SpaceX COO Envisions Road to Mars

Maitreyi Nair
Page Editor

Since its inception in 2002, SpaceX has continually demonstrated itself to be a company with high aspirations, specializing in manufacturing and launching advanced rockets and spacecraft. This past Friday, May 19, SpaceX’s current President and Chief Operating Officer, Gwynne Shotwell, visited Caltech to deliver an overview of the technology development and business plans for what is shaping up to be SpaceX’s loftiest goal yet – the human civilization on Mars.

Gwynne Shotwell, who graduated with degrees in Mechanical Engineering and Applied Mathematics from Northwestern University, started at SpaceX as the Vice President of Business Development and is currently the woman in charge of the operation. Shotwell gave descriptions of SpaceX’s operational history, discussing a variety of technological advancements, both of which are currently used to deliver payloads into Earth orbit, speaking frankly and, at times, with humor about the often bumpy road to their current launch and landing capabilities. Looking to the near future of advanced vehicle technology, SpaceX has several projects on the books: for one, they are currently in the late stages of developing a crew transport capability in the Dragon capsules as a part of their 2011 NASA contract, the timeline for which Shotwell said involves sending US astronauts back to the International Space Station starting preliminary launch and flight tests by the end of 2018, with an optimistic date of getting an initial ship landing on Mars in 10 years.

The very notion of reaching Mars, let alone colonizing it, is one of extraordinary magnitude, and, obviously, any serious plans to successfully pursue such an endeavor face significant challenges. In the interactive discussion portion of the afternoon, Shotwell took audience questions discussing such challenges, in one case bringing up the point that, as a private company, one of the greatest obstacles is that the equity necessary to fund a project such as this Mars colonization mission is on the order of tens of billions of dollars for each flight, though the cost should go down after the initial missions, and the rate of progress in this respect is slowed largely by economic obstacles. To alleviate this financial burden in the long run, Shotwell also described SpaceX’s plans for the development of a global broadband internet communication system using a “Satellite Constellation” to provide low-cost, reliable internet access through a space-based internet communication system. This plan was proposed by Elon Musk to address consumer and technological issues with the current internet provider system, practice for an extension of a similar system to a Martian colony and tap into the global internet market, providing capital for future Mars missions. Although the viability of such a venture is unknown, test satellites are slated to go up in the next year or so, and initial operation of the array could begin in 2020.

Apart from the purely economic challenges, there are still larger questions up in the air regarding manned missions to Mars that will need to be addressed and solved before any kind of colonization can happen at all, of considerable technical, financial, and cultural significance. SpaceX’s role in implementing a full colonization of Mars is necessarily limited by its niche as a manufacturer of spacecraft and launch vehicles, while other companies and governmental entities such as NASA have demonstrated interest and are actively preparing for similar missions, with NASA’s multi-stage “Journey to Mars” culminating in sending humans to low-Mars orbit in the early 2030s. In the end, as this project is only in its nascent stage, we cannot only wait and see what the next few years bring, keeping in mind Gwynne Shotwell’s words from the conclusion of Friday’s lecture: “[w]ithout his is not just a project for SpaceX - this is a project for humankind.”
Upcoming Events

Eastern Sierras Backpacking: Lake Sabrina
Friday 5:30pm - Sunday evening | June 2nd-4th | $40

Ever feel like backpacking in the snowy mountains in June? Join in a backpacking trip out to the beautiful Sierra Nevadas. We'll drive up to the mountains Friday and spend the night near the trailhead. On Saturday, we'll hike or snowshoe past Lake Sabrina in around 10 miles and explore the high lakes region. We'll camp in the snow, and get back late Sunday evening. It'll be a cold intense backpacking trip up around 10,000 feet in elevation. The mountains will be majestic, and the trip should be a blast!

Please contact jbrouill@caltech.edu if you have any questions.

Caltech Y Memorial Weekend Office Hours
Due to the Memorial Day Holiday we will be closing at 2:00 PM on Friday May 26th and closed on Monday May 29th. We will re-open with regular hours on Tuesday May 30th. Please contact caltechy@caltech.edu for any inquiries.

Caltech Y Photo Contest
Choose Your Favorites in the Caltech Y Photo Contest!
Wednesday | May 31st | 12 Noon
The Caltech Y Photo Contest is back. Vote for your favorite photos in our 2nd annual photo contest. Like us on Facebook—then “like” your favorite photo(s) in each category.

Perspective Adventure Service Civic Engagement Leadership

Voting will end at 12 p.m. (noon) on Wednesday, May 31. If you don’t have a Facebook account send us your votes by email.

We can’t wait to see which ones you pick!

Hathaway Sycamores
Every Wednesday | 6:00 - 8:00 PM | Highland Park
Volunteer at Hathaway Sycamores, a group that supports local underprivileged 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 Sherwood Richers at srichers@tapir.caltech.edu. Eligible for Federal Work Study.

Pasadena LEARNS
Every Friday | 3:00 - 5:00 PM | Pasadena
Come volunteer at Madison and Jackson Elementary 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 azhou@caltech.edu. Eligible for Federal Work Study.

Mentoring For Life
Every Monday | 3:30pm | Wilson Middle School Pasadena
Stressed out by college life? Step outside the Caltech bubble and mentor tweens who’ve never even thought about 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.
more tissue removed. But, asks patients find out that they must have more tissue removed. This will then need a follow-up surgery remains inside the patient, who through, not around, the tumor—to highlight key features, and then into thin slices, stained with a dye sent to a lab where it is rendered breast.) The extracted tissue is then mastectomy removes the entire as much of the undamaged breast to 75 percent of patients underwent of invasive breast cancer are surgeons removing breast cancer technology that could help Wang have developed an imaging breast-conserving surgery. to have larger nuclei and more of cells. Cancerous tissue tends nuclei and the packing density material, PAM reveals the size of more strongly than surrounding tissue. Because nuclei vibrate waves emitted by the vibrating system measures the ultrasonic use useful for clinical applications. This would make the technology interesting to highlight key features, and then analyzed. If tumor cells are found on the surface of the tissue sample, it indicates that the surgeon has cut through, not around, the tumor—meaning that a portion of the tumor remains inside the patient, who will then need a follow-up surgery to have more tissue removed. After a week or two waiting for lab results, 20 to 60 percent of patients find out that they must remain inside the patient, who will then need a follow-up surgery to have more tissue removed. But, asks Wang, “what if we could get rid of the waiting? With 3D photoacoustic microscopy, we could analyze the tumor right in the operating room, and know immediately whether more tissue needs to be removed.” Wang is a Bren Professor of Medical Engineering and Electrical Engineering in Caltech’s Division of Engineering and Applied Science. His lab invented 3D photoacoustic microscopy.

Photoacoustic microscopy, or PAM, excites a tissue sample with a low-energy laser, which causes the tissue to vibrate. The system measures the ultrasonic waves emitted by the vibrating tissue. Because nuclei vibrate more strongly than surrounding material, PAM reveals the size of nuclei and the packing density of cells. Cancerous tissue tends to have larger nuclei and more densely packed cells.

Indeed, as described by Wang and his team in a paper published in the journal Science Advances on May 17, PAM produces images capable of highlighting cancerous features with no slicing or staining required. Wang conducted this research while the Optical Imaging Laboratory was located at Washington University in St. Louis. He moved the lab to Caltech’s Andrew and Peggy Ching Department of Medical Engineering in January 2017.

Although Wang’s team has focused primarily on breast cancer tumors, his work has potential applications for any analysis of excised tumors—from melanoma to pancreatic cancer. In a proof-of-concept scan described in the new paper, PAM analyzed a sample in about three hours. Comparable traditional microscopy takes about seven hours to achieve the same results. However, Wang says that PAM’s analysis time could be cut down to 10 minutes or less with the addition of faster laser pulse repetition and parallel imaging. This would make the technology useful for clinical applications.

“Because the device never directly touches a patient, there will be fewer regulatory hurdles to overcome before gaining FDA approval for use by surgeons,” Wang says. “Potentially, we could make this tool available to surgeons within several years.”

The Science Advances paper is titled “FastLabel-free Multi-layered Histology-like Imaging of Human Breast Cancer by Photoacoustic Microscopy.” Among the collaborators are Terrence W. Wong, Ruiyin Zhang, Pengfei Hai, Chi Zhang, and Miguel Pietro, who are current or former members of the Optical Imaging Laboratory, and Rebecca Aft and Deborah Novack, who are clinical collaborators at Washington University. This research was funded by the National Institutes of Health and the Siteman Cancer Center.
LORI DAJOSE
Caltech Media Relations

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

This year, the Richard P. Feynman Prize for Excellence in Teaching has been awarded to Professor of Chemistry Brian Stoltz, who has taught at Caltech for 17 years.

Stoltz was nominated for the Feynman Prize by undergraduate and graduate students, alumni, and fellow faculty members, who praised his dedication and passion for teaching as well as his commitment to diversity and an individually tailored approach to mentorship. Many who have taken his courses credited Stoltz with their renewed enthusiasm for the subject. His teaching evaluations are “uniformly outstanding,” according to the citation.

Stoltz previously was awarded the ASCIT (Associated Students of the California Institute of Technology) teaching award and the Caltech Graduate Student Council Teaching Award, was named a professor of the month by the undergraduate-run Academics and Research Committee (ARC), and was awarded a Camille Dreyfus Teacher-Scholar Award. In addition, Stoltz has served for several years as the graduate and undergraduate chemistry option representative. He also has been engaged with pre-college education and outreach, working with local schools as well as the Caltech Prep magnet program and off-campus educational activities.

“I am so excited to have been nominated by my former students and colleagues, and to receive this amazing recognition from Caltech,” Stoltz says. “To be associated in this way with the most outstanding educators at the Institute and with Feynman himself is truly humbling.

It is an honor to work with such exceptional people on a daily basis and incredibly gratifying to know that I have had some impact on them as well.”

The Feynman Prize has been endowed through the generosity of Ione and Robert E. Paradise and an anonymous local couple.

Some of the most recent winners of the Feynman Prize include Ellen Rothenberg, Albert Billings Ruddock Professor of Biology; Kevin Gilmartin, professor of English; Steven Frautschi, professor of theoretical physics, emeritus; and Paul Asimow, the Eleanor and John R. McMillan Professor of Geology and Geochemistry.

The prize was established in 1993 to honor annually a professor who demonstrates, in the broadest sense, unusual ability, creativity, and innovation in undergraduate and graduate classroom or laboratory teaching. Nominations for next year’s Feynman Prize for Excellence in Teaching will be solicited in the fall. Further information about the prize and a full list of past recipients can be found on the Provost’s Office website.

WHITNEY CLAVIN
Caltech Media Relations

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

New Caltech professor talks about the intersection between chemistry and biology

New tenure-track professor of chemistry Alison Ondrus says she’s excited to apply the tools of organic chemistry to the study of biological problems and thinks Caltech, with its small, interdisciplinary environment, is the perfect place to do it.

Ondrus received her PhD in organic chemistry in 2015 from MIT, where she learned to synthesize structurally complex molecules. From there, she became interested in biological chemistry and started studying the Hedgehog signaling pathway as a postdoctoral scholar at the Stanford University School of Medicine. The Hedgehog family of proteins is responsible for many basic functions in many animals, including development and organization of the overall body plan. Mutations in Hedgehog pathway genes can lead to congenital deformities as well as both juvenile and adult cancers.

At Caltech, Ondrus plans to use her chemistry background to continue studying the Hedgehog signaling pathway and address mysteries about how essential small molecules, such as cholesterol, control Hedgehog activity during the development of embryos, a process known as embryogenesis.

Your PhD was in synthetic chemistry. What does this involve?

In synthetic organic chemistry, you build complex molecules from scratch. You start with a hypothesis for how to make an interesting molecular structure in the most convergent, elegant, efficient way possible based on the reactions that you choose. From there, you go to the lab and try to build the molecule.

How did you go from synthesizing chemicals to studying biological pathways?

I’d spent a lot of time just looking at the structures of molecules and appreciating the richness of structure, so when I had an opportunity to see how the same principles translated to biological activity, a new world opened up.

I started finding myself thinking more and more about all of the small molecules that are already present in our bodies. They’ve always been fascinated by human health and human development, and I started to question how these molecules participate in normal physiology and disease.

I started reading to try to find examples of where people had at least circumstantial evidence that small molecules played key roles in regulating a biological pathway, in particular in human health.

Through my reading, I came across the pathway that I now study—the Hedgehog signaling pathway.

Why is the Hedgehog signaling pathway important?

Hedgehog is important in almost every aspect of how an embryo becomes a human form, and its deficiencies showcase its importance. It’s responsible for establishing our body plan, from our left-right symmetry to how many digits we have as you can appreciate about Caltech.

We know that certain small molecules that are based on cholesterol can turn the pathway on or off, but we don’t know what enzymes produce these molecules, where they’re localized, or how they interact with the Hedgehog pathway. Elucidating these cellular processes is essential to understanding how the pathway controls things like body patterning, and brain development, and how that can go wrong and lead to cancer.

If we can understand what components of cholesterol cycle are affected by Hedgehog activity, then we can start to address much more specifically some of these medical conditions and intervene in ways that we haven’t yet considered.

How will you go about studying cholesterol in the Hedgehog pathway?

I’m going to merge the chemistry part of my background with my understanding of signal transduction to ask questions about cholesterol and related molecules, and their role in regulating the Hedgehog pathway. Small molecules are often the missing link in hypotheses regarding Hedgehog pathway signal transduction. You may have two proteins in the pathway that communicate via these very specific small molecules, but without having chemical tools to ask questions in a precise way, the mechanism remains unknown.

What are the exact structures of these molecules? How do they perform this communication? Something that’s unique about our lab is that we can synthesize the specific cholesterol molecules needed to answer these questions.

What do you like about Caltech?

At Caltech, there are really no barriers. Nobody says you can’t do something or that an idea is too unprecedented. There’s a cultural acceptance that doing new things is fundamentally exciting and valuable. That’s what I really appreciate about Caltech.

What do you like to do in your spare time?

I love yoga and riding my bike, and reading both Eastern and Western philosophy. I just finished listening to the audiobook of The Structure of Scientific Revolutions by Thomas Kuhn, which I recommend to anyone.
Many things go wrong in cells during the development of cancer. At the heart of the chaos are often genetic switches that control the production of new cells. In a particularly aggressive form of leukemia, called acute myeloid leukemia, a genetic switch that regulates the maturation of blood stem cells into red and white blood cells goes awry. Normally, this switch leads to appropriate numbers of white and red blood cells. But patients with acute myeloid leukemia end up with a dangerous accumulation of blood stem cells and a lack of red and white blood cells—cells that are needed to supply the body with oxygen and fight infections.

Now, researchers at Caltech and the Sylvester Comprehensive Cancer Center at the University of Miami are narrowing in on a protein that helps control this genetic switch. In healthy individuals, the protein, called DPF2, stops the production of red and white blood cells when they do not need to be replaced. That is, it turns the switch off. But the protein can be overproduced in acute myeloid leukemia patients. The protein basically sits on the switch, preventing it from turning back on to make the blood cells as needed. Patients who overproduce DPF2 have a particularly poor prognosis.

In a new study, to be published the week of May 22, 2017, in the journal Proceedings of the National Academy of Sciences, the researchers demonstrate new ways to impede DPF2, potentially rendering acute myeloid leukemia more treatable. They report new structural and functional details about a fragment of DPF2. This new information reveals targets for the development of drugs that would block the protein’s function.

“Many human diseases, including cancers, arise because of dysfunctioning genetic switches,” says André Hoelz, the corresponding author of the study. Hoelz is a professor of chemistry at Caltech, a Heritage Medical Research Institute (HMRI) Investigator, and a Howard Hughes Medical Institute (HHMI) Faculty Scholar. “Elucidating how they work at atomic detail allows us to begin the process of custom tailoring drugs to inactivate them and in many cases that is a significant step towards a cure.”

Red and white blood cells are constantly regenerated from blood stem cells, which reside in our bone marrow. Like other stem cells, blood stem cells can live forever. It is only when they become differentiated into specific cell types, such as red and white blood cells, that they then become mortal, or acquire the ability to die after a certain period of time.

“Our bodies use a complex series of genetic switches to differentiate a blood stem cell into many different cell types. These differentiated cells then circulate in the blood and serve a variety of different functions. When these cells reach the end of their lifespan they need to be replaced,” says Hoelz. “This is somewhat like replacing used tires on a car.”

To investigate the role of DPF2 and learn more about how it controls the genetic switch for making blood cells, the Hoelz group partnered with Stephen D. Nimer, co-corresponding author of the study, and Ye Xu of the University of Miami, to determine the structural information from Hoelz’s group to create a mutated version of the protein. The Nimer group then introduced the mutated protein in blood stem cells, and found that the mutated DPF2 could no longer inactivate the switch for making blood cells.

“The mutated DPF2 was unable to bind to specific regions in the genome and could not halt blood stem cell differentiation,” says Xu. “Whether DPF2 can also be blocked in the cancer patients themselves remains to be seen.”

The researchers say a structural socket in DPF2, one of the puzzle-piece-like regions identified in the new study, is a good target for candidate drugs.

The study, titled “Histone- Binding of DPF2 Mediates Its Repressive Role in Myeloid Differentiation,” was funded by a PhD fellowship of the Boehringer Ingelheim Fonds, a National Institutes of Health Research Service Award, the National Cancer Institute of the National Institutes of Health, a Faculty Scholar Award of the Howard Hughes Medical Research Institute, the Heritage Medical Research Institute, Caltech startup funds, the Albert Wyrick V Scholar Award of the V Foundation for Cancer Research, a Kimmel Scholar Award of the Sidney Kimmel Foundation for Cancer Research, and a Teacher–Scholar Award of the Camille & Henry Dreyfus Foundation. Other authors are Concepcion Martinez and Ye Xu of the University of Miami and Ly Phu Vu of the Memorial Sloan Kettering Cancer Center.
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

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Just some of the lowest lending rates and highest savings rates in the nation… and a state-of-the-art eBranch for easy, convenient online and/or mobile access to your account. We’re the overwhelming choice for financial services among the entire Caltech family. If you haven’t yet joined, call or visit us online or in person today. You belong here.
ASCIT Minutes

Meetings are every week in SAC 13

ASCIT Board of Directors Meeting
Minutes for 19 May 2017. Taken by Dana He.

Officer’s Reports:

V.P. of Academic Affairs (Kavya):

- Midnight donuts will be the night of Thursday, June 1.
- ASCIT Alumni party tonight. Transition dinner next Wednesday.

ASCIT Alumni party tonight. Transition dinner next Wednesday.

President’s Report (Sakthi):

- 1:01 pm
- Guests: Alice Zhai, Dana He, Sakthi Vetrivel, Kavya Sreedhar, Rachael Morton, Sara Adams, Sarah Crucilla,
- Officers Present: V.P. of Non-Academic Affairs (Rachael):

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

- the calIfornIa tech
- 53. Fuel
- 51. Bamboo stick
- 50. Printed characters
- 48. Single
- 46. Indigenous person
- 45. Give temporarily
- 43. Search thoroughly
- 41. Financial
- 40. Husks of cereal
- 38. Wheel shaft
- 36. Fuscous
- 33. Spline
- 30. Rise rapidly
- 28. Competitive activities
- 27. Hit lightly
- 26. Fuscous
- 25. Wheel shaft
- 24. Economic activities
- 23. Moose
- 22. Series of exercises
- 21. Moose
- 20. Small snake
- 19. Landlocked African country
- 18. Make a mistake
- 17. River embankment
- 16. Brass instrument
- 15. Indistinguishable
- 14. Broader
- 13. Finished
- 12. Cover with stone or mud
- 11. Long and difficult trip
- 10. Rind
- 9. Military chaplain
- 8. Outspoken
- 7. Obviate
- 6. Part of a church
- 5. Changeable
- 4. Rectify
- 3. Lair
- 2. Obviate
- 1. Military chaplain

Across
1. Launch area
4. Vitality
7. Adjust
12. Cover with stone or mud
13. Finished
14. Broader
15. Indistinguishable
17. River embankment
18. Make a mistake
19. Landlocked African country
21. Moose
22. Series of exercises
23. Digestive juice
24. Wide sweeping search
27. Hit lightly
28. Competitive activities
30. Rise rapidly
33. Spline
36. Fuscous
38. Wheel shaft
39. Era of history
40. Husks of cereal
41. Financial obligations
43. Search thoroughly
45. Give temporarily
46. Indigenous person
48. Single
50. Printed characters
51. Bambooch stick
53. Fuel

Down
1. Military chaplain
2. Obviate
3. Lair
4. Outspoken
5. Vacuous
6. Blend gradually
7. Hole punch
8. Device used for shaping metal
9. Escape
d10. Rind
12. Pastries
13. Fingers or toes
16. Brass instrument
20. Small snake
25. Crib
26. Tillary
27. Having delicacy or grace
28. stalk
29. Distance between two points
30. Lamentable
31. Domesticated bovine animals
32. Large web-footed bird
34. Decorative woven fabric
35. In the past
37. Conclusion
42. Take a small amount of liquid
44. Kind of hat
47. Examine carefully
48. Bird shelter
51. Small boat
52. Part of a church
53. Extremely cold
54. Rectify
55. Froth
56. Secret look
57. In addition
59. Chafer
62. Ballet step
63. Oculus
65. Pair

Bechel focus groups and group leaders have been decided.
- IHC is generally against Big I, so it probably will not happen. Would be in favor of doing joint party with Harvey Mudd at Mudd, but need to ask Mudd.
- Proposal to do house-associated campus-wide events. Possible events include Blackerathon and/or a Dabney tie-dye event.
- Proposal for ASCIT events such as campus-wide lasertag or paintball. Could get funding from the Student Investment Fund.
- Proposal to bring back the Mudos mud-pit tradition now that the drought is over.
- Will send out survey to gauge interest in proposed events.

Director of Operations (Sara):
- Blacker may still have cords for ASCIT lights, will ask Blacker.

Treasurer (Sarah):
- Refunded $600 to each house for ditch day, $400 to Caltech Hip-Hop Troupe, and $175 to Out of Context for concert.
- Will reimburse $400 for Ricketts and Blacker.
- Voted and approved request to reimburse $1,000 (in addition to $1,500 already given) for Techstock, which was needed for food for about 500-600 attendees.
- Proposal to raise dues starting January 2018, and to combine yearbook dues, which are currently around $19, and ASCIT dues.

Social Director (Alice):
- Plan to create general social calendar.
- Will talk to Tom Mannion and Harvey Mudd about possible joint party between Caltech and Mudd.
- Will send out email to get volunteers for ASCIT social team.
- Plan to organize Dodgers game on tentative date Sunday, June 11. Will send out survey to gauge interest. Needs to get funding from March Fund.
- Need to order ASCIT plaques.

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: 1:46 pm

ANNOUNCEMENTS

THE CALIFORNIA TECH

MAY 22, 2017

7

Crossword

Across
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Ma13 – Vector Calculus Bootcamp course has been approved by Curriculum Committee.

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Meeting Adjourned: 1:46 pm
Answers to current crossword (pg 7)

http://puzzlechoice.com