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Should I Become a Scientist?

". . . Science has much to say.
Science has much to say to the Islamist zealots who preach an intolerant doctrine.
It has much to say to young democrats enamored of the new technologies.
It has much to say to those who yearn for a better economic future.
And more importantly, it has much to say about the kind of values that we must adopt if our societies are to be truly open and democratic, for these are the values of science.

Dr. Ismail Serageldin
Founding Director of the New Library of Alexandria, Egypt

It's not denial. I am just selective about the reality I accept.

Bill Watterson
Calvin and Hobbes cartoonist

If they can't swallow facts, let them eat fiction.

Rain Bojangles

Why waste time learning, when ignorance is instantaneous?

Bill Watterson
Calvin and Hobbes cartoonist

Shutting off the thought process is not rejuvenating; the mind is like a car battery – it recharges by running.

Bill Watterson
Calvin and Hobbes cartoonist

The opportunities for science to make critical differences and influence policymaking in the 21st century are unprecedented in human history. Most, possibly all, global systems have, or might soon, cross tipping points that result in irreversible change. Human activities are influencing evolutionary processes. Some illustrative opportunities for science to make a difference follow.

The threat of global warming releasing huge amounts of stored carbon into the atmosphere is rapidly increasing. "An increasing share of global emissions [greenhouse gas] is from the production of internationally traded goods and services . . . " (ScienceDaily 2011a). "Cities worldwide are failing to take necessary steps to protect residents from the likely impacts of climate change, even though billions of urban dwellers are vulnerable to heat waves, sea level rise and other changes associated with warming temperatures" (ScienceDaily 2011b). The world's human population may reach 10.1 billion by 2100 (Gillis and Dugger 2011), even though global food shortages exist in 2011 with nearly 7 billion people on the planet. Agricultural productivity is down, and the overuse "of pesticides in Asia is raising the spectre of 'pest storms'" (Abbugao 2011). " . . . the Fukushima meltdown [has been raised] to level 7, the highest category on the International Nuclear Event Scale" (Global Research 2011).

The realm of science has a superb quality control system for potential students that begins with a rigorous series of requirements for obtaining a degree in any field of science, including required courses and qualifying examinations. Most graduate degrees require a thesis or dissertation. In many fields of science, a post-doctoral position is often a requirement before employment in a prestigious research institution. In short, a research career as a principal investigator requires an investment of time from one's life, even though many positions in science may require significantly less of an investment of time. A principal research investigator has much responsibility and a considerable amount of insecurity.

In addition to studying and investing a great deal of time, research in science generally requires a considerable amount of extramural funding. Competition for research funding is rigorous, and funding for a particular grant proposal is not assured. From 1948 to 1966, I worked for the Limnology Department of the Academy of Natural Sciences in Philadelphia, PA — all salaries at all departmental levels depended entirely on extramural funding. Not a single employee missed a salary payment during that entire period — most assuredly due to the tenacity of Director Ruth Patrick. However, a life dependent on obtaining needed funding in order to do research is not for everyone. In considering a scientific research career, one should search out the pros and cons of the field from a research scientist. At the very least, attending the annual meeting of a state academy of sciences would be enlightening. Such meetings usually provide opportunities for high school students in a junior academy.

Teaching can be combined with a research career or be one's primary focus as a scientist. I had the good fortune do my undergraduate work at Swarthmore College in Pennsylvania. Teaching is extremely important there, but most of the faculty are also involved in research.

Some of my colleagues over the years have told me that they knew what they wanted to do as adults while they were still children. A research career for myself never entered my thoughts at that age. Not until I reached Swarthmore College after World War II was I exposed to wondering why some aspect of nature was "the way it was." Professor Robert Enders skillfully steered me in that direction. Only a little of his time was needed to entice me because he intrigued me with such questions as "How can freshwater sharks exist in Guatemala?" When I speculated on an answer, he then asked "How would you verify that hypothesis?"

When I was admitted to the zoology department at the University of Pennsylvania, my major professor David Wenrich prepared me for research with freshwater protozoans by seeing that I knew how to identify them. When he was asked to recommend someone for summer work to identify protozoans on one of two river survey teams being assembled by Dr. Ruth Patrick of the Academy of Natural Sciences, he suggested me, even though I had only one year of acquiring some basic skills. Dr. Mary Gojdics was the protozoologist on the other team. She had publications, including a book on euglenoids, and was very helpful to a novice. Basically, each research scientist is primarily self taught, but the nudges from mentors keep one on the track and focused. When summer was over, I was given a position on the permanent survey team; Mary returned to teaching but did serve on the Academy team for several summers. In short, in the early stages of their careers, research scientists must be nurtured, which is primarily done by individuals rather than institutions.

Becoming a scientist takes a substantial amount of time in the long term. The good news is that a number of options, each with a different level of commitment, lead to a reasonable level of satisfaction. I have carried out research since 1948, and it still gives me joy even though I can no longer do field work or laboratory studies. However, I have never taken a year-long sabbatical even though I have been entitled to it for many years. I knew that research programs could not be turned on and off like a light bulb. When students and technicians are involved, cash flow cannot be interrupted because the researcher is not actively seeking grant funds. If summers are spent teaching and carrying out research, contact with a variety of research investigators is invigorating, and spouses and children usually enjoy the atmosphere at field stations.

A career in science may also provide an opportunity to be of service to both humankind and the other life forms with which humans share the planet. Climate change, exponential human population growth, and natural resource depletion need to be explained to non-scientists, as do many other issues such as sources of energy and the risks and benefits of each source. An important responsibility for present day scientists is to communicate the steadily increasing risks to humanity from rapid climate change, hazardous materials, and so on (e.g., Ehrlich and Ornstein 2010, Brown 2011).

On the "downside" of a scientific career is the chilling effect of political controversy on both scientific teaching and research as " . . . political controversies can shape what scientists choose to study" (Kempner 2008). "There is a tendency to think of scientists . . . as members of an intellectual community guided by norms of openness and transparency and committed to critique, organized skepticism, and the production of objective knowledge" (Kempner 2008). However, scientists are also spouses and parents who are highly focused on research and teaching, devoted to civility, and apprehensive about tenure and promotion. Few could deal with the assaults that some scientists have endured and are not emotionally equipped to cope with the controversies of the 21st century. For example, some scientific research will inevitably be perceived as a threat to special interest groups. In addition, public funds are often used to fund grant proposals for research that often sound weird to laypersons, even though the information would have scientific value. Many grant applications are not funded because too many requests are made for available resources. Proposals with titles that impress non-scientists will have a disturbing effect on science.

The last half of the 20th century and the early part of the 21st century has witnessed a well financed, concerted effort by a small group of scientists who did almost no original research on issues ranging from tobacco smoke to global warming and have cast doubt on the robust, scientific evidence (Oreskes and Conway 2010).

> *Why would scientists dedicated to uncovering the truth about the natural world deliberately misrepresent the work of their own colleagues? Why would they spread accusations with no basis? Why would they refuse to correct their arguments once they had been shown to be incorrect? And why did the press continue to quote them, year after year, even as their claims were shown, one after another, to be false? . . . a group of scientists . . . fought the*

scientific evidence and spread confusion on many of the most important issues of our time. . . . a pattern that continues today . . . about fighting facts and merchandising doubt (Oreskes and Conway 2010, pp. 8-9).

Nature will confirm that the robust evidence gathered by credentialed scientists is correct, and science will triumph over ignorance as it has always done in the past. The people who accept the misrepresentations of science will pay a terrible price. The “merchants of doubt” have effectively delayed action on climate change and other global crises so that some of the changes that have already occurred (e.g., changing ocean water from slightly alkaline to slightly acidic) are irreversible in human time frames. Other crises now occurring (e.g., melting of the planet’s glaciers) will probably continue and result in many irreversible changes (e.g., sea level rise). The human population is still growing exponentially. As a consequence, resources per capita are likely to decline substantially. Science has flourished in times of plenty and survived in times of scarcity; however, in the future, resources for science, education, the arts, and so on will be less abundant.

Science is basically an attempt to determine how the universal laws of biology, chemistry, and physics work and interact. A career in science is a never ending journey full of excitement and challenge. Data gathering seems boring to many people because they lack the vision to see the goal — discovery of new information. Earth’s biosphere is a dynamic system that may never be fully understood. Much remains to learn and discover, so science is a lifetime process that can be quite stimulating. A tremendous satisfaction can also be gained by accepting individuals as students, having them leave as colleagues, and watching their careers flourish. Fulfillment also comes from collaborating with scientists in other disciplines to explore transdisciplinary research. In short, exploring new areas of science with my students and colleagues has been incredibly stimulating. I cannot visualize being in a non-science career as my career in science has brought me great joy.

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