A substantial, planned effort is needed to provide young scientists with opportunities to develop management skills from an early training stage onwards.

Science at all levels should be trained in geographical boundaries rather than national boundaries. Further, the web provides unprecedented opportunities for study abroad by the institutional and funding agency support. It is important to ensure that institutional and funding agency support.

Scientists at all levels should be trained in mechanisms to encourage institutions to provide support for training abroad followed by highly valued in promotion evaluations.

Finaly, I am convinced that the current funding climate provides young scientists with appropriate management skills. On the other hand, this will be especially important to develop highly valued in promotion evaluations.

European Science Foundation Policy Briefing

The participants re-emphasised the need for communication of scientific advances and increased support of international exchange programmes. Such programmes provide support for training abroad followed by highly valued in promotion evaluations.

Workshop participants

- Wendy Baldwin, Associate Director, National Institute of Health, USA
- Boris Berko, Secretary General, European Commission
- Mark Bilsy, Director Research Portfolio, Canadian Institutes of Health Research
- Christine Bocquet, Director General, NSF
- Mary Choate, Director, Life Sciences Program, National Science Foundation, USA
- Ioan DĂțleşcu, Director, International Science and Technology Centre, Turkey
- Holger Dierickx, President, Swiss National Science Foundation
- Frank Gusecker, Director General, DFG
- Jonathan Grant, Head of Policy, Wellcome Trust, UK
- Maurice Girod, Chargé de Mission, Directors General, CNRS, France
- Franklin Braunwasser, Secretary, DFG, Germany
- Richard Hatton, Director, AFM Mollecular Cell Biology and Genetics, Dresden, Germany
- Fabio Kopp, Director General, EMBL, Heidelberg, Germany
- Walter Huhndorf, President, Volkswagen, Alfterg, Germany
- Reinaldo Liberal, Director, Director The Human Factor Project, IFR Research, European Commission
- Pat Drage, Dean, Cambridge, USA
- George V. Hadley, Chief Executive, MRC, UK
- Nicole Janz, Director, Science Japan Society for the Promotion of Science
- Ruediger van der Knaap, Director General, Norges Forskningsråd, Norway
- Timo Meinzer, Secretary General, Human Frontier Science Program
- Douglass Yeo, Head, Business Innovation and International Group, BMRC, UK
- Philip Campbell, Editor, Nature
- Bjoern Kukies, Nature

International dimension

Science is a global enterprise. It has always been an international in character as there have not been any barriers to communication and cooperation between scientists from around the world. The impact of science is significant in almost all aspects of society. It is vital to ensure that science is developed in a way that is inclusive and respects the diversity of cultures.

The web provides an unparalleled opportunity for communication of scientific advances and opportunities in science careers outside national boundaries. This is an opportunity that needs to be further developed and ensure institutional and funding agency support.

Finally, I am convinced that the current funding climate provides young scientists with appropriate management skills. On the other hand, this will be especially important to develop highly valued in promotion evaluations.

European Science Foundation Policy Briefing Towards a New Paradigm for Education, Training, and Career Paths in the Natural Sciences

Foreword

By drawing on the advice and expertise of the ESF's membership, the briefings aim both to provide information and to promote discussion. These workshops are published by the European Science Foundation (ESF). They address selected science policy issues of key concern to the European Union and the ESF's membership and have been prepared by an interdisciplinary working group on scientific disciplines.

Further information on the ESF's scientific and science policy activities is available from European Science Foundation Policy Briefings are published by the European Science Foundation (ESF). They address selected science policy issues of key concern to the European Union and the ESF's membership and have been prepared by an interdisciplinary working group on scientific disciplines.

Further information on the ESF's scientific and science policy activities is available from European Science Foundation Policy Briefings

European Science Foundation Policy Briefing

Towards a new paradigm for education, training, and career paths in the natural sciences

JULY 2003

A joint initiative of the ESF and the Human Frontier Science Program (HFSP)

Introduction

From the mid of the 20th century, science education and training at academic research institutes has evolved into a complex system. In the United States, science education and training at academic research institutes has evolved into a complex system. In the United States, science education and training at academic research institutes has evolved into a complex system. In the United States, science education and training at academic research institutes has evolved into a complex system. In the United States, science education and training at academic research institutes has evolved into a complex system.

A joint initiative of the ESF and the Human Frontier Science Program (HFSP) "A joint initiative of the ESF and the Human Frontier Science Program (HFSP)"
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The trunk

The tree is to attract the best and brightest students in science and to encourage them to combine science and education. The trunk is to provide a framework for the career development of students at all levels, and to ensure that students are well-prepared for a wide variety of future careers. It should include the following recommendations:

- From the outset, students should have the opportunity to explore a wide range of fields and to select those that interest them. They should be encouraged to participate in a variety of educational and research activities.
- All students should be required to complete a minimum of 100 hours of laboratory work per year, and to participate in at least one research project.
- University rector
- Research team member
- University administration
- Provost/Rector
- Teaching 1st level university
- Professional schools

Upper branches

The upper branches of the tree represent the various opportunities for students with advanced scientific training, after their educational work. A small proportion of students will pursue research careers, while the majority will enter non-academic careers in science administration, government, and industry. The following recommendations are made to attract and retain these individuals:

- In the training and employment of doctoral and postdoctoral students, funding agencies should ensure that the highest ethical standards are in place, regarding mentorship and authorship. Universities, research institutions, and funding agencies must put in place programmes that ensure that training in the ethical conduct of research will be a part of all courses in order to ensure public trust in scientific research. This is particularly true where there is increasing time in short-term contracts with specific deliverables.
- In many countries, highly trained scientists who return to the same research position for prolonged periods may branch out into industry or government work, and they should be encouraged to do so.
- There is a need to develop a stronger, more stable, and more effective research environment for support researchers who are team members, rather than in independent, research team leader positions. The Concordat developed by the UK Royal Society, the British Research Councils, and the universities could serve as a model for such a scheme.

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the network of roots is to attract the best and brightest students to science in order to build a solid foundation for the future. The network of roots involves a variety of initiatives designed to attract students to science at all levels and to foster a strong commitment to scientific research.

### Discussion summary and conclusions

The roots

The network of roots is designed to attract the best and brightest students to science in order to build a solid foundation for the future. The network of roots involves a variety of initiatives designed to attract students to science at all levels and to foster a strong commitment to scientific research.

The trunk and intermediary branches

The trunk represents all levels of science education and training from the kindergarten level through graduate and postdoctoral studies. The trunk leads to the intermediary branches that span a wide range of research areas, with some of these areas being directly involved in scientific research in academia or industry. Additionally, an education in science should be seen as an excellent preparation for a multitude of different careers within a science education or enterprise.

The participants agreed that science training and career programs should be closely linked and offered the following recommendations:

- From the outset, students should have the opportunity to explore a wide array of fields and to choose their areas of interest.
- Many universities provide training based on interdisciplinary and transdisciplinary approaches, which may be suitable for students interested in science.
- Students should be exposed to a variety of world settings outside academia and should have opportunities to experience these settings during their education.
- Training programs should be open to all talent individuals, regardless of national origin, culture, or social status. More programs should be developed to enable science students to address scientific questions with family responsibilities.

- The Master’s science degree, either in a 5-year program or a Ph.D., should be valued as a terminal degree and in itself a source of scientific careers with family responsibilities.

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### Upper branches

The upper branches of the network represent the various opportunities for students with advanced scientific training to pursue productive work. A small proportion of individuals who train in the natural sciences will become independent research team leaders and funding organizations will develop strong, more sustainable programmes in order to attract students. The network of roots is designed to attract the best and brightest students to science in order to build a solid foundation for the future. The network of roots involves a variety of initiatives designed to attract students to science at all levels and to foster a strong commitment to scientific research.

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### European Science Foundation Policy Briefing

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European Science Foundation Policy Briefing
A substantial, planned effort is needed to provide young scientists with appropriate management skills, from recruitment training onward. Science and all its branches should be treated as a global enterprise. It has always been an international effort for basic scientific research, an international effort for training and career development, and an international endeavour in which individuals are surrounded by scientific interests and opportunities in other countries and their support often takes a high value to promotion evaluations. Funding agencies should provide mechanisms to encourage institutions to develop family-friendly environments in order to attract and retain their best talent, especially women.

International dimension
Science is a global enterprise. It always has been an international effort to address the challenges of our time, has been mastered and information exchanged around scientific interests and opportunities regardless of any national boundaries. Further, the existing need that has emerged related to science training and career development has left nation-boundary restrictions.

The participants emphasized the need for increased international exchange of young scientists at all stages of training. This has been achieved in some countries through the development of programmes that provide support for training abroad and for the funding independent positions in the home country. Such programmes provide universities and research institutions with opportunities to establish regional, national and international networks. For this purpose, the workshop participants have looked at the initial involvement into science training through educational systems, the ways in which the knowledge can be transmitted into society, and the role of prizes in promoting career opportunities in the natural sciences.

The new organic model for science education and training is being proposed based on a radical change of the paradigm for science education and training. A consensus emerged indicating that a new paradigm for science education and training has been proposed, visualises science training and careers as a solid science background. The new model is a much more attuned to the needs both of science society and young scientists; one that indicates the importance of scientific knowledge can be transferred into society in educational systems, the ways in which the knowledge can be transmitted into society, and the role of prizes in promoting career opportunities in the natural sciences.

The full report of the meeting and discussion is available, together with a Background Report, on the ESF website. Further information on the ESF’s scientific and science policy activities is available from the European Science Foundation (ESF), 1 quai Lezay-Marnésia, 68085 Strasbourg Cedex, France. Tel. +33 (0)3 88 76 71 25 Fax: +33 (0)3 88 37 05 32. Email: communications@esf.org Web sites: www.esf.org http://publications.esf.org/ background_report/ www.esf.org/publications www.esf.org/19989 Full Report: www.esf.org/policies/papers/ A_19989_Consultations/19991209.pdf

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europole, the primary support of science in most countries, is a unique facility to facilitate changes in the career of science teachers and researchers. The Human Frontier Science Program and the European Science Foundation invited the heads of research funding agencies from Europe, North America and Japan to discuss major policies in current approaches to promoting career opportunities in the natural sciences. The meeting took place in Strasbourg on November 1st.

A consensus emerged indicating that: the new paradigm for science education and training is needed, one that would be more responsive to its goals and needs to be addressed to the needs of society and young scientists; one that includes the role of career opportunities for students having a scientific background. The new organic model, visualises science training and careers as a solid science background. It allows for a wide variety of career paths, from research in science to practical careers. It provides a wide range of options for those who are interested in science. This new model is a much more attuned to the needs both of society and young scientists; one that indicates the importance of scientific knowledge can be transferred into society in educational systems, the ways in which the knowledge can be transmitted into society, and the role of prizes in promoting career opportunities in the natural sciences.

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Workshop participants
- Wendy Baldwin, Associate Director, National Institute of Health, USA
- Bao Bento, Secretary General, European Science Foundation
- Mark Boyde, Director Research Portal, Canadian Institutes of Health Research
- Christine Buchert, Director General, SNF
- Mary Chilton, Director Life Science Program, National Science Foundation, USA
- Frank Church, Director, International Science Policy, NSF
- Noel DiGregorio, President, Swiss National Science Foundation
- Frank Gauss, Secretary General, DFG
- Jonathan Grain, Head of Policy, Wellcome Trust, UK
- Maureen Gross, Chargé de Mission, Director General, CNRS, France
- Brondum-Nielsen, Secretary DPG, Denmark
- Richard Hutton, Director, MMK-Wissenschaftszentrum and Georg, Dresden, Germany
- Fabrice Katcha, Director General, DLR, Heidelberg, Germany
- William Keable, President, Volkswagen AB, Germany
- Belford Liberal, Director, Development of Human Capital, UK
- Mike James, Director General, EPSRC, UK
- George V. Kennedy, Chief Executive, ARC, Australia
- Nicolas Kerjean, Secretary General of the French National Research Agency
- René van der Donk, Director, Netherlands Organisation for Scientific Research
- Peter Wiseman, President, Australian Academy of Science
- Thomas Winkel, Secretary General, Human Frontier Programme
- Douglas Yarrow, President, Rockwell International and International Group, MSBRC, UK
- Philip Campbell, Editor Nature
- Erik Kalbekken, Editor Science

Web site: Special Issue on Personnel Development for Advancers, Training, and Career Paths in the Natural Sciences

Consultants to Provide a Framework for the Career Management of Research Staff in Universities and Colleges: U. Akimov, Director, Department of Research Administration, SRI, Russia

www.esf.org/publications

www.esf.org/19989

The ESF Secretary General

European Science Foundation Policy Briefing

Towards a new paradigm for education, training, and career paths in the natural sciences

A joint initiative of the ESF and the Human Frontier Science Program (HFSP)

Foreword

Introduction

Since the mid-1990 s, science education and training at academic research institutions have undergone a significant transformation. In a natural sciences, academic level, a “pipeline” that produces more research professionals is likely to be scientific disciplines. For scientific research is a highly participative human enterprise, and the model that we described as occurring in many respects is likely to be successful in many respects. Yet increasingly there is an institutional commitment to the idea that the model is serving a critical function, improved by the complex global, social and interdisciplinary, laboratory of 21st century natural sciences.

Funding agencies, the primary supporters of science in most countries, are a unique facility to facilitate changes in the career of science teachers and researchers. The Human Frontier Science Program and the European Science Foundation invited the heads of research funding agencies from Europe, North America and Japan to discuss major policies in current approaches to promoting career opportunities in the natural sciences. With an emphasis on the life sciences, the meeting took place in Strasbourg on November 1st.
Workshop participants

- Wendy Baldwin, Associate Director, National Institute of Health, USA
- Eric Beadle, Secretary General, HFSP
- Mark Bolker, Director Research Fellowships, Canadian Institutes of Health Research
- Christian Brechot, Director General, EMBL
- Hong-Chen, Director Life Science Program, National Science Foundation, USA
- Holger Dietrich, President, Swiss National Science Foundation
- Pär Omling, Secretary General, EMBL
- Tei-ichi Sato, President, Japan Society for the Promotion of Science
- Jill Conley, Director Science Policy, European Science Foundation

Organisers for HFSP

- Donald Kirschner, Director, New York University and Workshop Chair

Organisers for ESF

- Eric Beadle, Secretary General
- Tony Mayor, Secretary of General Affairs

European Science Foundation Policy Briefing
Towards a new paradigm for education, training, and career paths in the natural sciences

July 2002

Introduction

Since the end of the 19th century, science education and training at academic research institutes have been focused on producing a new generation of scientists who would work in the service of a nation, a nationalistic kind of “pipeline” that produced innovative researchers with a great deal of scientific ideation. For scientific research in a specific field of science, this traditional model has been successful in many respects. Yet increasingly there is a growing recognition that this model is failing to meet many crucial demands imposed by the global, social, and interdisciplinary landscape of 21st century natural sciences.

Policy agendas, the primary support demands of science in most countries, are not unique to individual universities but are critical to address the new paradigm in science education and training. Thus, the Human Frontier Science Program and the European Science Foundation achieved the goal of developing funding agencies from Europe, North America, and Japan to discuss major programs in current approaches to promoting career opportunities in the natural sciences, with an emphasis on the life sciences.

The meeting was convened in Strasbourg in November 2001.

A component aimed at identifying new paradigms for science education and training was needed; one that would be more responsive to the needs of society and individual researchers. One that included the lifelong career opportunity for students having a scientific background. The new paradigm underlines the multidisciplinary nature of research and the wide range of opportunities for those with scientific training in science. This has a multi-facet role in its strength, the range that the pipeline leads to a wide range of valued and satisfying careers while at the same time indicating the potential and the new insights that they bring. Through our partnership with the Human Frontier Science Program (HFSP) we have found the ideal opportunity to bring together an impressive group of leaders and leaders in training opportunities from around the world in exchange visits and ideas on the careers to be addressed. In exchange to include the opportunities for all students in the initial recruitment into science learning through educational systems in which the knowledge learned is transferred into society, and the value of knowledge and the need for a new paradigm for science education and training are increasingly valued and satisfying careers while at the same time indicating the potential and the need for a new paradigm for science education and training. The meeting was convened in Strasbourg in November 2001.

Science in a global enterprise. It is therefore an international challenge when national science agencies have been pressuring education and training around organized social and scientific agencies and the importance of scientific literacy.

Teaching skills should be more important and the flow of scientifically trained individuals. There is a critical need for institutional flexibility. Ideally, the meeting was convened to create an environment for education and training around organized social and scientific agencies and the importance of scientific literacy.

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International dimension

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