REPORT
on research ethics in the biological sciences

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The present report is an attempt to identify the basic parameters of ethics in biological research. It is an issue that concerns all areas of biological research (e.g. clinical trials, research on the human embryo, research with human biological material, animal, plant and microorganism research). The commission has addressed ethical issues of specific research areas with previous recommendations.

Research ethics is of course an issue that concerns both natural sciences and humanities and is becoming increasingly topical within the international scientific community and international scientific organizations. An additional reason for discussing the issue in our country is the new legislation for publicly funded research that was recently adopted. We consider the assessment of the problems associated with research ethics – in particular with regards to safeguarding research independence and credibility – as a necessary condition for the effective implementation of the new legislation. In view of the importance that society attributes to science research ethics is not just an “additional” requirement for science advancement. Rather the opposite is true: appreciation of science by the public depends on the former respecting the values of society and is constantly tested with every research initiative. Whenever science disregarded these values in the past, the scientific work has been discredited and public opinion has grown suspicious.

The analysis that follows presents some elements of organization of research (Part I), considers the ethical parameters and problems to be discussed (Part II) and concludes with a number of proposals.

PART I

ELEMENTS OF ORGANISATION OF RESEARCH

Research provides empirical data against which theories are tested and questions are answered. It contributes to fulfilling the goals of Science among which gaining new knowledge, seeking scientific truth, avoiding mistakes and producing technology to facilitate everyday life.

Biological Research, its objective being the study of life, impacts directly on essential areas of human lives such as health and the environment. Besides, due to the significant breakthroughs of recent decades and the high expectations for producing more innovation in the future, biological research has come to occupy a very prominent position world-wide in terms of the value attributed to it by public opinion (Eurobarometer, 2007), the amount of funding it absorbs and the share of economic activity it generates.

1. Biological Research in Greece

In Greece, biological research is mainly conducted by Higher Education Institutions, Research Centers, Hospitals and, to a lesser extent, by the Industry, e.g. pharmaceutical companies, biotechnology companies, etc. According to data from the General Secretariat of Research and Technology (GSRT) on research as a whole for 2005, 64% of science and technology research staff are employed in government agencies or universities (Table 1).

Distribution of Research Manpower per sector of employment	**Man-years (FTEE)***	**Percentile**
Industry	12020,5	35,4%
Public Research Centres	4344,8	12,8%
Higher Education Institutions	17400,5	51,2%
Non-profit Private Research Centres	192,6	0,6%
Total staff employed in research in Greece	33958,3	100%

Table 1: Total Research Manpower in Greece in 2005. The numbers include researchers, technicians and support staff. Source: General Secretariat of Science and Technology (GSRT) **** FTEE**: Full-time Employment Equivalents, man-years*.

a. Supervision of Research

In Greece, the government influences the general orientation and scope of research through the formulation of a national strategic plan. The extent of influence exercised by the government on the orientation of research is based on the management of public funds allocated to it.

The national strategy for research and technology is approved by the *Inter-ministerial Committee for Research and Technology* (DEET) upon proposal by the *National Board for Research and Technology* (ESET). DEET is comprised of the Prime Minister and the majority of government Ministers[1]. The president of the ESET is invited to DEET meetings. The participation of virtually all ministries in the DEET testifies to the importance of research and technology for all sectors of public life.

According to the legislation in force the ESET is "an independent advisory body directly answerable to the Prime Minister". Its members include internationally acclaimed scientists among which the president of the National Council for Research and Technology (EOET) business executives and a representative of the civil sector. ESET formulates a proposal for the *National Plan for Research and Technology* (EPET) and submits proposals for the national research strategy to DEET for approval. ESET supervises the implementation of EPET.

Greece does not have a separate independent council for the coordination of research in the biological sciences. The ESET includes a section of Biology and Biotechnology but the role of sectors is unclear.

The newly-legislated EOET which was created by the new "Statutory Framework for research and technology" has two sectors, one for basic and one for applied research, and its main mission is the "implementation and management of actions in basic research, applied-technological research and innovation"[2]. In practical terms, EOET's task is to support research through the management of public funds mainly in order to finance research projects to be carried out in national research institutions following call opening and evaluation of submitted proposals. The proposals will be peer reviewed by Greek or foreign scientists of international acclaim. EOET was established by Act 3653/21.3.2008 and was still inoperative at the time the present

[1] a) Internal Affairs, b) Economy and Finance, c) External Affairs, d) National Defense, e) Development, f) Environment, Planning and Public Works, g) National Education and Religion, h) Employment and Social Protection, i) Health and Social Solidarity, j) Rural Development and Foodstuffs, k) Justice, l) Culture and m) Transport and Communication.

[2] Article 19 (2) Act no 3653 OJ A' 49/21.3.2008: Statutory framework of science and technology and other stipulations (Act of Parliament, 2008)

report was drawn up. Again, the law does not provide for a separate council dedicated to biological research.

Despite their dependence on public funds, Universities and Research Centres can determine the orientation of their research activity by appointing staff with desirable research interests and by raising non-public funds for research. According to data from the GSRT, the major source of non-government funding for Greek research centers comes from abroad, mainly the European Union.

b. Financing

The biggest provider of funds for public research in Greece is the state. In 2005, 47% of the expenditure was met with public funds, 31% of funds for research originated from the industry and 19% from abroad (table 2). Research in Public Research Centres and Higher Education Institutions is financed mainly with public funds or funds from abroad while the domestic private sector contributes very little (table 2).

The largest part of foreign funding is absorbed by public research centres and universities. Research in the private sector absorbs one third of the overall funds most of which is self-financing. Public research absorbs approximately 67% of the overall funds allocated for research (table 3).

Compared to the respective European Union average Greece spends a smaller share of its Gross Domestic Product (GDP) for research (0,7% as against 1,9%) whereas the contribution of the industry is even smaller (30% compared to 55%). The goal for 2010 is to increase the share of GDP for research and the contribution of the private sector (table 4).

Financing of Research in Greece	Research Centre				
Source of funding	**Private Sector**	**Public Research Centres**	**Higher Education Institutions**	**Non-Profit Private Research Centres**	Total
Private Sector	85,4%	1,3%	8,9%	2,1%	**31,0%**
State	6,3%	68,1%	65,6%	9,6%	**47,0%**
Higher Education Institutions	0,3%		3,4%		**1,7%**
Non-Profit Private Research Centres	0,3%	0,1%	0,8%	78,8%	**1,5%**
Foreign funds	**7,8%**	**30,6%**	**21,3%**	**9,6%**	**18,8%**

Table 2: Financing of research in Greece per source of financing and research centre. Source: GSRT, gross domestic expenditure for research & technological development, break-down according to source

	Expenses (in mil €)	% of the total
Companies	357,0	30,9
Public Research Institutes	233,9	20,3
Higher Education Institutes	547,7	47,5
Non-profit Private Law Bodies	14,6	1,3
Total	1.153,2	100,0

Table 3: Total expenses in research per entity of research. Source: GSRT gross domestic expenditure for research & technological development, break-down according to source

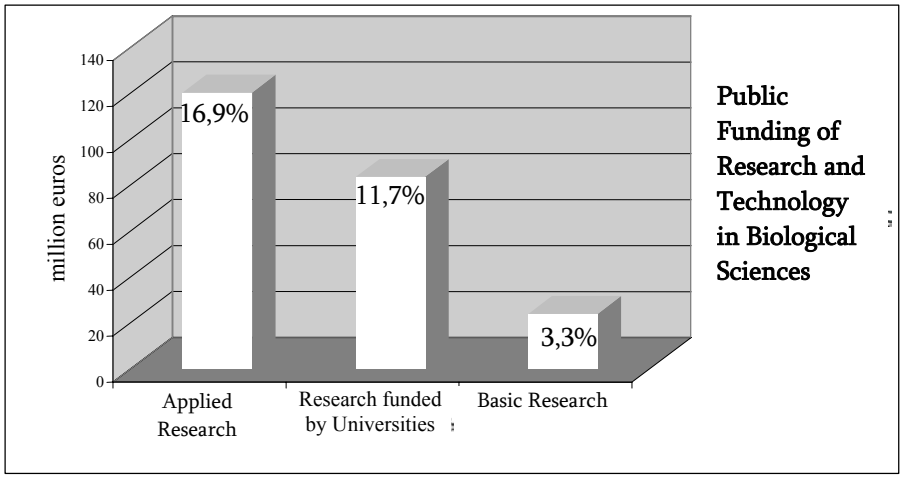
Indicator	Time	EU average	Greece
Gross domestic expenditure for research & technological development in terms of GDP	Today In 2010	1,9% 3,0%	0,7% (1) **1,5%**
Contribution of companies in the gross domestic expenditure for RTD*	Today In 2010	55% 65%	25% (1) **40%**

Table 4: Comparison of Current Expenses Greece/EU and goals for 2010. Source: GSRT *RTD: Research and Technological Development

With regards the allocation of funds per area of biological research, data from GSRT for public funding shows that within life sciences applied research is the prevalent type of research activity in terms of funds absorbed. In particular, in 2005 16,9% of the overall public funding for research and development went to applied research in the biological sciences; the respective share for basic biological research was 3,3 % (5 times smaller compared to funding for applied research). 11,7% of public funds for research was absorbed by biological research in Universities. An important element demonstrating the wider importance of the Biological Sciences is the fact that they absorb almost one third (31,9%) of the overall expenses for research (graph 1).

To date the management of public funds for research in order to finance selected project proposals was the responsibility of the GSRT. Under the new legislation, the management of these funds and the evaluation of proposals comes under the EOET[3]. Although the adopted procedures for the scientific evaluation of research proposals to be submitted to EOET follows international standards, there is no provision for the evaluation for the ethical evaluation of the proposals. The evaluation of ethics is a prevailing international trend and a necessary requirement for financing proposals in the 7th EU Framework Program (FP7).

[3] Article 23, Act 3653/2008.



Graph 1: Break-down of research funding in the Biological Sciences (Biology, Medicine, Environment, Agronomics) in Greece for 2005. Percentages shown represent funding for each research activity as a percentage of the total public expenses for research and technological development. Source: GSRT, Public Funding for Research and Technological Development per domain and objectives

2. Assessment of research

The assessment of quality of research is based on the number and quality of publications in internationally accredited journals, the participation in international conferences in the respective field, the success in securing funding for research and the generation of innovative ideas as reflected in awarded patents. Also, the co-operation between research teams nationally and internationally plays a very important role for the positive assessment of the work of researchers and research teams.

The professional recognition and career development of researchers depend on the positive assessment of their work. In addition to the personal motivation of each researcher for pursuing a career in research, publications, cooperation and funding, as significant criteria for the evaluation of institutions and individuals, are currently the most prominent driving forces for research; therefore, they are expected to play a key-role in the issues of research ethics that will be discussed below.

PART II
THE ETHICAL ISSUES

1. The value of research

Scientific research is a common as well as an individual good. As a common good research promotes human knowledge and innovation, contributing to the "well-being" of society as a whole. This dimension is inextricably linked with the freedom of researchers without which research is inconceivable. In this sense research also represents an individual good, recognized as such in the legal system (freedom of research). The above are enshrined in international and constitutional instruments like the UNESCO's declarations on Bioethics (art. 2(d), 15), on the Human Genome and Human Rights (preamble and art. 12, 14, 15, 17, 19) and the Greek Constitution (art. 16).

Thus, all democratic societies have an interest in developing research for many reasons since:

- findings are expected to contribute to better quality of life for all,
- policy-making can be based on scientific facts (Rosenstock and Lee, 2002),
- immediate economic benefits are expected from the introduction of innovation in the production process, the use of patents and the creation of new jobs,
- the creativity of research manpower is enhanced,
- research enhances education for all by renewing and enriching the content of knowledge (Tindemans 2007:24) especially in higher education and by nurturing a spirit of initiative, communication and co-operation between national entities and – in particular – respective foreign bodies.

Ideally, the individual and the social component of research should be harmonized. The concern for achieving maximum harmonization in specific actual contexts justifies the attention paid to research by modern states. This attention is exemplified in the constitutional protection of research, the adoption of programmatic legislation and the operation of specific institutions which draw up national strategies. The same degree of attention is seen on the supranational level in the respective institutional arrangements in the EU.

2. The predominance of the economy and its consequences

At the moment the economic parameters of the development of research are of particular interest as they tend to override all other dimensions. The following facts must be taken into consideration:

a) The development of modern research in large-scale facilities. Modern research has long ceased to be driven by the model of the initiative and personal work of isolated ingenious researchers. Today the driving force are research teams which do not act in isolation but are organized in international networks of co-operation. Correspondingly the required infrastructure cannot be achieved by isolated laboratories but by large-scale research centres usually operating as independent economic entities. These centres must ensure their viability through self-financing, i.e. by raising private funds since the state can only cover a minimal part of the required investment. Therefore, they are inclined to favour projects of applied research that yield immediate returns to specific sectors of the economy even if – in view of their size – they also allow to some extend activities directed to basic research (indirect return).

b) the link of the economy with innovation. Modern research is linked as never before with the economy as the latter funds innovation especially in relation to new technologies (Tindemans 2007: 24). A very competitive environment has emerged in this respect between the major players of world economy (USA, Japan, Europe and emerging economies); a fact that reinforces this close link.

These factors often create distortions and asphyxiating conditions for the freedom of researchers such as:

- limits to strategy (orientation to applied research and moving away from basic research which is the main contributor to the production of new knowledge),
- limits to the scope and even the context of applied research since priority is given to projects of immediate commercial use,
- too much preoccupation with fund-raising and the “management” of the research unit, disregard for the main scientific interest,
- readiness to “succumb” to the provider of funds even when the credibility of research suffers as a result (e.g. selective publication, even “fabrication” of data),

- too much competition between research centres (even within each centre) leading to lack of transparency, at the expense of the necessary communication and co-operation especially in case of ambitious research goals.

By restricting the freedom of research these symptoms virtually undermine its intellectual pursuit as a *rational endeavour to discover elements of reality of the world that surrounds us*.
Besides, if the value of research does not exclusively consist of supporting the economy but also concerns the preservation of other common goods, then the role of public support of researchers is crucial. The state, therefore, seems to dismiss its own responsibilities when it "withdraws" from the active support of research and invokes the interests of the market leaving the efficiency of research to be determined according to free market criteria. For these criteria operate unilaterally and, certainly, do not respect the value of research for society and for the individual, as explained above.

3. Research in the biological sciences

These general remarks are all the more relevant in the case of research in the biological sciences which is our focus. Certain particularities need to be stressed at this point.

a) Freedom and funding of research

The funding of research in biomedicine and biotechnology is a high risk investment because usually it requires large funds with a high possibility of failure. This exacerbates the difficulty of public financing especially with regards to basic research. Applied research takes an important precedence because it promises immediate returns.

b) Direct impact on society

Biological research either in human subjects or in other species has a direct impact on society because it is connected with sensitive values to a degree unfamiliar in other fields. The strategic orientation of international research is often criticized, for

example, for excluding research that would be useful to the Third World or research in rare diseases.

Research in human subjects (mainly clinical trials for medicines and other means of treatment, research in embryos or in biological material) endangers fundamental rights (privacy, personal data, health) and general principles (human value, equality). Research in other species (e.g. biotechnology) is connected with environmental protection, public health, even the respect we owe to these species (e.g. lab animals, rare species).

When such interests are put at risk it becomes all the more indispensable to ensure credibility and to comply with research ethics in both the aims and the methods used.

4. Issues of ethics in biological research

As mentioned above, the basic criteria of assessment of biological research are publications, co-operation between scientists and scientific teams and adequate funding. The urge to publish and to raise funds, in particular, has occasionally led to misconduct and fraud. In addition, the use of research findings in policy-making is a source of pressure on researchers from sponsors or other players with vested interests.

The publication of research findings is necessary to diffuse knowledge. However, the pressure exerted on researchers for more and more publications in highly respected journals can lead to unethical misconduct that has gone as far as fabricating the results. A recent case of fraud that hit the headlines was a publication by the Korean Woo Suk Hwang and co-workers in Science on the alleged successful cloning of human stem cells. This publication made Hwang quite famous and, had the fraud not been revealed, he would certainly have been rocketed to summits of professional celebrity. This case exemplified issues of ethics and review of the validity of research results as well as the inextricable link between ethics and the quality of scientific research (Resnik et al., 2006).

Not only is private financing seen as welcome but the increase of private funding figures among the goals of most national policies for research and technology worldwide (European Commission, 2007a). It has promoted progress in science and technology and has often made up for the inability of the state to provide adequate funds to all scientific fields. The decoding of the human genome, for instance, was made possible by a partnership of private and public bodies.

The source of financing, however, can affect the validity of research findings especially if the sponsor has a vested interest in the outcome of the research. One

example is clinical trials financed by pharmaceutical companies. It has been reported that trials of new drugs used in oncology and financed by the pharmaceutical company which is going to produce the drugs are eight times more likely not to reach negative results compared to independently funded trials (Friedberg et. al., 1999). Similar cases of manipulated research have been reported in other clinical and epidemiological trials including the notorious example of research manipulated by the tobacco industry (Tong and Olsen, 2005; Lesser et al., 2007). Public sources of financing can also be interventionist. The "Union of Concerned Scientists" has a list of cases of government intervention to conceal or manipulate research findings for political reasons.

To give the problem its real dimensions, according to US data on research conducted by publicly funded agencies, in the last 200 years there have been 200 cases of confirmed misconduct (Resnik, 2007). This figure which represents approximately 0,01% of the entire research community for this period probably underestimates reality but implies that such phenomena and specific cases of deliberate fraud are relatively limited. This, however, does not mean that the problem does not require serious consideration.

As the above examples demonstrate, the validity of biological research has a direct impact on society and often affects public health directly. The existence of and compliance with recognized code of ethics is important not only in order to defend the safety and the rights of volunteers or lab animals. It is also required to ensure the quality of the results, to maintain public support for research, to achieve accountability to society – the source of funds – and for the harmonious and effective co-operation between researchers (Resnik, 2007).

To deal with serious issues of research ethics like those mentioned above and in recognition of the significance of educating researchers in ethical topics, international scientific societies, universities and research centers have issued codes of ethics or ethical guidelines and specialized correct research practices for each research field. The Council for International Organizations of Medical Sciences, CIOMS) has issued ethical principles for biomedical research in humans[4] and animals[5], research in the human genome[6] and for epidemiological research[7]. The International Epidemiology

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[4] CIOMS international ethical guidelines for biomedical research involving human subjects (http://www.cioms.ch/frame_guidelines_nov_2002.htm)

[5] 1985 international guiding principles for biomedical research involving animals (http://www.cioms.ch/frame_1985_texts_of_guidelines.htm)

[6] 1990 declaration of inuyama on human genome mapping, genetic screening and gene therapy (http://www.cioms.ch/frame_1990_texts_of_guideline.htm)

Association recently issued principles of correct practice and conduct in epidemiological research (IEA, 2007). Some of the issues dealt with in these instruments can be summarized as follows (Shamoo and Resnik, 2002):

- **Honesty** as to the method and the findings in the publication and reporting of scientific studies,
- **Objectivity** in the design of trials and the analysis of results as well as in the consideration of the work of other scientists,
- **Integrity** in the observance of promises and assumed obligations and consistency between word and action,
- **Care** to avoid inadvertent mistakes and to keep good records,
- **Compliance with copyright,**
- **Confidentiality** with regard to information obtained during private meetings or when considering proposals for funding or papers for publication,
- **Responsible publications** whose goal should be the advancement of science and avoidance of pointless papers that reiterate available knowledge,
- **Care for the instruction of students,** protection of their prosperity and recognition of their right to decide for themselves,
- **Respect for colleagues,**
- **Social Responsibility,** the goal must be the common good and the avoidance or alleviation of social problems through research and education of the public,
- **Avoidance of discrimination** based on gender, nationality, ethnicity or any other factor irrelevant to scientific competence and integrity,
- **Preservation of professional competence** through life-long training and education,
- **Legality,** compliance with all laws and regulations governing the operation of research,
- **Care for animals** both in the design and the execution of research projects,
- **Protection of volunteers,** limitation of risks and maximization of benefits for volunteers and respect of their personality, especially in case of vulnerable groups.

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[7] 1991 international guidelines for ethical review of epidemiological studies (http://www.cioms.ch/frame_1991_texts_of_guideline.htm)

5. The problem of control

The issue of controlling the credibility and the ethics of research often inspires fears of a possible “bureaucratization”, imposition of “outside” regulations and interference of mechanisms irrelevant to the objective. Such deviations would unavoidably cause unjustified delay and, in the end, would discourage initiative even if designed correctly.

This eventuality, however, does not automatically eliminate the need for control; it merely draws our attention to the methods to be used. It is generally accepted that if control is exercised on the initiative and according to the procedures of the scientific community itself (self-regulation) the extent of “bureaucratization” would be restricted since the parties themselves have an interest in effective control.

RECOMMENDATIONS

The specificities of biological research call for some general guidelines:

Proposal I

The independence of research is a public good. A society that recognizes and safeguards this principle cannot accept the unconditional submission of researchers to purely economic parameters.
Therefore, some space needs to be ensured – and supported financially – for the unhindered development of research initiatives governed by principles, rules and priorities set by science itself (the respective scientific field) even under the afore mentioned circumstances.
This responsibility lies primarily with the state through the public funding of research. It is important, however, that non-state agencies can contribute here (e.g. non-profit organizations or charities).

Proposal II

The scientific community is the natural guarantor of independence of research both internationally and nationally. A national policy of research must be based on the community of scientists of every field in order to avoid the imposition of “outside” regulations. A principle similar to academic freedom in higher education should be adopted for research.

Proposal III

In terms of ethics, a national policy for research must ensure:

- Transparency in the allocation of funds to research projects according to specific and preset criteria including active support for basic research. The state is responsible for developing the latter even if the return to the economy is only indirect.
- The independence of the community of scientists and of research institutions in setting research priorities. The former can only be defended by a national planning board. Its members must come from the scientific community and serve for a specific mandate. The terms of establishment and operation of the

ESET generally meet these requirements. Research bodies must be free in their planning which means that the national board can set only general binding frameworks.

- Control of the accuracy and publication of all the results.
- Accurate recording of the individual contributions of researchers in collective publications in scientific journals.
- The investigation and publication of cases of unethical research conducted with public funds (fabrication of results, plagiarism, use of questionable methods, violation of bioethical principles, etc.),
- The encouragement of the initiatives of young researchers and researchers with significant experience from abroad.

Proposal IV

Research ethics needs to become part of the training and assessment of researchers. Appropriate for this purpose are ethical codes issued by research institutes and adapted to their individual needs. The state can encourage this process by providing some general principles (co-operation of ESET with the National Bioethics Commission).

Besides, the alignment of research ethics with international standards is critical given that these issues are now being discussed in a very wide context (Tindemans 2007: 28). Keeping up with developments and, if possible, participating with proposals and initiatives from the ESET would be very welcome.

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