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In Pursuit of the Renewable Frontier

The endearing feature of intellectual frontiers is that they are in endless supply. Explorers of continents fight their way through wildernesses until they arrive at the water's edge, and then sigh that there are no new mountains to conquer. Researchers, on the other hand, are part of an ever-expanding universe, inevitably creating new territories to explore as they complete the maps begun by the discoveries of the past.

No area of research illustrates this phenomenon more clearly than modern biology, which many believe is in its Golden Age. This issue of *Science* presents a *Frontiers in Biology* collection that contains an illustrative—but certainly not exhaustive—list of areas that have great potential for the future.

In the first article, Jim Hudspeth deals with an area of fantastic scientific challenge: the mechanisms of hearing. The cochlea is the most complex mechanical apparatus in the human body, with a million moving parts designed to convert sound waves into electrical signals. It relays to the brain a complex mixture of sounds, some of which are only slightly higher in energy than background noise.

Dennis Drayna and Ray White analyze an ancient problem, the inheritance of disease, using an unusual opportunistic combination of religion and recombinant DNA. Because Mormon families have large numbers of children, a tradition of record-keeping through many generations, and a generosity in terms of a helpful interest in community causes, an abundance of information about their hereditary lineage is available. The use of restriction enzymes, the delicate surgeons of DNA structure, adds a new tool to population genetics. The combination provides an ability to follow genetic diseases through generations. It has led to the mapping of the X chromosome and to a vast potential for increasing our understanding of genetic disease and for providing clinical help for individuals.

Differentiation is a puzzle constantly searching for new techniques, and Helen Blau and her co-authors discuss one of these that shows particular promise. By fusing two cells from different species, a hybrid cell is created that contains the nuclei of both cells. The resulting hybrid cell is stable and can be studied over long periods of time, making it appropriate for the study of muscle development and the timing of signals for gene expression during differentiation.

An example of "the medium is the message" is a new hormone, the atrial natriuretic factor, which plays a key role in water control, electrolyte balance, and blood pressure. It is described by Adolfo de Bold and offers hope for new therapeutic interventions in hypertension and heart failure.

The melodramatic world of the oncogene, those genes that have been frequently identified as being "at the scene of the crime" of cancer but have so far not been convicted of a clear-cut offense, is discussed by Robert Weinberg in a "whodunnit" that considers the current evidence but enticingly leaves the final chapter to be written in the future.

The finding that susceptibility to disease may be inherited in ways quite different from the inborn errors of metabolism has led to correlation of the immune apparatus with the tendency to contract certain diseases. Robert Goodenow and co-workers focus on one aspect of this problem that is of great interest in modern science: the role of the major histocompatibility complex in the immune surveillance of cancer cells.

As this issue goes to press and we plan new issues of frontiers in physics, chemistry, astronomy, and other areas, an editor cannot help but reflect on the personality of individuals who are satisfied by such an unceasing quest. Are we scientists just curious children who have never grown up? Are we the most idealistic of people, bravely confronting the ultimate challenges for the good of mankind? Or are we the most selfish of its citizens, who have discovered the ideal way of life: solving nature's crossword puzzles while being subsidized in our happiness? Whatever the answer, we are all, in the words of the poet, "emperors of the endless dark, even in seeking."

—DANIEL E. KOSHLAND, JR.