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## LETTERS

edited by Jennifer Sills

### NextGen VOICES

#### Results: Science Time Travel

If you could go back in time and share one piece of scientific knowledge from today, what time period would you choose, what would you share, and how might that information change the course of history? In April, we asked young scientists to hop in their time machines and report back.

We heard from almost 200 readers, with tales of travel ranging from the dawn of man, to ancient Greece and Rome, to the Industrial Revolution, to the World Wars and recent decades. They imagined the effects of sharing knowledge about climate change, disease prevention, and seminal works in a wide variety of fields. A sample of the best responses can be found below. To allow for as many voices as possible, in some cases we have printed excerpts of longer submissions (indicated by ellipses) and lightly copyedited original text for clarity. To read the complete versions, as well as many more, go to <http://scim.ag/NextGen7Results>.

#### Submit Now: Work-Life Balance

Add your voice to *Science*! Our new NextGen VOICES survey is now open:

**What one change would most improve work-life balance for scientists?**

To submit, go to [http://scim.ag/NextGen\\_8](http://scim.ag/NextGen_8)

Deadline for submissions is 16 August. A selection of the best responses will be published in the 4 October issue of *Science*. Submissions should be 250 words or less. Anonymous submissions will not be considered. Please submit only once.

earlier than it was, the impact on humankind would be immeasurably large.

JUGAL K. SHAH

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221 B.C.E., XIANYANG, CHINA. THE MAJESTIC Emperor Qin, who has conquered all opposing states and unified China, is declaring to the whole world that the great and the first feudal dynasty has been established. Fortunately, I travel back in time just to be here and see the unrivalled state celebration.



As the future scientific envoy, I have an audience with Emperor Qin and present my gift: Women are capable of doing the same thing as men; they even can do better. Certainly, with adequate data, glorious accomplishment stories, and plenty of examples, such as Madame Curie, Mrs. Thatcher, Deng Yaping, and Oprah Winfrey, I can convince Emperor Qin to give women more chances to receive education and give full play to their talent in science and technology, culture, politics, and the military. In that way, more than 2000 years later, China would surely be a super power stronger than today....

JIAN ZHANG

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I WOULD GO BACK TO ANCIENT ROME ON the morning of 15 March, 44 B.C.E., to the steps of the Roman Senate, and share Bayes' Theorem with Julius Caesar. In the days leading up to his assassination, Rome was awash with rumors of an assassination plot. According to legend,



an old soothsayer had forewarned Caesar himself of a great danger that threatened him on the Ides of March, and Caesar's own wife Calpurnia had a premo-

### NextGen Speaks



...I WOULD TRAVEL BACK TO THE years around 600 to 400 B.C.E., when there were heated debates in ancient Greece about the origin of life. I would tell the philosophers and lecturers of that time what we now know about life on a molecular level... I would like to see the impact this would have on art, industry, science, and religion throughout the centuries to come. This might even accelerate the onset of the scientific and industrial era by reducing the impact of religion in everyday life and perhaps even allow different cultures to understand each other better, once they realize that our nature is essentially the same.

MARTIN PAČESA

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...IF I COULD TRAVEL BACK IN TIME, I WOULD transport to Syracuse, Sicily, in 222 B.C.E. to introduce the fundamental theorem of calculus to Archimedes 10 years before his death. As the great mathematical genius of his era, he would have been most poised to understand and disseminate the knowledge of linking the concept of a derivative of a function with the concept of the integral.... So much technology of today, from the internal combustion engine to the principles of economics, has been made possible due to calculus. Perhaps in the present era we would be traveling in flying cars, or we would have colonized Mars. Or, more grimly, we would have achieved nuclear apocalypse. Undoubtedly, however, had calculus been introduced to the world 1900 years



Downloaded from <http://science.sciencemag.org/> on January 23, 2019

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How seabirds forage

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A burst of distant radio waves

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... nition of her husband's murder and tried to warn him of the danger. But were these dark forebodings and dire prophecies just idle gossip (noise) or a credible forecast of the future (signal)? Given this uncertainty, I would advise Caesar to guess the prior probability of an assassination plot and then update his prior based on the sundry rumors swirling around Rome. Had Caesar applied Bayesian reasoning, it is likely he would have followed his wife's advice and stayed home on that fateful day. Had he done so, Bayes' Rule might have changed the course of history, for the Roman Republic might have yet been saved, and perhaps we would all still be speaking Latin.

**ENRIQUE GUERRA-PUJOL**

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I WOULD TRAVEL TO CHINA IN THE YEAR 1070 with the knowledge of bacteria and fungi that produce substances capable of fighting infection. In 1070, Su Song compiled the *Bencao Tujing*, a revolutionary treatise on pharmaceutical botany, zoology, and mineralogy. By providing Su Song this knowledge, it would be in the hands of an individual capable of understanding, utilizing, and preserving this knowledge. Su's treatise survived until the 16th century, when it was incorporated into the *Bencao Gangmu* by Li Shizhen, demonstrating the lasting impact of his work. After Su demonstrated the efficacy of fungi, such as penicillium, during the Song Dynasty, which oversaw some of the most significant scientific advances in Chinese history, antibiotic pharmaceutical preparations would likely be developed. It would be over 250 years before arguably the most devastating pandemic in recorded history, the Black Death (caused by *Yersinia Pestis*), would arise in China, spreading west as far as Europe. The Black Death was responsible for over 100 million deaths.... In addition to the tragic death toll it exerted, the Black Death led to massive social unrest, including economic decline and widespread persecution of



those thought responsible. Providing Su Song with antibiotic knowledge in 1070 would allow ample time for development of appropriate therapies to combat the Black Death at its source, averting one of the greatest tragedies in the history of mankind.

**ZESHAAN N. MAAN**

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IN 1687, SIR ISAAC NEWTON PUBLISHED HIS *Principia* outlining the fundamentals of what quickly became called Newtonian mechanics. I would travel back to Cambridge, England, 5 years before this date and teach Einstein's, theory of relativity to Isaac Newton. The obvious change in history resulting from this action would of course be a massive head start for the field of modern physics.... However, I would argue that a less obvious but possibly more important consequence of this historical change would be its effect on how we teach science. Currently, high school students and first year undergraduates are taught the limited version of physics discovered by Newton. Only students who choose to continue in the discipline learn Einstein's



more generalized form of mechanics and how classical mechanics is encompassed in this modern understanding. If Newton had discovered both his and Einstein's contribu-

tions at the same time, the result would be an educational system that introduces a more complete view of physics to a wider audience of people from an earlier age....

**MATTHEW HAMMOND**

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... INSTEAD OF A PIECE OF TECHNICAL KNOWLEDGE, I would share something that would provide perspective: the photo of Earth taken by the Apollo 17 astronauts in 1972. "The Blue Marble," as it is often called, shows both the unity and finitude of the planet and its resources. The photo is emblematic of the modern environmental movement's birth in the 1970s. I would bring this photo to early 19th-century Britain, during the Industrial Revolution, when consumption of Earth's resources began to increase dramatically. Providing this information 150 years earlier would

be an opportunity for the soon-to-be industrialized culture of western Europe to reconsider its relationship with the planet.... For a little extra perspective, I would share the photo with its original orientation, Southern Hemisphere on top!

**STEVEN M. ROELS**

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I WOULD TRAVEL BACK TO 1847 TO JOIN Hungarian physician Ignaz Semmelweis at the Vienna General Hospital in his hand-washing crusade. At that time puerperal fever was epidemic, but its etiology unknown. After observing mortality from the disease to be three-fold higher in doctors wards compared to the wards run by midwives, Semmelweis drew up his novel intervention: hand-washing by physicians using a chlorinated lime solution. However, the medical fraternity vehemently rejected his proposed intervention, and ostracized him for it.... In hindsight, while we marvel at the brilliance and simplicity of Semmelweis's work, we have done little to celebrate a practice of accepting simple and unconventional work, even when backed by solid thorough science. Traveling back to the time of Semmelweis,



I would share the importance of embracing such unconventional work when supported by sound evidence and stringent scientific process.... Laying the foundation with Semmelweis, one can hope to cultivate a scientific culture founded in discussion and driven by radical innovation; encouraging the willingness and openness needed to accept alternative ideas—even those which may conflict with one's own beliefs....

**SAMUEL D. RUTLEDGE**

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...NOWADAYS IT IS EASY TO FORGET THAT COMMUNICATION among scientists once was difficult, due to geographic and linguistic boundaries. A striking example is that of Charles Darwin and Gregor Mendel. Their



written legacy allowed for the advance in genetics, yet they never met in life. If I could travel back in time, I would go to Downe, England, in 1866 and inform Charles Darwin of Gregor Mendel's results.

Realizing that Mendel's work provided the proof for evolution by natural selection, this would result in a modern synthesis 50 years ahead of time and advance medical genetics by 50 years. Accordingly, we would be much further in our understanding of human genetic diseases and closer to their treatments.

**ANTOINE DE MORRÉE**

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I MET ALFRED NOBEL IN SWEDEN IN 1895, A few days before he died.... He had just finished writing his last will, leaving much of his wealth to honor outstanding achievements in physics, chemistry, medicine, literature, and peace.... While drinking coffee together...I told him that in the future, scientists are communicators, writers needing to share ideas with clarity to different audiences. I described the new and diverse ways of communicating science in the time to come.



He smiled, enjoying looking into the future through my eyes. We both agreed that better science communicators are, ultimately, better scientists and that science is not just for scientists. When he fell asleep, I returned to the future. Although he thought my visit was part of his nap's dreams, minutes before dying

he included an award for science communication in the Nobel list. Ever since, writing and communication have become part of the syllabus in undergraduate and graduate programs, together with physics and chemistry. More efficient scientific communication has accelerated the pace of discoveries; created greater public scientific awareness, literacy, and crowdfunding; and inspired young generations to pursue careers in science. More than 108 academics have already been honored with the Nobel Prize in Science Communication. I hope one day I will win this award!

**PAULA DE TEZANOS PINTO**

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IT WAS A WINTER NIGHT IN 1896. TWO SWEDISH scientists, Svante Arrhenius and Arvid Högbom, were chatting in Arrhenius's office room. "I believe a doubling of atmospheric CO<sub>2</sub> would give a total warming of 5°C to 6°C," said Arrhenius. Högbom



agreed, but they both thought the warming would take thousands of years. At this point, I decided to show up. Rather than falling from the chimney like Santa Claus, I chose to knock on their door.

They were really shocked when they found a Chinese girl standing in front of them. "Hello, Professors, I travel back in time from 2013 to tell you that...since the early 20th century, Earth's mean surface temperature has increased by about 0.8°C. The primary cause is greenhouse gases produced by human activities. The Intergovernmental Panel on Climate Change indicated that during the 21st century the global surface temperature is likely to rise another 1.1°C to 2.9°C, even for their lowest emissions scenario. Global warming isn't just about things getting hotter; other changes include stormier, drier, and even colder conditions." The next day, they wrote to the government and the scientific associations to call people's attention to global warming and adaptations to eliminate it. Actions like reducing fossil fuel use, planting trees, and conserving water were known by people all over the world. Instead of destroying the planet, every single man on Earth began to protect and sustain it in their daily life.

**QIFEI HAN**

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I WOULD CHOOSE THOMAS EDISON IN THE beginning of the year 1900 in New York City. I would describe the events of the future and how he and I could help keep our environment cleaner.

I would give him designs to solar panels and hope that the future of solar technology would make America and other countries independent of oil production. Thomas Edison's name alone could create Edison Panels that would be on every Victorian home in the world, especially in hard-to-reach locations.... Fewer trees would be cut, and the world would remain more rural and yet prosper from a new power source.



**DAN FERRELL**

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IT'S 24 JULY 1948, AND I'M AT THE PALAIS des Nations, Geneva, Switzerland. I walk into the resting room of Dr. George Brock Chisholm, who is about to be appointed the first Director-General of the World Health Organization. I tell him that I come from



the 21st century, and that people in my time are suffering from the increasing prevalence of antimicrobial-resistant bacterial infections, mainly as a result of the misuse of antibiotics. I urge him, in a time penicillin is just being mass-produced, to emphasize the importance of appropriate antibiotic use to the world, and to develop and promote policies of proper use of antibiotics. He believes in me, and delivers the message in his acceptance speech. During his 5 years in office, he is actively involved in the development and promotion of national medicines policies and guidelines on proper antibiotic use....

**MAN KIT CHEUNG**

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## Letters to the Editor

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## NextGenVoices

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