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<table>
<thead>
<tr>
<th>DNA size</th>
<th>Amount DNA (μg)</th>
<th>Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ds DNA</td>
<td></td>
<td></td>
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<tr>
<td>23.5 kb</td>
<td>1.20 μg</td>
<td>75%</td>
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<tr>
<td>6.6 kb</td>
<td>1.30 μg</td>
<td>90%</td>
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<tr>
<td>1440 bp</td>
<td>0.80 μg</td>
<td>92%</td>
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<tr>
<td>517 bp</td>
<td>0.90 μg</td>
<td>94%</td>
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<tr>
<td>396 bp</td>
<td>0.14 μg</td>
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<tr>
<td>75 bp</td>
<td>0.06 μg</td>
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<td>44 bp</td>
<td>0.02 μg</td>
<td>72%</td>
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DNA size, DNA amount vs. recovery with QIAEX.

Recoveries of 32P end-labeled DNA fragments purified with QIAEX.

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Agricultural Research

At one time, agriculture was the principal research area funded by the federal government. But today the sums appropriated for R&D on it are tiny in comparison with those allocated to space or health. While appropriations for many agencies have expanded greatly since 1955, those for R&D in the U.S. Department of Agriculture (USDA) have remained at about $780 million in terms of constant dollars. Most of these funds have been spent intramurally by the Agricultural Research Service. Some have gone to state activities. The USDA did not initiate competitive grants activities until 1978. At that time, the appropriation for them was only $15 million. Annual appropriations grew slowly to about $44 million in 1988.

There is no question about the major contribution made by the R&D supported by USDA during the past hundred years. And for much of that time, U.S. agriculture enjoyed special advantages of fertile soil, innovation in farm machinery, and low-cost petroleum products. But today strong global competition is with us. Imports of food into the United States are increasing. Other countries, including developing nations, are successfully engaging in research. Advanced countries are devoting relatively more attention to agriculture than is the United States. The percentage of total R&D funds devoted to a category that included agriculture, forestry, and fishing in 1988 were: United States, 1.9; Japan, 6.5; Germany, 3.1; France, 4.6; and United Kingdom, 5.5. Yields of food grains in other countries often exceed those in the United States. In some countries labor or fertile land is cheaper than in the United States. If the United States is to maintain or increase its favorable balance of trade in agricultural products, it must enhance the quality of its agricultural products and increase production efficiency. To do this will require devoting a larger share of its creative talent to basic agricultural research. A means to this end would be to expand the USDA competitive grants program. A rationale for doing this and legislation authorizing it are already in place.

In 1989 the rationale for an enlarged competitive grants system was supplied by the Board on Agriculture of the National Research Council (NRC). It issued a report* that was unusually effective. The document won approval from the Bush administration and led to action under Public Law 101-624 to foster a National Competitive Research Initiative. Recommendations of the NRC were followed quite closely in the drafting of the legislation. The NRC report spotlighted six targets: plant systems; animal systems; nutrition; food quality and health; natural resources and the environment; engineering, products, and processes; and markets, trade, and policy. The legislation also targeted the six. Descriptions of the six targets were similar. In the legislation, the following appears specifying an area to be supported:

Plant systems, including plant genome structure and function; molecular and cellular genetics and plant biotechnology; plant-pest interactions and biocontrol systems; crop plant response to environmental stresses; unproved nutrient qualities of plant products; and new food and industrial uses of plant products.

Equally broad scope characterized specifications of the other areas.


To date that schedule has not been met. The actual appropriation for 1991 was $73 million and for 1992 and 1993 it was set at $97.5 million. A cap of 14% for overhead has been set. Nevertheless, there have been so many proposals that only about 22% could be funded for an average slightly over $50,000 per year.

It is early to ask about accomplishments. However, as one example, the tools and methods that were developed by National Institutes of Health and National Science Foundation investigators are being rapidly and successfully applied to plant and animal genomes and to detection of disease processes in both plants and animals. Research in areas included in the USDA competitive grants program (NRICGP) should have high priority and corresponding increased federal support.

Philip H. Abelson

* "Investing in Research: A Proposal to Strengthen the Agricultural, Food, and Environmental System" (National Academy Press, Washington, DC, 1989).
The Possibility of Tenure

A recent ScienceScope item about my tenure dispute with the University of California (10 July, p. 151) quoted me as saying that my minimum requirements for settlement included gaining tenure. There was an important phrase missing that changed the context of what I actually said. My minimum requirements for settlement included a process with the possibility of gaining tenure. It is easy to understand how the reporter might not have heard the entire sentence—the interview was conducted during a crowded, informal, and hurried press conference after my congressional testimony.

Jenny Harrison
35 Windsor Avenue, Kensington, CA 94708

GenPharm’s Knockout Mice

In his article “Researchers wrestle with concerns over cost and access” (Research News, 5 June, p. 1393), John Travis discusses transgenic animals that carry gene inactivations (knockouts) and their availability to the scientific community through GenPharm. We would like to point out some key aspects of this issue not mentioned in the article.

GenPharm recognized some time ago the need for a reliable and efficient source of widely used transgenic animals for the academic and industrial community. This need was not being met by university laboratories or by other businesses that supply animals for research. GenPharm initially invests a minimum of 9 to 12 months of work and tens of thousands of dollars on every strain it offers. This investment is not government subsidized. The investment enables researchers to expect from GenPharm substantial quantities of transgenic mice that are pathogen free, genotyped, and supplied promptly.

In most cases, patents are pending for transgenic animals that reflect the intellectual property rights of the inventors and the institutions in which they work. In order to breed and sell animals, GenPharm pays for a license from those who hold the patent rights for these animals. GenPharm has an obligation to the holders of the patent rights to protect their proprietary interests by limiting the breeding of these strains to the experimental needs of the investigator.

GenPharm does not and should not require any rights to discoveries made using mice it sells, and we will not accept new transgenic animals from institutions that require this condition of sale.

Fortunately, many problems in the field of biotechnology have been foreseen by academic institutions and by the National Institutes of Health, who have collectively adopted a policy of material transfer agreements under which transgenic animals fall. These agreements recognize the need to retain intellectual property rights and commercial rights to materials transferred between organizations. GenPharm’s restrictions are, in fact, similar to existing material transfer agreements at universities. They are not “severe” or “expensive” restrictions on breeding. Additionally, our mice are far from being at “unbelievably exorbitant” prices. At about twice the price of a Jackson Laboratory’s nontransgenic mouse line, the transgenic mice provided by GenPharm are reasonably priced.

We welcome feedback on our policies in this area and are ready to consider any suggestion for improving them.

Jonathan J. MacQuitty
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2375 Garcia Avenue,
Mountain View, CA 94043
Robert M. Kay
Vice President, Research & Development,
GenPharm International

Exclusive Academies

There is no simple answer, under the present rules, to Faye Flam’s query, “What should it take to join science’s most exclusive club?” (News & Comment, 15 May, p. 960). If one considers how “exclusive” the different major science academies in the world are (as measured by total number of members per million citizens), then the National Academy of Sciences (NAS) (with 7.9 members per million citizens) is not “science’s most exclusive club”: it still is more exclusive than the Royal Society (20.6) or the Royal Swedish Academy of Sciences (54.2), but less exclusive than the Accademia dei Lincei (4.6) or the Académie des Sciences (5.7) (1). “Exclusive,” of course, does not mean “better.”

Faye Flam quotes an unnamed chemist as stating that Carl Sagan’s admission to the
NAS "could open a floodgate to people whose science isn't spectacular." Well! I suspect that not all of the 1647 active members plus 287 foreign associates and 83 voluntary emeriti of the NAS have done "spectacular" science, if "spectacular" is taken to mean a major scientific innovation that has opened a new field or shaken the foundation of an established one.

That the NAS election process may be faulty is indicated by the observation that out of a total of 178 living American scientists deemed sufficiently prominent to be included with the great scientists of the past in the Concise Dictionary of Scientists (2) and in Asimov's Biographical Encyclopedia of Science and Technology (3), 44 (25%) are not even members. Because the NAS is so large (2017 total are affiliated), one can conclude that the vast majority of these members have done less "spectacular" work than at least some, if not most or even all, of the 44 nonmembers.

In order to improve the NAS election process and eliminate any "old boys" syndrome, the election of new members could be run by an external body, perhaps consisting of scientists whose original work may not have been of major significance (and who therefore would not qualify for membership), but who dedicate themselves to writing about science with some sophistication. Such persons are generally up-to-date as to what is cooking in science and should be reasonably impartial: it's part of their job. The NAS could also consider an age limit (say, 65 years) in order to make room for younger people and move the elders into the nonvoting emeriti category.

Cesare Emiliani
Department of Geological Sciences,
University of Miami,
Miami, FL 33124

REFERENCES


Fetal Tissue Supply

Although there has been extensive debate over the expected number of fetal specimens suitable for transplantation that would be available from spontaneous abortions and ectopic pregnancies, little relevant data have been presented (News & Comment, 29 May, p. 1274; Letters, 17 July, p. 310).

From 1974 to 1986 we attempted to obtain tissue from all spontaneous abortion specimens in a large Manhattan hospital as part of an epidemiologic study of karyotyped spontaneous abortions (1). Morphology was routinely assessed and an attempt was made to karyotype all specimens. We did not test for maternal or fetal infection. To estimate how many specimens might have been suitable for transplantation research, we recently examined data from the final phase of our study, when retrieval of specimens and the rate of successful karyotyping were optimal (2). To avoid confusion, we point out that the data referred to in a letter by Julianne Byrne (17 July, p. 310) derive from an earlier phase of this study (from January 1977 through August 1981), when Byrne was a doctoral student working on our project.

National Institutes of Health (NIH) guidelines (3) specify that at least 100 fetuses per year of 8 to 16 weeks gestation be available for screening from a fetal tissue bank. Our data indicate that this would require access to about 1250 spontaneous abortions. Of the expected 100 fetuses, there would be at most about 14 with no visible signs of maceration (autolysis) that could be considered possible candidates for transplantation.

A population of at least 10,400 pregnant women (4) is needed to yield the numbers required to participate in the tissue bank feasibility study. In most locations, therefore, ascertainment will require the collaboration of several medical centers, compounding the challenges of rapid identification of emergency admissions and screening before women have left the hospital or physician's office. This herculean effort is projected to cost $500,000 in each of six banks—all to yield 14 specimens per bank which may or may not prove acceptable for transplantation research.

Allowing the induced abortion debate to influence issues of fetal tissue research comes at great cost. We believe that the present NIH plan cannot be expected to produce sufficient numbers of usable specimens. There will be a significant loss of time in advancing transplantation research and of funding dollars that might be used for other research proposals with significant public health implications.

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18. High-order periodic orbits were specifically disallowed when looking for the chaotic attractor.
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An Initiation in Physics


A year course in quantum mechanics is both the centerpiece and the cornerstone of the first year of graduate study in physics. It offers a chance to show the next generation of physicists this marvelous and successful theory that has shaped our present understanding of nature. Each person faced with the task of teaching the subject will select from the wealth of available material those topics that he or she believes will best initiate the students into its rites and practices. Peebles in this book presents in a very personal style a set of topics that represents the conceptual development of quantum mechanics as a burgeoning theory, together with some concrete applications for which the mature theory calculates measurable quantities. By intention, many usual topics and much mathematical detail are omitted.

A long first chapter—about a quarter of the book—takes us from Planck's 1900 dictum that energy is quantized in thermal blackbody radiation to its application by Einstein and Debye (1907) to calculate heat capacities of solids at low temperatures. Bohr's model for hydrogen is reconciled with Schrödinger's wave equation (1926) by means of de Broglie's wave-particle duality. Rereading these "old ideas" reminds us that the birth of quantum mechanics actually took about 30 years. The time and space taken to recall this historical development are paid for by the absence of customary examples of solutions to Schrödinger's equation: the square-well potential, full detail for the hydrogen wave functions, a Kronig-Penney model to illustrate that not all physics is invariant under the full translation group.

Quantum mechanics and the general theory of relativity were conceived in close proximity, and both took the mathematical modeling of physical laws beyond the advanced calculus and special functions of the 19th century. Today's mathematical developments in quantum physics have led to new results in functional analysis, knot theory, and the topology of three- and four-dimensional manifolds. Von Neumann's belief that quantum mechanics would prompt essential contributions to some areas of pure mathematics has come to pass. His legacy, as well as that of Feynman's ideas on path integrals, continues to bear fruit for both physics and mathematics. The mathematical setting for quantum mechanics is an inner-product space of square-integrable wave functions with a finite-dimensional space tackled on for spin degrees of freedom. Peebles indulges in the customary ad hoc account of completeness for eigenfunction expansions for self-adjoint operators. The term "Hilbert space" is never mentioned, and I always feel that completeness of the inner-product space, say for periodic boundary conditions in a box, reveals part of the mystery connected with the spectral theorem. Momenta and position also appear to be everywhere defined operators, without examples of boundary conditions that make them (different) unbounded self-adjoint operators in Hilbert space. Though such distinctions are rarely made in the first-year graduate curriculum, they are, I believe, a fair reflection of how our understanding of quantum mechanics has progressed since the beginning of this century. The conceptual development closes with a most welcome chapter on how a quantum mechanic is to interpret a physical measurement. A Stern-Gerlach experiment serves as the occasion for a nicely reasoned discussion of pure and mixed spin 1/2 states, and the celebrated "paradoxes" of the double-slit experiment and Einstein, Podolsky, and Rosen are debunked with the uncertainty relation and Bohr's complementarity principle. The readable of Wiggen's friend illustrates the difficulty that arises in trying to separate the measurer from the measurement, and Bell's theorem elegantly disposes of conventional hidden variables as a deterministic framework for the probabilistic interpretation of measurements in quantum mechanics.

No course in quantum mechanics would be complete without applications to physical systems composed of atoms, molecules, and scattering experiments. Perturbation theory for discrete eigenstates is used to find the hyperfine splitting of spectral lines in atomic hydrogen and the Rayleigh-Ritz variational procedure for estimating ground-state energies for helium. A brief account of scattering amplitudes with s-wave bound states and resonances precedes the treatment of the final topic, Dirac's relativistic wave equation for the electron with its prediction for the electron spin magnetic moment. The account is clear and accomplished with a minimum of mathematical and calculational detail.

This book certainly has a place among textbooks on quantum mechanics. It will not satisfy those who need a full-scale account of the mathematical details or a wide range of applications. It is a guide to the physics of quantum mechanics and will serve those who seek a clear account of a selection of important examples encumbered with calculational detail. Instructors who must provide homework problems and students who must prepare for exams will find an excellent selection of problems ranging from the conceptual to the applied.

John L. Challifour
Department of Physics,
Indiana University,
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