

CONTENT *The Human Frontier Science Program (HFSP) is an international organization devoted to funding basic research in the life sciences. Its emphasis on interdisciplinary research and the support of young scientists from different continents clearly distinguishes this small organization from many national agencies. Postdoctoral fellowships, support for transition to scientific independence and research grants for international teams of scientists are awarded solely on the basis of scientific merit. Despite the limited budget of about 55 Mio. USD per year, the funding programme is highly acclaimed in the scientific community, and the outstanding quality of the funded research continues to attract countries interested in membership.*

Science without borders

The Human Frontier Science Program (HFSP) – support for basic research in the life sciences

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• Many scientists, in particular those of the younger generation, have never heard of the Human Frontier Science Program (HFSP), founded almost 16 years ago. Some take it for a part of the European Union because its office is located in Strasbourg, France, while for others it is a branch of the United Nations because of its intercontinental support for science. Neither of these views is correct (see 'Who funds HFSP?' on page 231). This article provides an overview of HFSP, its governance and funding programmes with the aim of replacing myths with facts. The information is especially attuned to young scientists who have recently received their Ph.D. and are preparing for a postdoctoral training abroad. It tries to capture the essential and distinguishing features of HFSP without going into the formalities of application. Specific application details are available on the website of the organization (www.hfsp.org).

HFSP was initiated in the mid 1980s by Japan and eventually founded by a group of leaders in politics and science from the G7 countries as 'an international, non-governmental, non-profit association devoted to the promotion of basic research' in the life sciences (see 'Estab-

lishing an international organization' on page 235). In the statutes of the organization, the founding members established that particular importance should be placed on scientific merit, that the research collaborations be international, in particular intercontinental, interdisciplinary and that researchers be encouraged early in their careers by way of fellowships and research grants. The original goals proved to be very effective: within less than a decade, the small funding organization had developed an excellent reputation and was accepted and appreciated by the scientific community. Moreover, scientific reviews by external, independent organizations in 1995, 2001 and 2005/2006 provided unambiguous evidence of the high quality of the research funded by HFSP. These evaluations form the basis of continued endorsement at the highest political levels.

During the initial phase, from October 1989 to March 1992, HFSP supported an impressive range of projects that would have had little or no chance of being funded by national research granting agencies. The second 'fully-fledged' phase began in April 1992. Since then HFSP's funding programmes have embraced the

entire range of basic research in the life sciences from molecular approaches to higher brain functions aimed at deciphering the mechanisms of living organisms. To keep abreast of developments in the life sciences, HFSP sees a clear need for the participation of scientists from disciplines other than biology, such as chemists, physicists, mathematicians, computer scientists and engineers to understand the complex structures and regulatory networks that characterize the living state.

HFSP's organization and selection procedure

• HFSP is governed by its *Board of Trustees* which is comprised of two representatives from each of the 13 members of the *Human Frontier Science Program Organization* (HFSP/O; see 'Who funds HFSP?' on page 231). Board members are appointed by the supporting bodies of their countries, i.e. ministries or national research agencies which annually provide the HFSP funds (e.g. in Germany the Federal Ministry of Education and Research and in Japan the Ministry of Finances). In fiscal year 2005, HFSP's

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annual budget amounted to 55.6 Mio. USD, 56% of which was generously provided by Japan (Table 1). The board approves the budget and decides on the ongoing and new funding programmes. It also makes the final decision on who will be awarded fellowships and research grants based on the recommendation by the Council of Scientists.

The Council of Scientists is comprised of active senior scientists, again with two representatives from each of the members. They are expected to have a broad knowledge of the research trends in their field. They discuss the funding recommendations of the two review committees with regard to the available funds and ensure that there is scientific coherence between the work of the review committees (see below) and the global state of ‘cutting-edge’ research.

There are two review committees, one for fellowships and one for research grants. Their members scrutinize and evaluate the applications for fellowships and research grants and recommend those they consider worthy of funding. Both review committees contain at least one scientist from each HFSP member and occasionally additional members from other countries. The reviewers are chosen such that all applications can be assessed by an expert in that field of research. Currently, the Fellowship Review Committee is composed of 26 members and the Review Committee for Research Grants has 24 members.

Finally, administrative support is located in a small Secretariat in Strasbourg that organizes the annual

Who funds HFSP?

CONTEXT

• HFSP is funded by the Human Frontier Science Program Organization (HFSP) which, in turn, is supported through annual contributions by the management supporting parties (MSP) that include the G7 countries Canada, France, Germany, Italy, Japan, the United Kingdom and the USA, which founded HFSP. Later on, Australia, the Republic of Korea, New Zealand, Switzerland, and the European Commission representing all of the remaining European countries that are not G7 countries (and are therefore not represented as individual member countries) joined the HFSP. In December 2006, India was welcomed as the latest member of the HFSP. In 2005, Japan contributed 56% of the entire budget. Each of the above members nominates two representatives for the 26 seats on the Board of Trustees.

award competitions and manages the funded projects.

The funds for fellowships, Career Development Awards and research grants are distributed entirely on scientific merit. There is no lobbying for the interests of a particular scientific discipline or member country, either by the review committees, Council of Scientists or Board of Trustees. For this reason, HFSP considers applications for membership only from countries whose scientific status enables their scientists to compete effectively with scientists from the other member countries in the grant and fellowship programmes.

Funding objectives

• Since its establishment, HFSP has created a framework involving and supporting researchers in many different countries who are capable of shaping the science of the future. HFSP funding starts at the postdoctoral level and aims to promote the most original projects of contempo-

rary research in the life sciences by granting fellowships, Career Development Awards and two types of research grants. During almost 16 years of operation, researchers from 69 countries have received HFSP funding; 2,076 Long-Term-, 22 Cross-Disciplinary Fellowships and 72 Career Development Awards and 696 research grants involving further 2,744 scientists were awarded during this period.

The structure of the research community in many countries has made it increasingly difficult for young scientists to obtain independence and establish a research group. HFSP therefore has a strong focus on young researchers, and its programmes are specifically designed to provide young scientists with a longer-term perspective of support up to the stage of senior investigators. For example, the combination of a fellowship and a Career Development Award is particularly attractive to applicants who seek international experience early in their careers and who wish to develop their laboratory upon return to their home country. In 2006, scientists under 40 years of age involved in HFSP research grants were awarded 16.64 Mio. USD. If this amount is added to the 13.89 Mio. USD for fellowships and 8.70 Mio. USD for Career Development Awards, 70.3% of the total research budget was allocated to junior researchers.

The distribution of funds between the different programmes is deliberately flexible to ensure that the best possible use is made of the available

Geographic Region	Contribution for fiscal year 2005 (Million USD) and percentage of contribution
Asia/Pacific	32.3 (58%) (31.25, i.e. 56% provided by Japan)
Europe	13.4 (24%)
North America	9.9 (18%)
Total	55.6 (100%)

TAB. 1: Contributions to the HFSP budget for fiscal year 2005 by geographic region

budget. The two review committees discuss the applications for the different programmes at their meetings in January. The chair of each review committee, together with an observer from the *Council of Scientists* who participates in the January meeting, presents a report, i.e. a priority list of applicants and projects to be funded, to the *Council of Scientists* at its annual meeting in early March. The council also reviews the *Career Development Award* applications and – in the light of the real budget (as the financial year closes on March 31st) – discusses the optimal use of funds. Following their presentation, the *Board of Trustees* makes the final decision on the allocation of fellowships and research grants. In 2006, this resulted in a strong support for both *Career Development Awards* and *Young Investigator Grants*.

The fellowship programmes

• HFSP established two postdoctoral fellowship programmes to help train the next generation of scientific leaders while at the same time increasing their mobility both between countries and disciplines. The increased complexity of science and its methodology and the necessity of learning new approaches mean that it takes longer for a young investigator to complete the research training and become independent. HFSP has therefore developed a more comprehensive approach to support outstanding young scientists.

HFSP considers interdisciplinary approaches to be necessary for addressing the scientific questions in the fields that it supports. The aim of the fellowship programmes is therefore to encourage applicants to embark on a new project and to propose highly original and innovative research for which preliminary results are not required. Previous research can obviously represent the stepping stone towards a new and innovative project. In both fellowship programmes, applicants are expected to be exposed to new thinking and training (fellow's benefit), while their own expertise may represent a valuable

Discipline	HFSP Member Country
Biophysics	EU (Netherlands), Germany
Cell biology	Australia, France, Italy, UK
Chemical physics	USA
Cellular & molecular neurobiology	Canada, France, Germany, Japan
Cognitive neuroscience	Canada
Computational neuroscience	Japan
Developmental biology	Australia, EU (Austria)
Immunology	USA, Switzerland
Molecular biology & genetics	Israel, Italy, USA
Plant science	France, Republic of Korea
Structural biology	France, two from UK, EU (Sweden)

TAB. 2: Balance in scientific disciplines and country representation for the 26 members of the Fellowship Review Committee in award year 2006. For reviewers representing the European Union on the committee, the country where the laboratory is located is indicated in brackets.

addition to the host laboratory (host benefit). Candidates for both programmes are required to apply to work in another country and must have at least one first-author or joint first-author publication in press at the time of submission. Applicants from HFSP member countries are free to choose the host country while applicants from non-member countries can only apply to work in a laboratory located in an HFSP member country.

The financial support provided by both fellowships is the same. All fellows are awarded 3 years of funding for research training in a country other than their own. The fellowship provides an annual living allowance based on the cost of living in the host country, a research and travel allowance and, in the first year, an allowance to learn the language of the host country. Fellows who are accompanied by family members may also qualify for a family allowance. On average, a 3-year fellowship for postdoctoral research in the USA amounts to about 150,000 USD.

Applicants for HFSP *Long-Term Fellowships* are encouraged to propose a significant change in their research direction and to seek training in new fields to broaden their scientific horizon. At the same time, more emphasis is being placed on attracting appli-

cants with a different background and an interest in biological research to apply for HFSP fellowships. To this end, the *Cross-Disciplinary Fellowship* programme was launched in 2005. This new programme presents an opportunity for applicants with a doctoral degree in e.g. physics, chemistry or mathematics to receive extensive research training in biology. Thus, since 2005, two types of fellowships are available:

(i) *Long-Term Fellowships* are for applicants with a Ph.D. degree in the life sciences who are expected to broaden their horizon by moving into a new research area that is different from their doctoral studies or previous postdoctoral training.

(ii) *Cross-Disciplinary Fellowships* are intended for postdoctoral fellows with a Ph.D. degree in the physical sciences, chemistry, mathematics, engineering, computer sciences or any other appropriate field who wish to receive training in the life sciences. Applicants for this programme should propose a significant change in discipline by demonstrating how this will help their training in biology and how their specific expertise will bear on the biological question to be studied.

While a change in country at the beginning of the fellowship is obliga-

tory, candidates are expected to return to their home country towards the end of the fellowship. The third and final year of funding can either be used in the host laboratory or can be used to return to the home country to prepare the transition to scientific independence. In the latter case, fellows can defer the start of the third fellowship year for up to 2 years

while receiving support from other sources. Since this option was introduced, more than 55% of the fellows (award years 2000–2003) have used the opportunity to take additional time for advanced research training. This intervening period is of particular importance to *Cross-Disciplinary Fellows* who genuinely propose significant changes in their research direction, since it enables them to gain more expertise in the new scientific environment. To further improve the conditions of the fellowships, the possibility of parental leave was introduced in December 2004. All fellowship holders may now apply for up to 3 months paid parental leave. In addition, starting 1 April 2007 all HFSP fellows with children are entitled to receive a child allowance as a contribution to the high cost of day care.

Fellowship applications are accepted once a year and are submitted online via the HFSP website. After the submission deadline in September, each application is carefully evaluated and ranked by two members of the *Fellowship Review Committee* (Figure 1). Those applications that receive the highest ranks are then thoroughly discussed by the entire committee and recommended for funding or declined. The applications for the two fellowship types are discussed independently of each other so as to acknowledge the sometimes different background and academic record of the applicants. During the last 6 years, the majority of fellowships were awarded to candidates between 25 and 32 years of age.

While the conditions for review and the provisions for fellowship awardees are continually being updated, the selection of fellowships (about 90–100 per year) has become more and more competitive (Figure 2) and, in 2006, the success rate fell below 15%. Due to budgetary constraints, the increase from 2 to 3 years of support and in the amount of the stipend in 2000 led to a decreasing number of awards per year. However, having reached a low in 2001, the number of applicants is now slowly but surely rising again.

The Career Development Award

• The transition from being a ‘supervised’ postdoctoral researcher to becoming a young investigator, who manages an independent research group, is probably the most important step in an academic career. At this stage, young scientists face a variety of tasks, such as hiring personnel, for the first time. Another equally important point at this stage is establishing a research programme and to secure independent funding to build up a laboratory. In particular, the change in research direction during the postdoctoral stage renders this no easy task. HFSP has therefore introduced a competitive *Career Development Award (CDA)* to encourage fellows to return to their home country as independent researchers heading their own laboratories. The award facilitates the fellow’s transition during this crucial period in his/her career by providing 3 years of support. The CDA thus ‘buys precious time’ to develop a research programme and to build up a reputation, in order to secure additional funding, for example, by means of a HFSP research grant.

The CDA is open only to former HFSP fellows who return to their home country. Applicants must either be in the process of obtaining or must already hold a position in their home country which enables them to conduct independent research. They may apply for the CDA after having completed at least 2 years of their HFSP fellowship and can do so for up to 2 years after the termination of their fellowship. Since the beginning of this programme, the majority of CDAs were awarded to candidates between 33 and 36 years of age, thus bridging the funding gap between HFSP’s fellowship and research grant programmes.

The first CDAs were made in March 2003. Since then, 72 young scientists who received the award have returned to their home country* and started their independent laborato-

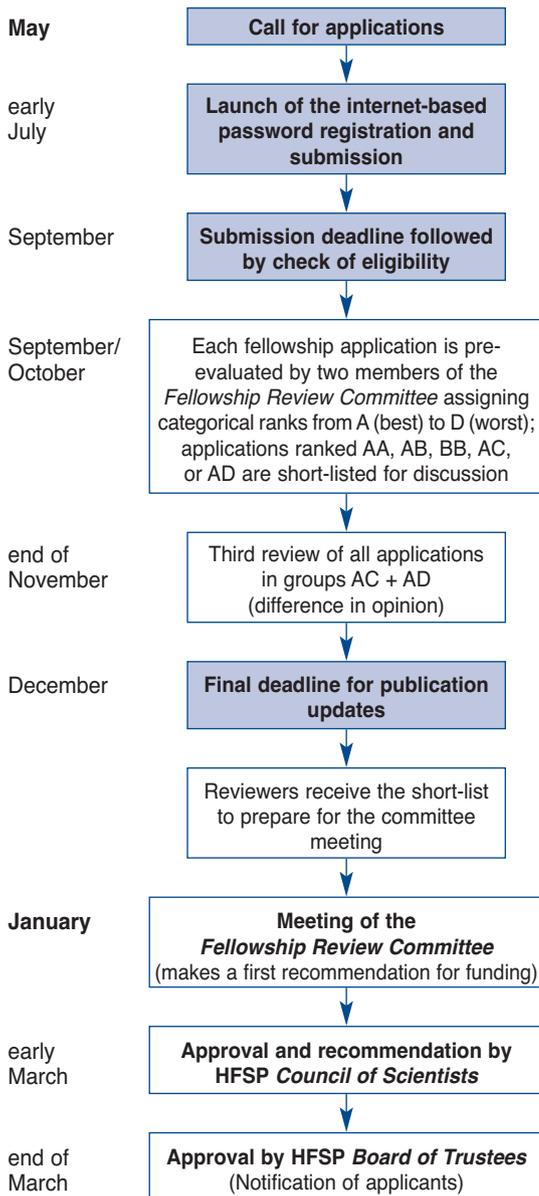


FIG. 1: Steps in the selection of HFSP Long-Term and Cross-Disciplinary Fellowships from announcement to final award decision. Fields in bold mark specific events while fields in blue emphasize important deadlines for applicants.

* Argentina, Australia, Belgium, Canada, the Czech Republic, China, Denmark, Finland, France, Germany, Greece, Italy, Israel, Japan, Korea, Spain, Switzerland, the Netherlands and the USA

ries. Despite the success of this programme, the number of awards is still too low to support all the fellows that repatriate. Between 2000 and 2002, HFSP supported 319 fellows of which about 55% chose to return to their home country.

The value of the award was recently increased from 180,000 to 300,000 USD for a period of 3 years. Applications for a *CDA* are submitted via the HFSP website in November each year. Each application is initially evaluated by two members of the *Council of Scientists* together with external reviewers. The most promising candidates are then discussed again by the entire council at its annual meeting in March.

Short-Term Fellowships

• The *Short-Term Fellowships* enable young researchers to spend between 2 weeks and 3 months working in a laboratory in another country to learn new techniques or establish new collaborations. Former *Long-Term* or *Cross-Disciplinary Fellows* can also use this support for return visits to their previous host laboratories to complete work initiated under their past HFSP fellowship. In this way, this programme provides an ideal opportunity for scientists to expand their professional network early in their careers. Applications for *Short-Term Fellowships* are accepted

throughout the year and provide travel and *per diem* support, depending on the length of the research project.

Research grants

• Research grants enable teams of scientists from different countries and continents to combine their expertise to approach questions in the life sciences that could not be answered by the work of the individual laboratories. Emphasis is placed on novel collaborations that bring together scientists from different disciplines (e.g. biology, chemistry, physics, computer science and engineering). To stimulate novel, ambitious ideas and innovative approaches, preliminary results are not required and applicants are expected to develop new lines of research.

Research teams of 2–4 scientists must be international, and great emphasis is placed on intercontinental collaboration. The principal applicant must be from one of the member countries. However, other participating scientists and laboratories may be situated anywhere in the world. One exception to the rule is made for current or former holders of HFSP *CDAs* maintaining their laboratory in non-member countries, who may act as principal applicants provided the team includes at least one other applicant from a member country.

Two types of research grants are available. *Young Investigator Grants* are awarded to teams of researchers, all of whom have held their independent position (e.g. assistant professors, lecturers or equivalent) for no more than 5 years. *Program Grants* are awarded to teams of independent researchers at any stage of their careers, although participation of independent investigators early in their careers is encouraged because this represents a valuable experience for younger team members.

Each year, about 34 research grants are funded for 3 years. For both types of grants, the amount depends on the size of the team: a grant team composed of two principal investigators, i.e. a two-member team, receives 250,000 USD per year, three-member teams 350,000 USD per year and teams with four or more members 450,000 USD per year.

Interdisciplinary review

• The HFSP research grant and fellowship programmes each receive more than 700 applications per year. Thus, the members of the two review committees are not only entrusted with a tremendous amount of work, but also with a great responsibility. By selecting the most promising research teams and fellows, and in particular by encouraging submissions from researchers outside the life sciences, these two committees take on the primary responsibility of steering the scientific course of the programmes. Scientists nominated for one of the HFSP review committees must therefore not only be acknowledged experts in their fields but also have a broad professional experience to be in a position to evaluate applications that involve scientists from fields other than biology. The selection of new review committee members involves suggestions by retiring reviewers and the *Council of Scientists*, and extensive web searches by the HFSP *Secretariat* to find the necessary expertise.

For an international funding programme that promotes the collaboration and exchange of scientists in in-

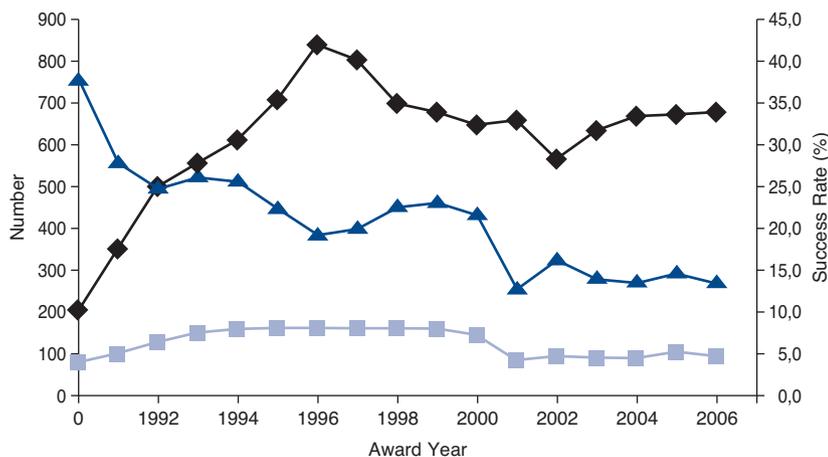


FIG. 2: Development of application numbers, fellowship awards, and success rate for the HFSP fellowship programme. Numbers are based on Long-Term Fellowships (1990–2004) and total fellowships (Long-Term and Cross-Disciplinary Fellowships) for 2005 and 2006. (◆: applications; ▲: success rate; ■: awards)

CONTEXT

Establishing an international organization

• During the mid 1980s, the government of Japan considered the establishment of a global network of researchers in the basic life sciences, the Human Frontier Science Program (HFSP). For Japan, this was a means of making a significant contribution to international efforts to promote basic research in the life sciences. The specific areas of research to be supported were subsequently defined at a number of international meetings involving scientists and politicians of the G7 countries. In 1987, the Japanese Prime Minister of the time, Yasuhiro Nakasone, made a decisive step forward and proposed to the assembled heads of governments at the G7 Economic Summit in Venice that HFSP be founded.

In the late 1980s, further international talks among the G7 nations prepared the ground for the foundation of the implementing organization, the Human Frontier Science Program Organization (HFSP/O). These countries agreed on the shape that HFSP should take and on the general scientific areas and activities to be supported. Within this frame, an 'International Scientists' Committee', which had started work in 1987, made further amendments to HFSP's organization, and defined the details of its activities, research areas and peer-review procedures. The proposed programme was later endorsed by the participating G7 governments, who agreed to put HFSP into effect for an initial, experimental phase of 3 years. To facilitate the launch of HFSP, Japan offered to provide significant funding for this initial phase. The administrative support, i.e. the Secretariat of HFSP/O, was established in October 1989 in Strasbourg, France. The first awards were granted in March 1990.

terdisciplinary research across continents, it is of paramount importance to have a review system in place that is balanced in terms of representation of countries and scientific disciplines (Table 2). Without a review system that is accepted by the scientific community, it would not be possible to encourage applications from research grant teams that include physicists, mathematicians or chemists. It must also be ensured that application guidelines do not discriminate against applicants from certain fields who wish to change to the life sciences (for example, by acknowledging publishing traditions that differ from the life sciences). Both review committees have a regular turnover of members, since no member can participate for more than 4 years (or five if elected to the Chair). This guarantees a continuous change in nationalities and research expertise, the latter being carefully monitored to make adjustments if necessary.

One element that distinguishes HFSP's review process is that reviewers from outside biology are assigned to applications, for instance, where a *Cross-Disciplinary Fellowship* applicant proposes significant changes from the previous work. Likewise contributions of an experimental physicist in a *Program grant*

are evaluated by a reviewer from this field. Applications for research grants and for CDAs are also sent to external reviewers ('mail reviewers') that supplement the breath of expertise of the responsible review body within the HFSP. The 'complementary' review of HFSP applications ensures that all aspects of a research project or a candidate's record receive due consideration and that funding decisions are well-founded.

In addition, the statutory requirement that there is at least one reviewer from each HFSP member on each review committee provides access to a much larger, global pool of scientists who might serve on the committee. Such a diverse committee reduces the risk of geo-political bias in the selection of awards, and ensures that no collaborating or competing scientists are on the same committee. Due to the broad scientific discussions during committee meetings, retiring reviewers often find this selection procedure a very satisfying and stimulating experience for their domestic review duties.

The HFSP Journal

• To make the aims of HFSP better known and to provide an additional avenue for the publication of the results of basic interdisciplinary re-

search in the life sciences, HFSP/O decided to launch a scientific journal – *The HFSP Journal*. In June 2005, *HFSP Publishing* was established as a not-for-profit organization to support the journal and was granted permission to use the HFSP name and logo. The scope of *The HFSP Journal* is 'to publish high-quality developments in basic research in the area of life sciences over a wide range of organizational levels using strategies or technologies from the more quantitative disciplines, e.g. physics, chemistry, mathematics, engineering or informatics'.

The HFSP Journal will use complementary review of scientific papers and commissioned articles. For this reason editorial board members and reviewers from different disciplines support the journal. The journal is hosted online through the *American Institute of Physics* (<http://hfspj.aip.org/>) and offers both subscription and open access. If authors choose the latter option and pay an open-access fee, they can make their research articles freely accessible immediately upon online publication. The first issue of *The HFSP Journal* is due to be published in early 2007 and scientists in all countries are invited to contribute to this new endeavour to advance our understanding of the complex nature of the living state.