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cover The fossil record is rich in information on past changes in biodiversity and patterns of extinction. Echinoderms such as those on the cover (maximum test diameter 8 centimeters; arms may exceed 1 meter), Uintacrinus socialis Grinnell from Kansas (Smoky Hill Member, Niobrara Formation), are thought to have adopted a planktonic existence, and they were abundant and globally distributed in Late Cretaceous seas. The Uintacrinida order suddenly became extinct well before the end of the Cretaceous. See p. 754. [Photo by John Weinstein, courtesy of the Field Museum of Natural History]

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Science
Preserving Biodiversity

T he preservation of species diversity is a problem that must today be confronted by one species, Homo sapiens. That one species has become so efficient at reproducing itself and dominating all other forms of life that it is in the act of endangering all species, including itself. Thus, in the long, evolutionary battle, Homo sapiens has prevailed, by using its brains, but will win only if it can now use the same brains to limit its victory and ensure its own survival.

As Ehrlich and Wilson point out in an article in this issue, there may now be as many as 100 million species, but if current rates of development continue, one quarter of them could be eliminated within 50 years. The human population is projected to double in the next half century, with a possible five- to tenfold increase in global economic activity projected to meet the demands of the growing population. Such uncontrolled growth would threaten all the species of the earth.

For this issue of Science we also invited a number of scientists interested in the area of biodiversity to define the crisis and suggest solutions. No consensus is reached, but a number of steps in the right direction are mentioned, all of which require political courage. Jablonski puts the problem in paleontological perspective. In the past, species extinction and recovery occurred over relatively long periods. Nine thousand years, the estimated time of the extinction of large mammals in the Pleistocene, is a short period in terms of evolutionary time, which is measured in millions of years, but an extremely long period in terms of political time, which is usually measured in 4 ± 2 years. The dilemma for the saving of species is therefore that politicians, listening to the anguish of farmers, homeowners, and even scientists, must put off present crises in order to help future constituents who would at best vote for their great-grandchildren. Moreover, there is no obvious solution to which all the biodiversity advocates can point.

Yet a pattern does emerge from the points of view expressed in this issue. Soulé neatly divides the subject into five areas of knowledge about biological diversity, six major classes of human interference, seven areas of biotic degradation, and an eightfold road to possible solutions. Morowitz takes the side that not all species can be saved. He argues that the uniqueness of a particular species should be a component of priority setting and that emphasis should be shifted to priority for habitat preservation. Erwin places priority on evolutionarily dynamic lineages that will create future biodiversity. Charles Mann interviews paleontologists and others who question the pervasiveness of the extinction data.

What emerges from these papers, which provide an excellent starting point for focusing on possible solutions, is that the diversity of species is worth preserving because it represents a wealth of knowledge that cannot be replaced. Moreover, today’s extinctions are unlike those in previous eras, in which long periods of recovery could follow extinctions. The present situation is an inextricably irreversible one in which human overpopulation will destroy most species unless we plan for protection immediately.

Accepting that the goal is worthwhile requires that more energy be devoted to planning and priorities and less to emotionalism and indignation. It seems obvious that an attempt to save every species will irritate loggers, dam-builders, astronomers, and eventually all others, and is an impossible chore. Numbers alone are not the answer. Millions of new beetles do not compensate for the loss of lions, tigers, and elephants. As these scientists point out, however, a multi-pronged approach—expanding the list of protected areas, judiciously choosing certain species for preservation, providing artificial environments such as zoos, botanical gardens, germ plasm storage, seed banks, and so on—are parts of a program that is feasible.

Once agreement is reached on the measures that must be taken, the political and moral problems must be solved. Some of the most obvious solutions involve preserving wild natural areas in developing countries, where the land is cheap, but the human need for it is desperate. In the developed countries, the humans are better off, but the land has become very valuable, and important habitats border on densely populated areas.

We may need to select politicians whose time scale is in Pleistocene epochs rather than terms of elective office. Southwood has explained the hyperdiversity of insects as based on "size, metamorphism, and wings." Homo sapiens even without wings has expanded more effectively than any other species because of its brains. It is time we use them for the benefit of posterity.—Daniel E. Koshland, Jr.
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patients to generate $231 million. Because lovastatin is so popular with physicians, it is quite probable that in the United States alone at least this many patients take this medication regularly. Although Vagelos does not provide the percentage of the retail price returned to the pharmaceutical company, the payback period to his company forlovastatin is probably an incredibly short two or so years. Therefore, this drug, I would argue, is priced too high.

PETER E. OETTINGER
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Response: It is true that breakthrough medicines such as lovastatin return their costs of research and development (R&D) in a relatively short period of time. But breakthrough medicines must fund much of the ongoing research of an innovative pharmaceutical firm and sustain it through the so-called "dry" research periods.

Only three of ten marketed medicines return their average costs of R&D. The other seven medicines ride on the success of those three (1).

It took 23 years to recoup the R&D cost of the average new medicine introduced in the 1970s. This means that a rare commercial success, such aslovastatin, makes possible the entire pharmaceutical research and development enterprise.

For example, if the economic performance of the anti-ulcer drug Tagamet (cimetidine) were removed from the performance of the 100 new medicines introduced in the 1970s, the remaining 99 would not even recover their total R&D costs.

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Surgeon-Warriors?

My recent anthropological researches on surgeons (1) illuminate the problem of the distinguished neurosurgeon Frances Conley, whose resignation from the Stanford Medical School was profiled on 14 June (News & Comment, p. 1484). Surgery is the most macho and masculine of the medical specialties, and male surgeons tend to view themselves as engaged in battle with disease and death (2). A significant proportion of them—but by no means all—therefore believe themselves entitled to the perquisites of warriors, including admiring and subservient women, and they have no space in their lives for women as peers and colleagues.

Recently I extended my researches to women surgeons, a group growing in number. I have observed that some have had to cope with problems similar to those of Conley. What is significant and hopeful, however, is the proportion of them who, nevertheless, maintain the highest technical standards of performance yet combine these with compassion and an ability to engage in human dialogue with their patients.

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15. Polyclonal antisera were generated by injecting rabbits with purified GABPs or GABP1. Antisera were added to gel-shift reactions at a dilution of 1:20. Pre-immune sera did not affect the migration of protein-DNA complexes.

16. C. Thompson and S. L. McKnight, unpublished observations.

17. L. A. Chodosh, in Current Protocols in Molecular Biology, M. Ausubel et al., Eds. (Wiley, New York, 1988), vol. 2, p. 12.5.1. Cross-linking with UV was performed with an oligonucleotide composed of a 2A binding site flanked by 10 bp of nongenomic sequence (5'-AACCAAGC1TGCGGAACGGAAGCGGAAACCG-GACCCG-3'). Oligonucleotides were labeled to high specific activity by the fill-in reaction with the Klenow fragment of DNA polymerase I in the presence of all four dNTPs. Oligonucleotides were then exposed to UV. Samples were boiled in SDS-sample buffer and subjected to electrophoresis on SDS-polyacrylamide gels. Cross-linked species were visualized by autoradiography.

18. Gel filtration chromatography was performed with a Superose-6 column (10 by 300 cm; Pharmacia) in buffer B with 0.4 M NaCl. The column was calibrated with molecular mass standards thyroglobulin, apoferritin, catalase, bovine serum albumin, and ribonuclease. Each protein (50 to 100 μg) was chromatographed at 0.5 ml/min. Elution volume was converted to Kav by the equation Kav = (Ve - Vo) / (Ve - Vo) where Ve = void volume = 8.1 ml; Vo = total bed volume = 24.0 ml; Vc = eluted volume. The Stokes radius was calculated from a plot of (-logKav)1/2 as a function of the Stokes radius (G. K. Ackers, Adv. Prot. Chem. 24, 343 (1970)). The GABPs eluted as a single peak at 15.2 ml; GABP1 at 14.0 ml; GABP2 at 15.8 ml. A mixture of equal amounts of GABPs and β1 chromated as a single peak at 12.1 ml. The mixture of GABPs and GABP2 chromatographed as a single peak at 13.9 ml.

19. R. G. Martin and B. N. Ames, J. Biol. Chem. 236, 1372 (1961). Sedimentation coefficients were determined on 4.5 ml to 30% glycerol gradients in 25 mM tri-HCl, pH 8.0, 75 mM NaCl, 0.75 mM EDTA, 1 mM DTT. Each protein (30 μg) was loaded in 0.1 ml together with catalase, bovine serum albumin (BSA), and cytochrome c as internal standards. Gradients were centrifuged at 4°C for 40 hours at 39,000 rpm (SW50.1 rotor). Fractions (0.25 ml) were collected and analyzed by SDS-PAGE with Coomassie blue staining. The S value for each sample was determined by its sedimentation relative to the BSA and cytochrome c standards. Native molecular masses were derived with the use of the Stokes radius and measured sedimentation coefficients as described [L. M. Siegel and K. L. Mutton, Biochim. Biophys. Acta 112, 546 (1966)]. Partial specific volume was calculated from the predicted amino acid sequences of each GABP subunit [E. J. Cohn and J. T. Edsall, in Amino Acids and Peptides as Ions and Dipolers Ions, E. J. Cohn and J. T. Edsall Eds. (Reinhold, New York, 1943), pp. 370–381].

20. T. A. Brown and S. L. McKnight, unpublished observations.

21. Deletion mutants of GABPs were generated by polymerase chain reaction and expressed in pTS (14). Soluble bacterial extracts containing deleted variants of GABPs were used for binding reactions. NH2-terminal deletions of GABP1 were generated by exonuclease III digestion, followed by digestion with SI nuclease and nuclease of Bam HI linkers. All deletions were sequenced and subcloned into the appropriate pET3 vector [A. H. Rosenberg et al., Gene 56, 125 (1987)] to maintain the proper reading frame. The COOH-terminal deletions were generated with the use of 3' deletions of the cDNA inserted in Bluescript (Stratagene) and subcloning via EcoR-Amp18 or Sac I-Amp18 fragments into the pET-GABP1 plasmid that had been digested with the appropriate enzymes. Translation termination codons were provided by vector sequences so that, in some cases, extra amino acids were added to the open reading frame. All GABP1 derivatives were insoluble and were resolubilized in 8 M urea; the solubilized protein was dialyzed against 10 mM tris, pH 8.0, 75 mM KC1 or NaCl, 1 mM DTT, 0.2 mM PMSF, 1 mM benzamidine, 10 percent glycerol before being used in binding reactions. All derivatives were expressed equivalently as determined by Coomassie staining of SDS polyacrylamide gels.


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"I don't know why—I just like to attack the upper respiratory tract."
referred to as "figures" in the text) demonstrate most of the important graptolite morphology and are the real strength of the book. Such features as details of the prosicula, metasicula, and crossing canals and other structures rarely preserved on most specimens are shown in splendid scanning electron micrographs. The book includes almost everything that is important for a general understanding of graptolites and with its fine illustrations will be useful for those who are instructing students or who are just collecting fossils.

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Approachable Immunology


The major challenge facing the immune system is similar to that faced by the writer of a textbook on the subject: a constantly changing environment. The last 10 years have seen an explosion in our knowledge of the workings of the immune system, with many of the mysteries of the complex cellular and molecular interactions finally beginning to be elucidated. This explosion of information has made it difficult to find an introductory textbook on immunology that is both up-to-date and of high quality. The publication of this book has solved that problem, at least for the near future.

The key attribute of this book is the clarity and conciseness with which it presents this complex and abstruse field. Text and figures are well coordinated, and the figures are outstanding, presenting the information clearly and simply but still conveying the essence of the experiments.

The text, comprising 19 chapters, is divided into four sections: Introduction to Immunology; Lymphocyte Specificity and Activation; Effector Mechanisms of Immune Responses; and Immunity in Defense and Disease. Each chapter has four to six subsections, including a summary and about a dozen key references. Informational boxes are included to provide important or noteworthy background information on diverse aspects of immunological research that are crucial for understanding modern immunology but that fall between the cracks in many courses. A sampling of the topics found in these boxes are CD-molecule nomenclature, hybridomas, transgenic mice, cytokine receptor families, and immunity to malaria. Another nice teaching aid is the availability of a moderately priced slide set of the figures from the book.

Aimed primarily at medical students, this comprehensive, balanced, and approachable presentation will provide both medical students and Ph.D. candidates with an excellent foundation in immunology. The book is not so comprehensive as to scare them off, but there is enough substance to convey an understanding and appreciation of the immune system. An essential but often missing component of immunology textbooks is the clear establishment of the connection between the immune system and clinical medicine. Section 4, which focuses on the role of the immune system in defense against pathogens and on diseases caused by abnormalities in the immune system, firmly establishes this link.

How does this book compare to those already in use? In my opinion, it is the best available textbook of immunology for medical and research-oriented graduate students. The popular Essential Immunology by Roitt, the seventh edition of which was published in 1991, is also thoroughly illustrated, but it is less comprehensive and is better suited for undergraduates. On the other hand, the excellent Fundamental Immunology, edited by William Paul, is very comprehensive, with each of the chapters written by a leading expert, but is more suitable for advanced students. Molecular and Cellular Immunology fills a gap between these two extremes. It is a scholarly work that gives substantive account of current immunology in a way that is ideally suited for a medical graduate student's first exposure to the subject.

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Books Received


