

Q&A

Questioning the candidates



Barack Obama accepted *Nature's* invitation to answer 18 science-related questions in writing; John McCain's campaign declined. Obama's answers to many of the questions are printed here; answers to additional questions (on topics including biosecurity, the nuclear weapons laboratories and US participation in international projects) can be found at www.nature.com/uselection. Wherever possible, *Nature* has noted what McCain has said at other times on these topics.

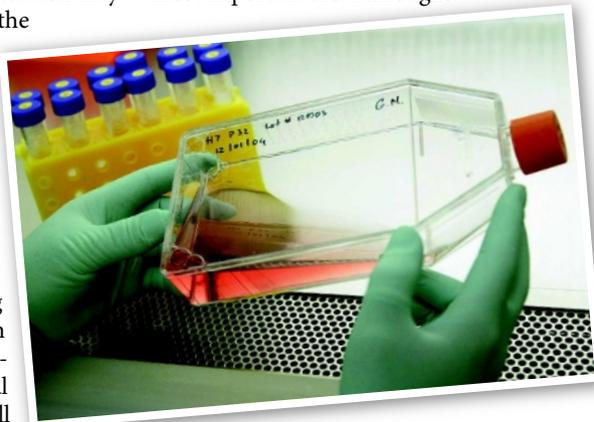
What will be your highest priority in the science and technology arena?

Barack Obama: I am committed to strengthening US leadership in science, technology and innovation, and doing so will be a central priority for my administration. Our talent for innovation is still the envy of the world, but we face unprecedented challenges that demand new approaches. For example, the United States annually imports \$53 billion more in advanced technology products than we export. China is now the world's number one high-technology exporter. This competitive situation may only worsen over time because the number of US students pursuing technical careers is declining. The United States ranks 17th among developed nations in the proportion of college students receiving degrees in science or engineering; we were in third place thirty years ago.

Federally supported basic research, aimed at understanding many features of nature — from the size of the Universe to subatomic particles, from the chemical reactions that support a living cell to interactions that sustain ecosystems — has been an essential feature of American life for over fifty years. While the outcomes of specific projects are never predictable, basic research has been a reliable source of new knowledge that has fuelled important developments in fields ranging from telecommunications to medicine, yielding remarkable rates of economic return and ensuring American leadership in industry, military power and higher education. I believe that continued investment in fundamental research is essential for ensuring healthier lives, better sources of energy, superior military capacity, and high-wage jobs for our nation's future.

Yet, today, we are clearly under-investing in research across the spectrum of scientific and engineering disciplines. Federal support for the physical sciences and engineering has been

declining as a fraction of gross domestic product for decades, and, after a period of growth of the life sciences, the National Institutes of Health (NIH) budget has been steadily losing buying power for the past six years. As a result, our science agencies are often able to support no more than one in ten proposals that they receive, arresting the careers of our young scientists and blocking our ability to pursue many remarkable recent advances. Furthermore, in this environment, scientists are less likely to pursue the risky research that may lead to the most important breakthroughs.



Finally, we are reducing support for science at a time when many other nations are increasing it, a situation that already threatens our leadership in many critical areas of science.

This situation is unacceptable. As president, I will increase funding for basic research in physical and life sciences, mathematics and engineering at a rate that would double basic research budgets over the next decade to support our scientists and restore US scientific leadership.

John McCain has similarly promised to fight for increased funding at some of the country's leading science agencies, but without specific targets in terms of dollars or time frames. "Under a McCain administration, science and research will have a very high priority," says Jay Khosla,

who advises the campaign on health policy issues. "He will do everything it takes to ensure we will continue to be leaders, especially in the field of innovation." One potentially major stumbling block to those looking for more research funding: McCain has said he would freeze domestic discretionary spending, which includes science money, for one year if elected in order to help trim overall spending levels.

In general, McCain has stressed less government control and more business- and technology-oriented approaches to spurring innovation, such as a \$300 million prize for advanced battery technology. On the campaign trail he touches on many of the same themes as Obama, such as the perceived need to educate more American scientists and engineers; McCain would, for instance, provide bonuses for high-performing teachers in subjects such as maths and science, and support education programmes at science agencies such as the National Science Foundation and the Department of Energy.

Biomedical innovation is expensive and very slow; it takes \$1 billion and the better part of a decade to develop a new drug. What would your administration do to make it easier to turn research into cures?

Obama: Americans have good reasons to be proud of the extraordinary role that medical science has had in combating disease, here and throughout the world, over the past century. Work sponsored by the NIH, other government agencies and our pharmaceutical and biotechnology industries has produced many vaccines, drugs and hormones that have improved the quality of life, extended life expectancy and reduced the dire consequences of many serious illnesses and disabilities.

While it may never be easy to "turn research into cures", I understand that biomedical scientists are seeing enhanced opportunities to use their science to improve health. I will encourage the development of biological markers of disease that might simplify the evaluation of new therapies, the use of genetic information to select patients most likely to

D. DOVARGANES/AP

benefit from new treatments, and the multi-disciplinary efforts that are now possible at many research centres. In addition, I will support increased attention to research that focuses on prevention, early detection and improved management of disease.

Furthermore, I believe there is more that we can do to ensure new treatments are developed and made available to the public more efficiently. I believe that we must increase funding for the NIH to reverse the funding trends that have left our nation's scientists with fewer resources as research costs escalate. We must also do a better job of providing resources to the Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), and other federal agencies that help ensure that when these medical advances are turned into exciting new treatments, we are able to ensure that they are swiftly and safely considered for widespread usage. Additionally, we must prioritize removing barriers both between federal agencies and across public, private and nonprofit organizations to ensure better and more efficient collaboration on new innovations.

McCain has also said he would strongly support funding for the NIH. "McCain wants to make sure we are doing everything possible to give the young scientists of today the resources they need to go out and bring research to cures," says Khosla. The health-care platforms of both candidates tend to focus on how to make health insurance more affordable and accessible to Americans, and McCain has talked about technologies that could benefit public health — such as telemedicine — to bring the latest medical knowledge to many more patients.

Many scientists are bitter about what they see as years of political interference in scientific decisions at federal agencies. What would you do to help restore impartial scientific advice in government?

Obama: Scientific and technological information is of growing importance to a range of issues. I believe such information must be expert and uncoloured by ideology. I will restore the basic principle that government decisions should be based on the best-available, scientifically valid evidence and not on the ideological predispositions of agency officials or political appointees. More broadly, I am committed to creating a transparent and connected democracy, using cutting-edge technologies to provide a new level of transparency, accountability and participation for America's citizens. Policies must be



determined using a process that builds on the long tradition of open debate that has characterized progress in science, including review by individuals who might bring new information or contrasting views. I have already established an impressive team of science advisers, including several Nobel laureates, who are helping me to shape a robust science agenda for my administration.

In addition I will:

- Appoint individuals with strong science and technology backgrounds and reputations for integrity and objectivity to the growing number of senior management positions in which decisions must incorporate science and technology advice. These positions will be filled promptly with ethical, highly qualified individuals on a non-partisan basis;

- Establish the nation's first Chief Technology Officer (CTO) to ensure that our government and all its agencies have the right infrastructure, policies and services for the twenty-first century. The CTO will lead an interagency effort on best-in-class technologies, sharing of best practices and safeguarding of our networks;

- Strengthen the role of the President's Council of Advisors on Science and Technology (PCAST) by appointing experts who are charged to provide independent advice on critical issues in science and technology. The PCAST will once again be advisory to the president; and

- Restore the science integrity of government and restore transparency of decision-making by issuing an Executive Order establishing clear guidelines for the review and release of government publications, guaranteeing that results are released in a timely manner and not distorted by the ideological biases of political appointees. I will strengthen protection for 'whistle blowers' who report abuses of these processes.

McCain has similarly pledged to fill key technical positions in his administration with qualified scientists and engineers, including having a science adviser working directly with the president. "McCain will seek to

restore the credibility of scientific research" in the federal government, says campaign adviser Floyd DesChamps. McCain has argued that taxpayers' investment in scientific research should be repaid with the untarnished results of that work.

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What role does nuclear power have in your vision for the US energy supply, and how would you address the problem of nuclear waste?

Obama: Nuclear power represents an important part of our current energy mix. Nuclear also represents 70% of our non-carbon generated electricity. It is unlikely that we can meet our aggressive climate goals if we eliminate nuclear power as an option. However, before an expansion of nuclear power is considered, key issues must be addressed, including security of nuclear fuel and waste, waste storage and proliferation. The nuclear waste disposal efforts at Yucca Mountain [in Nevada] have been an expensive failure and should be abandoned. I will work with the industry and governors to develop a way to store nuclear waste safely while we pursue long-term solutions.

McCain has proposed building 45 new nuclear power plants by 2030, with an eventual goal of a total of 100. McCain has not addressed where the nuclear waste from these and current reactors would go, and he has supported the Yucca Mountain storage project in the past.

You support a cap-and-trade system for regulating greenhouse-gas emissions; what lessons from the European emissions-trading system would you implement?

Obama: I will implement a market-based cap-and-trade system to reduce carbon emissions by the amount scientists say is necessary: 80% below 1990 levels by 2050. While Europe has

E. SCHNAKENBERG/GETTY



had important successes with its system, it also has made mistakes that we should learn from. Unlike the European system, my plan would aim to cover virtually all greenhouse-gas emissions, would auction off all of the permits instead of giving them away, and would make sure there was stability in the market for permits and their price. My plan would use the proceeds of the auction for investments in a clean-energy future, habitat protection and rebates and other transition relief for families.

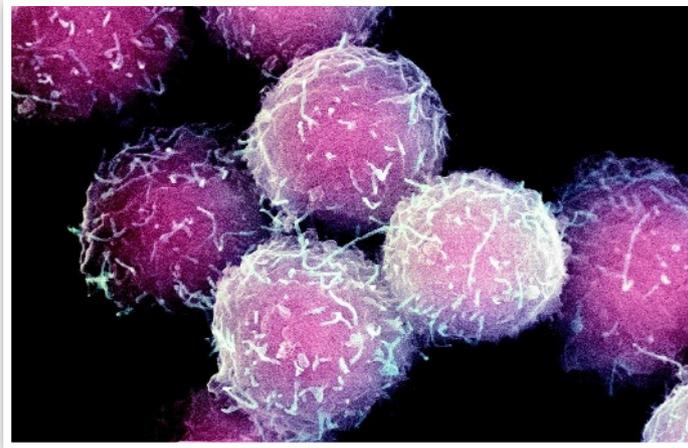
McCain has described his own vision of a cap-and-trade system, but with a different target; the McCain plan calls for reductions of emissions by 60% below 1990 levels by 2050. McCain would initially give away emissions permits instead of auctioning them. McCain would also allow emissions allowances to be 'banked' or 'borrowed' for different time periods, as well as establish a national 'strategic carbon reserve' that could release permits during difficult economic times. He would also allow unlimited offsets, from both domestic and international sources, to ease into a newly set up cap-and-trade system.

Does your stance on tapping domestic oil reserves stand at odds with your goals for reducing national emissions and combating climate change? How will you balance the two?

Obama: With 3% of the world's oil reserves, the United States cannot drill its way to energy security. But US oil and gas production plays an important role in our domestic economy and remains critical to prevent global energy prices from climbing even higher. There are several key opportunities to support increased US production of oil and gas that do not require opening up currently protected areas.

Increasing domestic oil and gas production in the ways I propose in no way lessens my commitment to combating climate change, one of the great challenges of our time. I am committed to implementing a market-based cap-and-trade system to reduce carbon emissions 80% below 1990 levels by 2050, and I will start reducing emissions immediately by establishing strong annual reduction targets with an intermediate goal of reducing emissions to 1990 levels by 2020.

McCain currently favours a more aggressive offshore-drilling policy than Obama; both candidates, like the Democratic-led Congress, have changed their earlier stances opposing such drilling in the face of rising oil prices and



to students studying the origins of humanity. But the next year a Colorado paper reported him saying that such viewpoints should not be taught in science class.

Would you lift President Bush's ban on federal funding for research on human embryonic stem-cell lines derived after 9 August 2001? Under what conditions do

you find it acceptable to create a human embryonic stem-cell line?

Obama: Stem-cell research holds the promise of improving our lives in at least three ways — by substituting normal cells for damaged cells to treat diabetes, Parkinson's disease, spinal-cord injury, heart failure and other disorders; by providing scientists with safe and convenient models of disease for drug development; and by helping to understand fundamental aspects of normal development and cell dysfunction.

For these reasons, I strongly support expanding research on stem cells. I believe that the restrictions that President Bush has placed on the funding of human embryonic stem-cell research have handcuffed our scientists and hindered our ability to compete with other nations. As president, I will lift the current administration's ban on federal funding of research on embryonic stem-cell lines created after 9 August 2001 through executive order, and I will ensure that all research on stem cells is conducted ethically and with rigorous oversight.

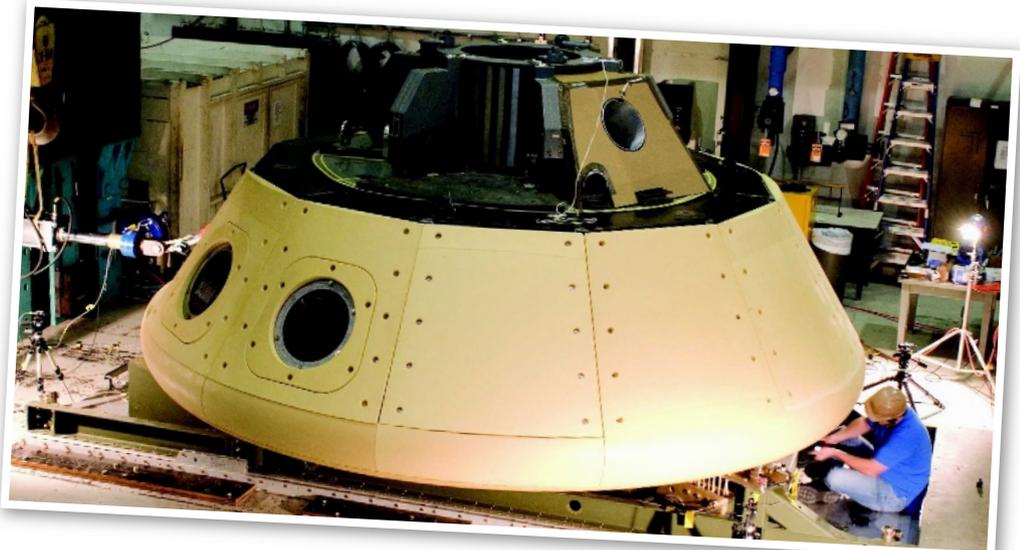
I recognize that some people object to government support of research that requires cells to be harvested from human embryos. However, hundreds of thousands of embryos stored in the United States in *in vitro* fertilization

public pressure to do something about it. However, McCain sees climate change as a national security issue, and maintains that it is a major priority for him. He emphasizes developing new emissions-reducing technologies with minimum costs in order to soften any blow to the national economy. McCain's intermediate goal for emission reductions is also 1990 levels by 2020.

Do you believe that evolution by means of natural selection is a sufficient explanation for the variety and complexity of life on Earth? Should intelligent design, or some derivative thereof, be taught in science class in public schools?

Obama: I believe in evolution, and I support the strong consensus of the scientific community that evolution is scientifically validated. I do not believe it is helpful to our students to cloud discussions of science with non-scientific theories like intelligent design that are not subject to experimental scrutiny.

McCain said last year, in a Republican primary debate: "I believe in evolution. But I also believe, when I hike the Grand Canyon and see it at sunset, that the hand of God is there also." In 2005, he told the *Arizona Daily Star* that he thought "all points of view" should be available



clinics will not be used for reproductive purposes, and will eventually be destroyed. I believe that it is ethical to use these extra embryos for research that could save lives when they are freely donated for that express purpose.

I am also aware that there have been suggestions that human stem cells of various types, derived from sources other than embryos, make the use of embryonic stem cells unnecessary. I don't agree. While adult stem cells, such as those harvested from blood or bone marrow, are already used for treatment of some diseases, they do not have the versatility of embryonic stem cells and cannot replace them. Recent discoveries indicate that adult skin cells can be reprogrammed to behave like stem cells; these are exciting findings that might in the future lead to an alternate source of highly versatile stem cells. However, embryonic stem cells remain the 'gold standard', and studies of all types of stem cells should continue in parallel for the foreseeable future.

Rather than restrict the funding of such research, I favour responsible oversight of it, in accordance with recent reports from the National Research Council (NRC). Recommendations from the NRC reports are already being followed by institutions that conduct human embryonic stem-cell research with funds from a variety of sources. An expanded, federally supported stem-cell research programme will encourage talented US scientists to engage in this important new field, will allow more effective oversight, and will signal to other countries our commitment to compete in this exciting area of medical research.

McCain's stance on embryonic stem-cell research has been the subject of much speculation among researchers. He has voted twice before to lift President Bush's funding restrictions on such work, but his running mate Sarah Palin opposes the work. His public position is perhaps best summarized in his response to questionnaires from advocacy groups such as Research!America last year and ScienceDebate2008 this year: "While I support federal funding for embryonic stem-cell research, I believe clear lines should be drawn that reflect a refusal to sacrifice moral values and ethical principles for the sake of scientific progress. Moreover, I believe that recent scientific breakthroughs raise the hope that one day this debate will be rendered academic. I also support funding for other research programmes, including amniotic fluid and adult stem-cell research which hold much scientific promise and do



not involve the use of embryos. I oppose the intentional creation of human embryos for research purposes and I voted to ban the practice of 'fetal farming', making it a federal crime for researchers to use cells or fetal tissue from an embryo created for research purposes."

Do you see astronauts on the Moon as a worthy goal for the country?

Obama: I believe that the United States needs a strong space programme to help maintain its superiority not only in space, but also here on earth in the realms of education, science, technology, the environment and national security. Technology developed for space missions has been applied to improve everything from computers and medical technology to baby formula and automobiles.

As president, I will establish a robust and balanced civilian space programme. In achieving this vision, I will reach out to include international partners and to engage the private sector to amplify NASA's reach. I believe that a revitalized NASA can help America maintain its innovation edge and contribute to American economic growth.

I will re-establish the National Aeronautics and Space Council, which will coordinate civilian, military, commercial and national security space activities and report to the president. This council will oversee a comprehensive and integrated strategy and policy dealing with all aspects of the government's space-related programmes, including those being managed by NASA, the Department of Defense, the National Reconnaissance Office, the Department of Commerce, the Department of Transportation and other federal agencies. It will solicit public participation, engage the international community and work toward a twenty-first-century vision of space that constantly pushes the envelope on new technologies as it pursues a balanced national portfolio that expands our reach into the heavens and improves life here on Earth.

Human spaceflight is important to America's political, economic, technological and

scientific leadership. I will support renewed human exploration beyond low Earth orbit. I endorse the goal of sending human missions to the Moon by 2020, as a precursor in an orderly progression to missions to more distant destinations, including Mars.

McCain has released an extensive space platform, including calling space exploration a "top priority" for the country and manned space flight

"a reflection of national power and pride". Unlike Obama, McCain has explicitly committed to funding the Constellation programme to replace the space-shuttle fleet (although without details on how he would accomplish that). He also says he would maintain the nation's space infrastructure, including the related workforce, and focus on maximizing the research possibilities of the International Space Station. He would maintain investments in aeronautics research as well as the infrastructure for Earth-monitoring satellites.

Would it make sense for more overseas students who receive PhDs at American universities to stay in the country and contribute to its research base and its wealth? What immigration reforms would you support?

Obama: I believe that we must enact comprehensive immigration reform to restore our economic strength, relieve local governments of unfair burdens stemming from an inefficient federal immigration system, ensure that our country and borders remain secure and allow a path to citizenship for the 12 million undocumented immigrants who are willing to pay a fine, pay taxes, and learn English. A critical part of comprehensive immigration reform is turning back misguided policies that since 9/11 have turned away the world's best and brightest from America. As president, I will improve our legal permanent resident visa programmes and temporary programmes to attract some of the world's most talented people to America.

McCain, as a senator from Arizona, has long been involved in immigration issues, mainly through strengthening federal security at land border crossings. He supports immigration reforms to allow more highly skilled workers to stay and work in the United States after graduation.

Reporting by Alexandra Witze. See Editorial, page 431.