Science is a human endeavor driven by an innate desire to acquire an ever-deeper understanding of the workings of nature and to meet human needs. Throughout history, scientists have continuously increased our knowledge of the world, and their innovations and inventions have immensely improved the human condition. Present-day society relies heavily upon science-based discovery, technology, and policies — whether in information systems, energy management, or disease control. Thus, nurturing future generations of scientists is important for the development of society. How can nations best develop future generations of scientists? The major issues, outlined below, include improving education and career paths in science, encouraging social values in scientists to interact with society, and promoting a diverse workforce with opportunity for women, minorities, and scientists in developing countries. How these fundamental questions are addressed will have an enormous global impact on the future of science in and for society.

Supporting Scientific Career Development

The future of science depends on education and support for younger scientists. However, in academia the prospects for their career development are challenging. The post-doctoral research (postdoc) stage is often a bottleneck for career advancement in developed countries due to insufficient principal investigator positions, while in developing countries such positions remain limited in general. Postdocs are also hired by senior research-grant awardees to work on specific projects on a short-term basis, resulting in significant risk for their career choices. With limited academic career opportunities, the pressure to “publish or perish” for all researchers can create an adverse environment for career development, leading to dropout, or even misconduct. Specific training and career paths need to be developed for doctoral-level researchers in economic sectors outside of academia, including industry, commerce, service, education, media, government and non-government organizations. Given diverse career paths, scientists can contribute to sectors of knowledge-based economies that place a high value on critical thinking, evidence-based decision-making, and technological and conceptual innovation. To enable alternate career paths, universities can provide young scientists with opportunities for self-assessment, learning transferable skills, and engagement with other sectors of society.

The evaluation of research productivity based on publications constitutes a series of crucial checkpoints in the career development of young scientists. The widespread indiscriminate use of single metrics for scientist evaluation, such as a journal’s impact factor, is inappropriate for evaluation of scientists. Instead, balanced rigorous reviews by scientific experts assessing productive production are recommended. Assessment should be based on multi-faceted criteria and research evaluation guidelines such as DORA [2] as well as research-related activities such as societal involvement. This would ensure scientists’ productivity, creativity, and ability to take scientific risks and pursue interdisciplinary and transdisciplinary research.

Scientists’ Roles and Responsibilities in Society

While the primary mission of scientists is to develop and critically examine new knowledge, and pursue innovation and social progress, they also are expected to learn, perform, and take leadership positions in other important roles and responsibilities in and for society. First, scientists certify and systematize the acquired body of scientific knowledge and transmit it to the next generation. Second, scientists educate and mentor younger colleagues of successive generations and diverse backgrounds, to ensure the propagation of scientific values including critical inquiry and thinking, broad perspectives, and high ethical standards. Third, scientists get involved in outreach activities, communicate scientific developments to the general public, and engage citizens and young people who wish to improve their understanding of science [3]. The implementation of science and technology by policy makers also depends on a dialogue with
stakeholders in society, so that scientists can know the
corns, perspectives, and priorities of society, and contribute
to policy-making by offering evidence-based information related
to policy choice. A critical aspect of these exchanges is that
public stakeholders must be able to trust the validity of scientific
results, whereas scientists bear the responsibility of meeting
these expectations. The support for science and scientists in
society is based on this trust/responsibility relationship, and the
scientific community is responsible for training and enforcing
appropriate ethical research standards.

Creating a Diverse Global Workforce

Inclusion of Women and Minorities in Science

The healthy development of science and research communities
is impossible without the participation of scientists from diverse
backgrounds. Although the proportion of women scientists and
those from minority groups, in terms of ethnicity, physical
disabilities and other groupings, varies among countries, they
are rarely represented in fair proportion, especially at higher
levels within organizations and in terms of equitable compensation.
This under-representation is both a pervasive social injustice and
a massive loss of potential contributions to science and society.
Women are in some cases better represented among younger
generations of scientists, but still face severe challenges in their
later career development. Among these concerns is that the
critical age range for childbearing overlaps with the traditional
period for career development from junior to senior positions. To
mitigate this issue, parental duties can be handled by both men
and women, and additional flexibility within the workplace can be
promoted. The availability of child-care facilities is also
important. A second problem is that more women researchers
work in academia than in business enterprises [4] despite the
increasing employment of scientists in business at a faster rate
than academia in the global competition for building
knowledge-based economies. Given this unfavorable situation,
improvements in the working conditions for diverse researchers
in both academia and industry is essential so that high-quality
scientists can compete in a fair way for jobs regardless of gender
or other backgrounds. Toward this goal, developing and
exposing young scientists to successful peer role models for
women and minorities is critical. Finally, training in cultural
sensitivity is required in the scientific community along with
policymaking that mitigates unconscious biases, ensures flexible
timing in promotion decisions at all career stages, and protects
work-life balance for all.

Supporting Scientists in Developing Countries

Science is a borderless activity and has long served as a role
model for international cooperation. Many global issues remain,
particularly with respect to capacity building and researcher
mobility and training in developing countries, which can be
adequately addressed only through effective collaboration
between developed and developing countries. Bilateral and
multilateral cooperative programs and partnerships between
developing and developed countries, and their research
universities and institutes, are strongly encouraged and can be
better supported and incentivized by governments, to move from
the directional depletion of human scientific resources called
“brain drain” to the more equitable model of “brain connectivity
and circulation”. Such exchange-focused collaborations should
aim at strengthening the capacity of institutions to reach a
critical mass of researchers in developing countries. This should
span all levels from pre-doctoral, doctoral, and post-doctoral
training to independent research, to expand careers and
opportunities. The formation of bilateral and multilateral
programs for researcher exchange and new international
institutes would enhance this pattern of mobilization.

Ensuring Access to Scientific Information

All researchers worldwide should have access to the academic
scientific literature and opportunity to publish their own research
based on its quality irrespective of their financial means.
Scientific societies, research organizations, publishers and
governments should collectively strive to establish a sustainable
economic model to mitigate the disparities in access to scientific
information and to publication opportunities in different research
environments. Various ideas have been proposed for the future
of academic publication that go beyond the traditional model
based on journal subscriptions levied by the publishing industry.
This “Open Access” principle supports free access to scientific
publications by all researchers and by the public. While the
merits of open access policies are appreciated, concerns remain
with quality control of the peer review and publication process
that can be prone to malpractice (e.g. predatory publishing) and
these must be resolved. An alternate business model involves
public subsidy of journal subscription fees. For scientific
publications to be sustainable and beneficial to scientists, a
solution to cost sharing among journals publishers, journal
subscribers, authors of journal articles, and the public sector
must be viable and equitable.

Recommendations by the G-Science Academies

Connecting Scientists and Society

(1) Science Education

The scientific community, policy makers and society can better
promote science education and prepare future scientists, and all
students, with inquiring minds, critical thinking, broad
perspectives and ethical integrity.

(2) Career Development

Providing positive research environments and creating
opportunities for doctoral students and post-docs to learn wider
subjects and skills to pursue careers in broader sectors of
industry, government and education is recommended.

(3) Scientists’ Assessment

The use of single metrics for scientist evaluation, such as
number of publications, citations, or journal impact factor should
be replaced by those reflecting the quality and importance of the
science and the diverse activities of scientists.

(4) Public Communication

Prioritizing public education and communication to the public
and children on scientific developments, and engaging citizens
to improve their understanding of science is needed.

(5) Resource for Policy

Evidence-based advice of scientists on issues in social choice
and policymaking is critically important. Policymakers can seek
scientists’ input on these issues, and training scientists for such
purposes is necessary.
Creating a Diverse Global Workforce

(8) Women and Minority Groups

Working conditions for scientists and practices that enable diverse representation and career prospects of women and minorities in a discrimination-free environment are essential.

(7) Developing Scientific Capacity

Developed and developing countries can collaborate to strengthen global scientific capacity and mutual mobility at pre-doctoral, post-doctoral, and investigator stages.

(8) Access to Scientific Information

All scientists should have access to academic literatures and opportunities to publish their research results. Sustainable publication systems with appropriate cost-sharing should be developed.

References: