rayes fouled out with three minutes remaining, but not before gathering a team-high 17 points and six rebounds in each with 5-for-11, converted on five free throws and added two assists, three steals and one block. D’Costa even scored the Beavers’ first two points of the season on a layup in transition following a Lewis steal.

Sophomore guard and fellow San Diegan Nika Haleftiras and Alexa Lauinger each scored eight points to give their team some key depth scoring. Freshman Grace Peng got the start at guard and responded by hitting the starting point guard and responded by leading the team with four assists to go with seven points.

Caltech had its chances throughout, and looked especially in sync early when it took a 21-16 lead into the second quarter. Neither team led by more than eight points and the Beavers even outshot and outrebounded the Redhawks by the time the final buzzer sounded.

Freshman guard Alec Andrews got his start in his first regular season game at Caltech and made the most of his opportunity. Andrews, who also started against Cal State Fullerton last Friday, led the Beavers with 12 points, all of which came from four three-pointers on six attempts. Three of Andrews’ triples came in the second half when his team needed them the most. Andrews also contributed in other facets of the game with five rebounds, two assists and two steals.

Senior center Nasser Al-Rayes asserted himself beneath the glass despite only scoring five points. Al-Rayes closed the game with 12 rebounds, 11 of which came on defense. He also blocked four shots, more than any other player on either team.

Seniors Ricky Galliani and David LeBaron each had 10 points and four rebounds. Galliani got to the free throw line more than any other player and converted on five of his eight attempts.

Occidental threatened to pull away early in the second half, but Caltech kept things close with a 11-5 scoring run keyed by an Andrews three-pointer at 13:16. By the four-minute mark, however, the Tigers had put the game firmly out of reach.

Andrews tries with all his might to prove that he is so much more than “just a fresh.”

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“We prepare to be successful at each phase of the game,” Edlinger said. “We are amped about the season opener and believe there is exciting basketball ahead on Tuesday and way beyond. Our fans are going to see great athleticism,” Edlinger said. “We came out ready and focused on specific details. That was good to see. We created good opportunities for ourselves on both ends of the court.”

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Men’s basketball battles DI CSU Fullerton

FULLERTON, Calif. (Nov. 11, 2016) -- The Caltech men’s basketball team rounded out its preseason schedule when it took on Division I California State University, Fullerton at Titan Gym on Friday night. The Titans were not the first DI team the Beavers saw this preseason, with Caltech previously having battled Big West Conference favorite Long Beach State the prior weekend. Friday’s game marked the second time the Beavers have played the Titans, as the first meeting back in 2014 was Caltech’s first game in program history against a Division I opponent.

“The reason we play these Division I games is to help us prep in the best manner possible for the rest of the season,” Head Coach Dr. Oliver Edlinger said. “They provide great challenges since they are on the road and we don’t have much info on the opponents. They allow us to really look at every detail of the game. Plus, they are really fun to be involved in.”

Determined not to allow the road nerves to get to them, the Beavers started strong. Senior big man Nasser Al-Rayes held his own against a larger Titans squad by making plays both in the paint and on the perimeter. He drained the game’s first shot, a three-pointer on a pass from fellow senior Ricky Galliani to give the Beavers an early boost and finished the game 3-for-9 from beyond the arc. The versatile center was an especially big part of the Beavers’ game plan early on, as he logged 13 of the team’s 18 first-half points, while Galliani finished the contest with four points of his own.

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Sophomore guard and fellow San Diegan Nika Haleftiras and Alexa Lauinger each scored eight points to give their team some key depth scoring. Freshman Grace Peng got the start at guard and responded by hitting the starting point guard and responded by leading the team with four assists to go with seven points.

Caltech had its chances throughout, and looked especially in sync early when it took a 21-16 lead into the second quarter. Neither team led by more than eight points and the Beavers even outshot and outrebounded the Redhawks by the time the final buzzer sounded.

Freshman guard Alec Andrews found his way into the starting lineup and tied Al-Rayes for the team lead in minutes. He made three of four shots for seven points. Senior Ricky Galliani and David LeBaron each had 10 points and four rebounds. Galliani got to the free throw line more than any other player and converted on five of his eight attempts.

Occidental threatened to pull away early in the second half, but Caltech kept things close with a 11-5 scoring run keyed by an Andrews three-pointer at 13:16. By the four-minute mark, however, the Tigers had put the game firmly out of reach.

Andrews tries with all his might to prove that he is so much more than “just a fresh.”

That smart, though. Killer Kate’s krazy kourt face.
ASCIT Minutes

No ASCIT meeting this week.
Meetings are every week in SAC 13

ASCIT Board of Directors Meeting
Minutes for 11 November 2016. Taken by Tim Liu.
Officers Present: Andrew Montequin, Tim Liu, Bobby Sanchez, Kalyn Chang, Robin Brown
Call to Order: 12:06 pm

President’s Report (Andrew):
● Present and accounted for
● Happy Veteran’s Day

Officer’s Reports:
V.P. of Academic Affairs (ARC Chair: Tim):
● Met with Core Curriculum Steering Committee and voted on the pass/fail changes
● Student Faculty Lunch is happening on November 21st
V.P. of Non-Academic Affairs (IHC Chair: Bobby):
● Met with Joe Shepherd and Dean Gilmartin to discuss town-halls about Bechtel
● Library committee is being formed
Director of Operations (Sakthi):
● Met with DevTeam to talk about improvements to Donut
● Club steering committee met
Treasurer (Kalyn):
● Houses have been using inter-house joint event funding
Social Director (Robin):
● Movie night for Fantastic Beasts and Where to Find Them on November 18th
● Big I is happening on February 11th
Secretary (Alice):
● 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: 12:28 pm

Join the Meditation Mob!

Tuesdays, 12:00 - 12:50

Want to learn more about mindfulness meditation? It’s a great way to improve your attention and to become more grounded in the present moment.

There’s no religious component. We use secular, evidence-based meditation techniques.

We meet in the small room just off the lounge in Winnett. All students are welcome, from total beginners to more experienced meditators.

Mailing list and MP3 archive: counseling.caltech.edu/students/meditation
Planning for the Betchel Residence has continued into this year, bringing with it a variety of discussions about safety and student life in Caltech’s undergraduate housing facilities. Part of the current proposal for Betchel is for the doors of the student rooms to have keycard-controlled locks, and it has been suggested that this be rolled out to the other undergraduate residences. While on the surface this proposal seems to improve security, it in fact reduces it, as well as being costly and inconvenient for all parties. There are better alternatives.

The current state of affairs is as follows: access to the undergraduate Houses is controlled via keycard readers on the external doors. There are no keycard readers inside the building, and instead, the rooms are fitted with mechanical pushbutton locks. These locks are not particularly secure; with only 1082 combinations, a dedicated person could try each one within an hour. As far as I know, this has fortunately not been an issue; theft is uncommon, and occurs when doors are left propped open. Still though, one argues, there’s nothing wrong with using more secure locks. It certainly can’t hurt, right?

One of the benefits of the current system is that it has “two-factor authentication”. One proceeds among security researchers is that there are three ways to identify yourself: something you know, something you have, and something you are. Generally speaking, systems that use multiple authentication factors are more secure than those that use only one. Currently, access to undergraduate rooms requires two factors: a student ID (something you have) and a lock combination (something you know). With keycard readers on the rooms, we reduce to just one authentication factor. As an example of how this is less secure, consider that students frequently lose their ID cards (ask the card office). Anyone who finds that card can get into the residence. But if the locks are replaced with keycard readers, now they can immediately get into that students’ room. The name on the ID could even help them find out which room it is, since many undergraduate rooms have the occupants’ names displayed on their doors. The current combination of keycards and locks is stronger than just using a keycard alone.

Secondly, this proposal would cause a significant inconveniences for students. One of the great things about the House system is that, unlike many students, the house is effectively another home. Having to carry your ID with you whenever you leave your room would feel like having to bring your house keys whenever you leave your bedroom. When you forget your ID and get locked out of the house, sure, it’s a little frustrating, but you just need to knock on the door or call a friend, and they can let you in. But if you lock yourself out of your room, now you need to find your roommate, if you even have one. This can range from a minor inconvenience to a serious issue. Being locked out of your room in a towel is annoying, but ultimately harmless. Being unable to reach your medication without calling and waiting for security to assist you is not. It also would be more of an inconvenience to staff, in particular the RAs and Security, who would have to spend much more time responding to locked-out students. This is particularly true if a student loses their ID during a time when the card office is not able to replace it for an extended period of time (for example, on a Friday after business hours).

Furthermore, giving a friend access to your room is a fairly common practice. If you’re out of town, friends can pick things up from your room, stop by to water plants, or care for a pet. Some students who live off-campus like to be able to leave their things in a friend’s room, or nap there in between classes. Even if there is a mechanism for students to grant their friends keycard access, this doesn’t help non-student guests such as parents, friends, or professors. These guests would have to stay confined to the room when the host isn’t around, and wouldn’t be able to walk freely around the house or even use the bathroom without concern for being locked out. On a similar note, adding prefrosh’s keycards to every individual host’s room for prefrosh weekend would be a logistical nightmare; similar troubles would likely be encountered by hosts of athletic recruits or other prospective applicants who aren’t given the ability to leave their keycards in the host’s room. As a result, they would have to be able to leave their things in a friend’s room, or nap there in between classes. Even if there is a mechanism for students to grant their friends keycard access, this doesn’t help non-student guests such as parents, friends, or professors. These guests would have to stay confined to the room when the host isn’t around, and wouldn’t be able to walk freely around the house or even use the bathroom without concern for being locked out. On a similar note, adding prefrosh’s keycards to every individual host’s room for prefrosh weekend would be a logistical nightmare; similar troubles would likely be encountered by hosts of athletic recruits or other prospective applicants who aren’t given the opportunity to leave their keycards in the host’s room.

The proverb among security researchers is that there are five “something you know, something you have, something you are” alternatives.

For all parties, there are better alternatives. There are less secure, consider that students frequently lose their ID cards (ask the card office). Anyone who finds that card can get into the residence. But if the locks are replaced with keycard readers, now they can immediately get into that students’ room. The name on the ID could even help them find out which room it is, since many undergraduate rooms have the occupants’ names displayed on their doors. The current combination of keycards and locks is stronger than just using a keycard alone.

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Fortunately, there’s a good alternative. Electronic keypads, such as the ones in Marks-Braun, or in Ruddock 131, are significantly more secure than the current locks, without the disadvantage of keycard readers. The ones in Marks-Braun are set to 6 digit combinations, for a total of 1,000,000 possibilities, literally a factor of a thousand more than the current locks. And because they are also a type of combination lock, there are very few side-effects. There is still two-factor authentication, because it’s a “something you know/ method, and when you lose your ID, the process for getting back into your room is exactly the same as before. Lastly, you can still give your friend your combination if you need to. The only downside I’ve come up with so far is that, depending on the type of keypad, you may not be able to change your combination yourself. While I personally believe there’s no pressing need to change our current locks, if the consensus is otherwise, I strongly suggest the use of keypads instead of keycards.
Answers to current crossword (pg 7)

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i'm thankful for dank memes

can somebody please eat either one of us

Happy Thanksgiving from the California Tech!