# Sequencing the human genome

SIR—The prospect of sequencing the entire human genome (*Nature* **322,** 11; 1986) raises a number of questions, some answers to which we wish to suggest.

The first is "why?". After all, not only do we not have any idea what we would find in such an alphabetic morass, but we do not even know enough about genomic structure to know what to look for. The fact that such a bizarre project may be "technically feasible" is hardly a justification. It is as technically feasible to excavate the entire country of Kenya to a uniform depth of six metres for hominid fossils, or to determine the wiring diagram of all the synaptic connections in the human brain; but any biologists who proposed such projects would doubtless be obliged to carry them out in a padded laboratory. Similarly, sequencing the genome would be about as useful as translating the complete works of Shakespeare into cuneiform, but not quite as feasible, or as easy to interpret.

A better reason is that such a major endeavour would occupy every living molecular biologist, regardless of competency, for several years, thus solving the growing unemployment crisis. The social consequences of keeping molecular biologists off the streets, where they might develop into thugs, ruffians, land-fraud swindlers, or worse, are obvious. Alternative suggestions, such as obtaining a genetic map of humans using restriction fragment length polymorphisms, suffer in that they would employ clinicians and (far worse) population geneticists and anthropologists. Any sense of social responsibility dictates keeping these latter groups on the streets where they belong. Similarly, all attempts to limit the project to sequencing only a single small chromosome must be resisted, as this would not be sufficiently labour-intensive to employ enough molecular biologists.

Second, whose genome gets sequenced? As both X and Y chromosome sequences are required, women must be excluded from consideration. A haploid set is required as diploids often show an embarrassing amount of variation between homologues. The extraction of such a set will prove difficult, given the scarcity of recorded haploids in human history. As molecular biologists generally ignore any variability within a population, the individual whose haploid genome is chosen will provide the genetic benchmark against which deviants are determined. Much care must be taken in the selection of the exemplary individual to serve as this ultimate genetic role-model; it would be most embarrassing to throw out the first 500,000 kilobases and have to start resequencing a new individual if some character flaw is discovered late in the project.

However, the recent success of obtaining DNA from both an extinct species (*Nature* **312,** 282; 1984) and a mummy (*Nature* **314,** 644; 1985) suggests the possibility of using a venerable deceased human for a subject. This is quite in keeping with the spirit of the proposed sequencing project, as much of its justification involves the creation of new technologies. We would like therefore to be the first to suggest that the genome of the father of modern biology, Charles Darwin, be the one sequenced. We leave it to our English colleagues to arrange to have his remains exhumed from Westminster Abbey for the honour.

Unfortunately, it would hardly honour Darwin's memory, as the conceived sequencing project violates one of the most fundamental principles of modern biology: that species consist of variable populations of organisms. Alas, every dog has his day, and if the molecular vulgarians have theirs, "the" genome of "the" human will be sequenced, gel by acrylamide gel.

And what is to be done, finally, when this sequence is obtained? Perhaps the scientific community can enlist David Wolper to stage a worldwide tribute to the genome, culminating with every person on Earth symbolizing a nucleotide and joining hands to form all 22 autosomes and both sex chromosomes. It would be a fitting finale to a grand scientific project.

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# Special relativity

SIR—Aspden[1], Psimopoulos and Theocharis[2] discuss the need for a Michelson–Morley type test in space and raise interesting points about the effects of standing waves in rotating and translational motion of optical apparatus. Some time ago, I carried out a relevant investigation using a special standing-wave sensor manufactured by the General Electric Co.[3]. This photoelectric sensor incorporates a photomultiplier tube through which a laser beam can pass to be reflected back on itself by a mirror. This allows the device to scan translationally along the standing wave set up by the interference in the beam. The experiment shows that the spacing between nodes in the standing wave set up by two oppositely-directed light rays from the same laser source is a function of the orientation of the apparatus.

The forced optical condition assuring light speed isotropy as suggested by Aspden is not supported by the experiment, and initial indications are that the beam modulation pattern is attributable to the Earth's motion through space at cosmic speeds commensurate with those found from the isotropy assumption of 3K cosmic background radiation. In effect, it appears that in the standing-wave conditions, the waves move at different speeds in opposite directions relative to the apparatus and, as their frequencies are the same, they present different wavelengths in the two directions and so affect the nodal spacing.

A detailed report on the experiment is available prior to eventual formal publication. Meanwhile, it is of interest to note that the optical configuration resembles that of the Sagnac experiment, the basis of the ring laser gyro technology mentioned by Aspden, Psimopoulos and Theocharis. However, the sensor scans linearly along a section of the modulated beam in a non-rotating system, rather than being at rest, as in the gyro, and sensing effects of rotation of the apparatus.

Clearly, this research will have interesting implications for the theory of relativity, as foreseen by your recent leading article[4]. It may also help us to resolve the large errors found in the global satellite positioning system. If present findings are sustained, it may not be necessary to extend the Michelson–Morley tests into outer space in order to obtain positive, as opposed to null, results in interferometric tests of linear motion.

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2. Psimopoulos, M. & Theocharis, T. *Nature,* **321,** 734 (1986).
3. Silvertooth, E.W. & Jacobs, S.F. *Applied Optics* **22,** 1274 (1983).
4. Maddox, J. *Nature* **316,** 209 (1985).

# Science and faith

SIR—In his review of John Barrow and Frank Tipler's *The Anthropic Cosmological Principle* (*Nature* **320**, 315; 1986), William H. Press comments that the authors' end " . . . is nothing less than the fusion of matters of science with matters of individual faith and belief. It has taken us a long time to separate these matters, each to its own legitimate arena in human affairs. We should not lightly allow them to become once again jumbled . . . ."

Although they are generally accepted, is it helpful to be given such delineations of "legitimate" arenas, which would seem to carry restrictive bias into the unfolding of human thought and experience? I personally find a segmented life no more attractive than a jumbled one.

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