



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

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



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Foreword

When the idea for a meeting to discuss the recruitment, training and transition to independence of young researchers was first proposed, I accepted this enthusiastically as the future of science depends on young people, their enthusiasm and the new insights that they bring. Through our partnership with the Human Frontier Science Program (HFSP) we have been able to bring together an impressive group of heads and leaders of national funding agencies from across the World to exchange views and ideas on the issues to be addressed, to exchange in order to meet both common challenges and those specific to each country and organisation.

The meeting and this report have looked at the initial recruitment into science learning through educational systems, the ways in which this knowledge can be transferred into society in general by its utilisation in providing a variety of valued and satisfying careers while at the same time looking at the way in which research careers develop. We then faced the issue of the delicate stage which we termed 'transition to independence'.

The full report of the meeting and its discussion has been published by ESF and HFSP and is available, together with a Background Report, on the HFSP web site. The aim of this Policy Briefing is to make the conclusions and summary widely available in the public domain and to encourage debate. In particular, it is hoped that young scientists will respond to the conclusions and provide further input into what must be an ongoing and iterative process. I hope that policy-makers at all levels will also respond positively to the report.

Enric Banda
ESF Secretary General

Introduction

Since the end of the 19th century, science education and training at academic research institutions has been viewed as proceeding along a narrow, unidirectional track, a "pipeline" that produces new research professors within a given scientific discipline. For scientific research in a select group of nations, this traditional model has proved to be successful in many respects. Yet increasingly there are signs of inadequacies; this model is failing to meet many crucial demands imposed by the complex global, social, and interdisciplinary landscape of 21st century natural sciences.

Funding agencies, the primary supporters of science in most countries, are in a unique position to facilitate changes in the culture of research training and support. Thus, 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 problems 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 consensus emerged indicating that a new paradigm for science education and training is needed, one that would be more expansive in its goals and more attuned to the needs both of society and young scientists; one that indicates the rich career opportunities for students having a solid science background. The new organic paradigm, unlike the traditional narrow, unidirectional pipe or hierarchical pyramid models, visualises science training and careers as a tree with a richly ramifying, highly permeable network of roots and branches reflecting the broad range of inputs into the science pipeline and the wide range of opportunities for those who receive training in science. This tree has a width equal to its height strengthening the image that the pipeline leads to a wide range of valued

The European Science Foundation acts as a catalyst for the development of science by bringing together leading scientists and funding agencies to debate, plan and implement pan-European initiatives.

careers, some of which are directly involved in scientific research while others may be associated with science in varying degrees and could be found in venues such as industry, schools, administration, government, the media, business and many other domains.

Discussion summary and conclusions

The roots

The role of the roots is to attract the best and brightest students to science and to enhance interactions between science and citizens. The roots have two aspects: science education at all academic levels below the university level and scientific outreach that supports interactions between scientists and political bodies, business, industry and the general public.

In order to achieve these goals, the participants made the following recommendations:

- Science literacy needs to be strengthened at every educational level. It should instil in citizens early in life an appreciation of and familiarity with scientific language, ideas, and modes of investigation. Concerted efforts are required to introduce young people from all ethnic, cultural, and economic backgrounds to the language and culture of natural science.
- The training of science teachers must receive greater emphasis and good science teachers at all levels must be recognised and appropriately rewarded. Advanced scientific degrees should be required of those teaching science, especially at the secondary school level and above. Web-based teaching aids offer a revolutionary new opportunity to keep teachers abreast of new developments in science, to enhance lesson plans and to enrich student-learning experiences.

The trunk and intermediary branches

The trunk represents all levels of science education and training from the first university degree through graduate and postdoctoral studies. The trunk leads to the intermediate branches that span a wide range of valued careers, only some of which are directly involved in scientific research in academia or industry. Alternatively, an education in science

should be seen as excellent preparation for a multitude of diverse careers in which a science education is essential.

The participants agreed that science training and career programmes must be redesigned and offered the following recommendations:

- From the outset, students should have the opportunity to explore a wide array of fields and to test where their talents and interests lie through a broadly based scientific curriculum.
- Many universities provide training based on classically defined disciplines. In order to meet new scientific challenges and to better prepare students for a variety of future careers, barriers between departments should be removed. Funding agencies can facilitate this change through the support of cross-disciplinary and inter institutional training programmes.
- Students should be exposed to a variety of work settings outside academia and should have opportunities to experience these settings during the course of their education.
- Training programmes must be open to all talented individuals, regardless of national origin, race, or minority status. Moreover, programmes need to provide mechanisms that enable women scientists to combine scientific careers with family responsibilities.
- The Masters science degree, often viewed merely as a stepping-stone to a Ph.D., should be valued as a legitimate endpoint in itself to formal scientific training providing suitable preparation for a wide variety of important careers.
- Emphasis should be placed on mentorship and career guidance for students at all levels including newly independent investigators. Students should also be trained in skills outside pure scientific research, such as teaching and personnel and financial management – skills that are useful to the future teacher, administrator and head of laboratory alike.
- Universities have the responsibility to provide guidance for students regarding different career opportunities. Guidelines associated with training programmes from government and private funding agencies should clearly support a number of legitimate formal educational endpoints, all of which can lead to excellent professional opportunities.

- 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 part of all curricula in order to ensure public trust in scientific research. This is particularly true with an increasing trend to short-term contracts with specific deliverables.
- In many countries highly trained scientists who remain in the same research positions for prolonged periods may be treated as long-term temporary workers or “permanent post-docs” with poor remuneration, security, and benefits. There is a need to develop a stronger, more stable, and more ethical career structure to support researchers who are team members, but not in independent, research team leader positions. The Concordat¹ developed by the UK Royal Society, the British Research Councils and the universities could serve as such a model.

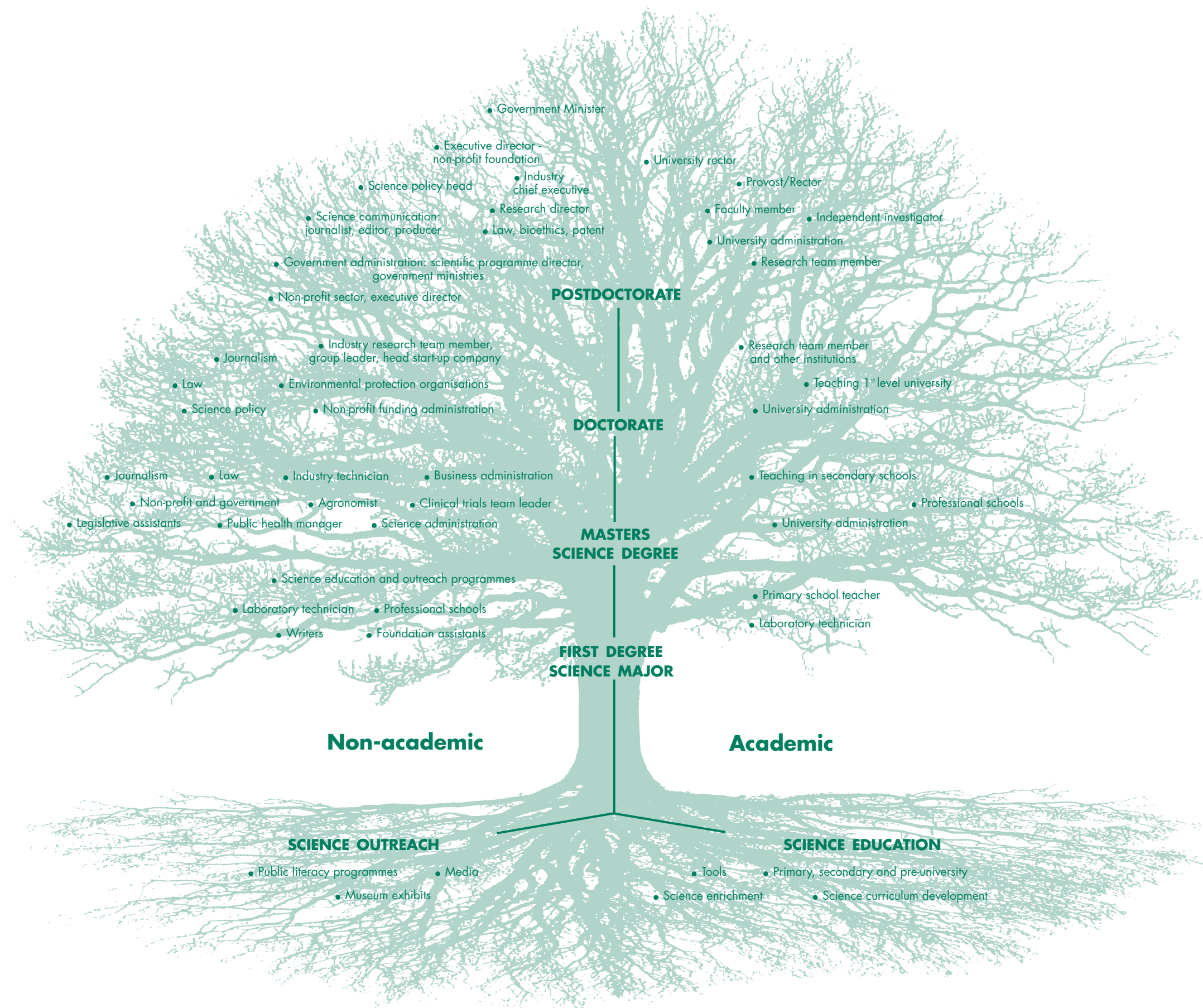
Upper branches

The upper branches of the tree represent the various opportunities for students with advanced scientific training, after their postdoctoral work. A small proportion of individuals who train in the natural sciences will be able to obtain independent research positions and advance up the academic ladder. The choices of the remaining group may include pursuing research in industry, serving as research team members, or obtaining high-level administrative positions in the private or public sector.

Since, in many countries, there are limitations in the number of independent research positions, the following recommendations were made to attract and retain the brightest young individuals to careers in research and stimulate innovative research:

- Provide the most talented young investigators with the freedom to direct their own research and support these opportunities by increasing flexibility through development of innovative new programmes and changes in employment practices. Where these practices cannot be modified, the creation of internal “mobility and independence” programmes should be put in place.

¹ Concordat to Provide a Framework for the Career Management of Contract Research Staff in Universities and Colleges, 1996, Royal Society, London



- A substantial, planned effort is needed to provide young scientists with appropriate management skills, from pre-doctoral training onward.
- Scientists at all levels should be trained in communication to effectively convey their findings to the broader scientific community, to political leaders, and to the general public.
- It is important to ensure that institutional criteria, utilised for promotions and the awarding of prizes, stress excellence and originality and not merely quantity of publications. Teaching skills should be more highly valued in promotion evaluations.
- Funding agencies should provide mechanisms to encourage institutions to develop family-friendly infrastructure in order to attract, retain, and support their best talent, especially women.
- Finally, it became apparent during the course of the meeting that there was a paucity of quantitative information about the outcomes of training programmes in different countries and the flow of scientifically trained individuals. There is a critical need for databases that assess the mobility of scientific researchers within the “tree of science” and within disciplines and geographical regions. The participants strongly endorsed the development of adequate databases to track the results of the different funding schemes encouraging public and private funding agencies to build toward universal tracking system to follow scientifically trained individuals. This information would enable policies to be developed which are soundly based on valid data.

International dimension

Science is a global enterprise. It has always been an international endeavour in which individuals have pursued training and collaboration organised around scientific interests and opportunities rather than national boundaries. Further, the meeting made clear that issues related to science training and career development know no geographical boundaries.

- The participants re-emphasised the need for increased support of 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 followed by funding for independent positions in the home country. Such programmes provide universities and research institutions with opportunities to recruit talent and also induce a need for institutional flexibility. Ideally, the first step should be to provide undergraduate and pre-doctoral students with greater opportunities for study abroad by the institution of additional exchange programme.
- The web provides unprecedented opportunities for communication of scientific advances and opportunities in science-based careers without any geographical restrictions. This medium needs to be further developed and requires institutional and funding agency support.

Web sites:

Towards a New Paradigm for Education, Training, and Career Paths in the Natural Sciences

Full Report:

www.hfsp.org/pubs/position_papers/fundersreport2002.pdf

Background Report:

www.hfsp.org/pubs/position_papers/background_report.pdf

Concordat to Provide a Framework for the Career Management of Contract Research Staff in Universities and Colleges:

www.royalsoc.ac.uk/templates/search/websearch.cfm?mainpage=/funding/fell_concord.htm

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By drawing on the advice and expertise of the ESF's membership, the briefings aim both to provide information and to promote discussion.

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