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DIALOGUE CONCERNING NATURAL APPROPRIATION

ABSTRACT. Two utilitarian defenses, traceable to Bentham and Mill, are commonly offered for patents. It is contended that patents induce innovation, and that patents induce disclosure of innovation. Patents on some or all of the human genome pose particular challenges for these defenses. In the first instance, patents on nucleotide sequences entail the perverse notion of human reproduction qua infringement. In the second place, when such patents are available (as is presently the case), the two defenses involve a counterfactual claim, viz., that if there were no such patents, biotechnological progress would wane. Even if these challenges are met, concerns about respect for humanity generate opposition to property interests in compounds manipulated outside the human body but significantly homologous to compounds found in humans. This stance about things human might appear to commit the fallacy of division. In a dialogue between a Kantian and a utilitarian, arguments for and against property interests in the human genome are presented.

In discussions whether governments should grant patents on nucleotide sequences of human deoxyribonucleic acid (“DNA”), one often hears predictions of social costs and benefits consequent on territorial division of the human genome. Costs and benefits come to the fore because a patent is an economic privilege that transforms otherwise concealed knowledge into a marketable public good, and because in studying the optimal provision of public goods, economists often employ cost-benefit analysis. Prospective inventors and investors follow suit, often seeming to presuppose consequentialist morality as they defend the patent system on which their expectations rest. The orthodox defense of the patent system leans on incentive effects. Nonconsequentialist views are more likely to be found among those who have no stake in the patent system. The following conversation occurs as Hugh, a utilitarian, encounters Ike, a follower of Kant’s moral philosophy.

HUGH. I suggest that governments should grant patents on life forms, including human DNA sequences, because allowing such patents will yield higher preference satisfaction, regardless of harm to some in any given case, than not allowing them. We utilitarians differ amongst ourselves whether aggregate or average preference satisfaction should be the maximand, but that difference matters only when population is nonconstant. I shall put this difference to one side by referring only to “preference satisfaction.” Patents effect two principal benefits. First, they provide in-



centives that induce helpful inventions. Second, they induce inventors to disclose their inventions instead of preserving the inventions as trade secrets, thereby (a) facilitating advances in social welfare as others improve on the disclosed inventions and (b) assuring that each invention enters the public domain when its patent's finite term ends. The strategy of inducing disclosure has succeeded since at least the seventeenth century when the Royal Society began to recognize as an inventor one who would publish a putative invention's details in the Society's proceedings.

IKE. I should have thought that those whom you seek to motivate with such incentives would work sedulously even if no patent were available. Watson and Crick, Cohen and Boyer, the latter the inventors of the fundamental technique of recombinant DNA who joined in patent applications only at the behest of a host university—they all worked without patent incentives in mind.

HUGH. "He who has no hope that he shall reap," wrote Bentham in defense of patents, "will not take the trouble to sow" (Bentham 1793, 71). Entrepreneurs claim that if there were no patents on human nucleotide sequences, they would not spend enough money on research to achieve therapeutic advances.

IKE. Indeed they routinely offer that sort of claim when challenged to defend any type of patent. On its face, the claim is a counterfactual conditional. As I understand things, it is considered settled under the law of many industrialized countries that DNA sequences are patentable. With such patents having been available since shortly after the invention of recombinant DNA technology, no one has had the opportunity to observe a situation in which all other circumstances of the biotechnology industry remain the same but patents on DNA sequences cannot be had. One cannot run the control experiment necessary to establish the hypothesis that the patents in question are necessary for the innovations desired.

HUGH. I concede inability to run the control experiment. But should we not err on the side of providing the greatest incentives for innovations that alleviate suffering and improve collective welfare?

IKE. Many incentives other than patents induce innovations. An inventor may attain a monopoly by preserving an invention as a trade secret. The state may subsidize research. The availability of some particular kind of patent is not a *sine qua non* of technical progress merely because patent holders declare it so.

HUGH. In the eighteenth century the livestock breeder Robert Bakewell of Leicestershire maintained animal genomes as trade secrets. Bakewell kept secret the family trees of his livestock, drafted restrictive rules for a breeders' guild, and even infected his rams with "rot," as he called it,

before sending them to slaughter. By this last move, he discouraged any other farmer from intercepting and breeding his rams. His regimen would not succeed today. The possibilities of reverse engineering and the wide dissemination of scientific knowledge render it unlikely that an inventor can maintain a biotechnology invention as a trade secret for as long as a patent monopoly would endure. That is now twenty years.

IKE. You began by speaking of preference satisfaction. Then you adverted to the relief of suffering and to increases in collective welfare. Here you presume a utilitarian social welfare function. I of course do not join in that assumption. Leaving that aside for the moment, I mention some ways in which patents on products may impede progress as I think both you and I understand progress. We should worry about disincentives created by patents. Consider that if we ward off some part of nature as a monopolist's territory and discourage other scientists from investigating it, we disrupt the engine of scientific progress, which runs best on the volatile fuel of open and rapidly disseminated results. Presently in order to protect patent prospects, some scientists delay publishing results, and in particular, some delay deposit, or refuse deposit, of DNA sequence data into public databases. Consider too that scientific excitement about DNA chips, microarrays of DNA sequences placed on wafers so as to achieve efficient screening of DNA samples for nucleotide sequences of interest, must diminish when investigators learn that they may neither fabricate nor use such a chip without a license from the patent owner of each patented sequence that the chip would contain. The number of required licenses may be in the hundreds. As governments indulge patents on nucleotide sequences, they splinter the genome into wildly disconnected fiefdoms. Patents on products have also directly constrained the alleviation of suffering. A case in point involves erythropoietin, a protein that stimulates red blood cell production. Erythropoietin is vital for patients suffering from anemia, especially during end stage renal disease. As the story unfolds, a patent issues to one company on the natural isolate of erythropoietin merely months before a patent issues to another company on a recombinant erythropoietin. The former patent then precludes commercial sale of the recombinant. Thereupon patients lose the benefits, in greater availability of the protein and lower prices, that the recombinant would have afforded.¹ To cite another case, if it advanced collective welfare to grant Eli Whitney a patent on his cotton gin, the same cannot be said for a patent recently issued on *all* recombinant cotton. Similarly overbroad is a patent issued on all manner of *ex vivo* gene therapy (Nowak 1995). And even when a patent's scope seems reasonable, its issuance subjects society to the whims and fortunes of monopolists who in some cases are malevolent, bankrupt,

or intent only on preventing others from selling invented products that those patent owners themselves do not even intend to sell. How can one be confident that patents do not diminish preference satisfaction? It seems to me that your analysis of consequences is speculative. Your stance would importune us, in striking a deal with prospective inventors on the incentives purportedly needed to induce their creativity, to accept in the bargain the neglect of a fundamental moral principle. To wit, for all things human, we owe a particularly high level of respect. We are obliged to treat no one solely as a means but to treat everyone as an end-in-himself in a kingdom of ends.

HUGH. We respect humans as ends when we endeavor to overcome diseases that could afflict any one of us. I concede that some patents are overly broad. I also grant that any improved product can be kept off the market by a patent on that of which it is an improvement. The economist Joan Robinson describes the rationale for a patent thus:

A patent is a device to prevent the diffusion of new methods before the original inventor has recovered profit adequate to induce the requisite investment. The justification of the patent system is that by slowing down the diffusion of technical progress, there will be more progress to diffuse Since it is rooted in a contradiction, there can be no such thing as an ideally beneficial patent system, and it is bound to produce negative results in particular instances, impeding progress unnecessarily, even if its general effect is favourable on balance. In many lines of production legal patents are unimportant and the same essential paradox shows itself rather in the jealous guarding of "know how" by the progressive firms (Robinson 1969, 87).

What Robinson describes as contradiction and paradox we may more carefully describe as the conjunction of beneficial and detrimental effects. In any case, she reminds us that domination of improvements by a prior invention is not peculiar to the sort of patents that we are discussing. Rather it is a price that we agreed to pay in instituting the patent system. We pay that price in order to induce inventions and their disclosure. I concede too that some overweening or ill-fated patent owners thwart progress by abusing or sitting on patents. In all, I balance the occasional case of retarded progress against the multitudinous cases of progress aided. Perhaps we differ in willingness to take risks.

IKE. I am more concerned about letting our appetite for progress lead us into granting ownership claims on persons. This is repugnant because humans own themselves, not each other. To claim ownership of a person is to treat the person solely as a means. Are not patents on human DNA sequences such ownership claims? Even when one describes a claim over merely part of a human, any such claim interferes with a person's autonomy. Bodily parts are integrated.

HUGH. A patent does not create or allow an ownership claim over any person. A biotechnology patent confers only the privilege during its twenty-year term to bar others from making, using, or selling a compound first formed by an inventor in the laboratory, which is to say outside any human body. Forming such compounds involves no invasion of anyone's bodily integrity—except for the fully consensual donation of fluids and tissues. The right to exclude others from copying a living being is not the same as the exertion of physical control over the being or any other interference with how the being's life will go. Hence what rhetoric characterizes as a challenge to the autonomy of persons is no such thing at all.

We utilitarians pay close attention to morality, in particular to aggregate welfare. The grant of a patent renders an invention a marketable public good, which is to say that the invention metamorphoses into an excludable and nonrivalrous good. Other examples of excludable and nonrivalrous goods are cable television reception and online scholarly journals. Cable television reception is excludable by the operator's scrambling of the satellite signal and is nonrivalrous because no one's reception diminishes another's. Online journals are excludable by requiring subscription fees for site access and are nonrivalrous though congestible. Were it not for a patent property interest, an invention not successfully protected as a trade secret would become a nonexcludable nonrivalrous good, which is to say a pure public good. We know from welfare economics that pure public goods are underprovided in perfect competition. One way to promote the provision of more pure public goods is to create a legal means of exclusion. Exclusion allows an inventor to internalize the positive externalities of a good's provision. Thereupon the inventor gets paid by others who use the invention.

IKE. To play sceptic about your suppositions concerning consequences, I observe that you need to show that the ability of a monopolist to constrict output and to charge more than marginal cost is offset by whatever welfare gains you hypothesize. We should rue misallocations of resources when welfare gains do not exceed the detriments of monopoly pricing. The counterpoise from economic theory runs thus. Patents are not the only means of inducing intellectual public goods. Subsidies may be a more efficient means because subsidies avoid the effects of market imperfections. I contend that we should encourage research by implementing subsidies, tax incentives, and increased support for academic institutions.

HUGH. I recall for you Mill's observation that unlike other monopolists, a patent holder "is not making the commodity dear for his benefit, but merely postponing a part of the increased cheapness which the public owe to the inventor, in order to compensate and reward him for the service"

(Mill 1871, V, ch. X, § 4, 295–296). Mill argues that a subsidy may prove less efficient than a patent:

[I]n general an exclusive privilege, of temporary duration, is preferable; because it leaves nothing to any one's discretion; because the reward conferred by it depends upon the invention's being found useful, and the greater the usefulness the greater the reward; and because it is paid by the very persons to whom the service is rendered, the consumers of the commodity. So decisive, indeed, are these considerations, that if the system of patents were abandoned for that of rewards by the state, the best shape which these could assume would be that of a small temporary tax, imposed for the inventor's benefit, on all persons making use of the invention. To this, however, or to any other system which would vest in the state the power of deciding whether an inventor should derive any pecuniary advantage from the public benefit which he confers, the objections are evidently stronger and more fundamental than the strongest which can possibly be urged against patents.

IKE. I understand that a subsidy scheme, when compared with other incentives, might fail to be Pareto optimal. There might exist a more efficient scheme, one that yields greater technological innovation and raises the lot of some without diminishing the lot of anyone. But by dint of the constraint that I earlier mentioned—inability to run an experiment observing a biotechnology industry in the absence of the patents in question—economists have been unable to assemble an empirical basis for saying whether the patent system is Pareto superior to alternatives. If we implemented a subsidy scheme, we could compare the extent of technological innovation during the past with the results of subsidies.

Mill's remarks do not take account of the robust biomedical research engine constituted by universities and nonprofit research institutions. We could imagine—perhaps at some price in efficiency, but with ample collateral benefits—a government that so extensively funds nonprofit research in the biomedical sciences that we scarcely need profit-motivated research. In such case, patents are unnecessary and the results are superior. The fruits of research immediately enter the public domain, whereupon firms use those fruits to manufacture beneficial products. The need for biotechnological innovation sustains a case for increased support of nonprofit research, not patents.

HUGH. Suppose that your surmise is incorrect. Suppose that the patent system coaxes profit-motivated research whose practical applications we could not reasonably expect from intellectually-motivated academics.

IKE. That might be. But a moral constraint remains. We have a duty to respect others. In Kant's words, "humanity is itself a dignity" (Kant 1797, 6: 462). Humanity is above price. You refer to various compounds formed outside the human body. Those compounds are human.

HUGH. Forgive me, but your argument seems to perpetrate the fallacy of division. It resembles “Epiphenomenalists are disappearing, Sinclair is an epiphenomenalist, therefore Sinclair is disappearing.”

IKE. The predicate “human” may not distribute. I am not committed to saying that human insulin is human in the same way as I am human. Instead I say this. There are good reasons—including a concern for the welfare of humankind—to be circumspect, whatever labels one uses, about compounds for which there is a high degree of homology between the version in *homo sapiens* and that in other species. Many of the substances on which patents are sought are homologous to human compounds to a significant extent. If they were not homologous, the patented substances could not be introduced into humans and would be commercially worthless.

HUGH. Let us assume identity of molecular structure between a given protein in a human and one to which a patent (on the protein or the gene encoding it) pertains. Why could we not will, as a universal law, the permissibility of such a patent? Which person would we fail to treat as an end-in-himself in a kingdom of ends?

IKE. I agree that in allowing a given patent, one *can* steer clear of encroaching on any person’s autonomy. But even if the autonomy of no one in particular is threatened by a patent, the autonomy of many of us together might be. Therein lies an objection to the controversial incipient practice of “patenting the genomes” of indigenous populations. Until now I should have thought, with Kant, that an end-in-itself could not be the product of our will. Yet now we contemplate that by genetic interventions in gametes and zygotes, parents who conceive by *in vitro* fertilization will be able to choose portions of an offspring’s genome. Meanwhile the set of patented nucleotide sequences grows ever larger. By these patents, governments establish property interests in compounds homologous to integral components of ends-in-themselves. Because genes and other sequences by which one person’s genome differs from another’s lie interspersed among sequences that they share, any given patented sequence may contain a subsequence peculiar to some proper subset of the population. To constrain reproduction of such a subsequence is to constrain reproduction of distinctive personal genetic characteristics. To constrain reproduction even of widely held subsequences also bodes ill. Those widely held subsequences in general will be critical to normal health. Whether in respect of sequences found in small or large subsets of the population, consider what happens when parents pass nucleotide sequences to their children. If as against parents, a biotechnology firm successfully enforces a patent on any of those transmitted sequences, the firm will abridge the parents’ reproductive autonomy. We have not squarely confronted this contretemps only because

germ line intervention is not yet feasible. Soon it will be. By dint of a child's inheritance of a patented gene, the patent owner may charge the parents with infringement for conceiving or giving birth! The patent owner may so charge even the child for "using" the patented "invention."

HUGH. I know of no one who asserts the proposition that a human conception or birth may constitute patent infringement.

IKE. Anyone advocating human DNA patents is committed to that proposition. To see this, consider what happens when a scientist working for a company modifies the germ line of an animal through laboratory transgenesis. The company then procures a patent on the transgenic animal, just as did Harvard University on "the Harvard mouse." The company next arranges for the breeding and sale of transgenic animals. If, without paying a royalty to the company as patent owner, any buyer of one of these transgenic animals breeds them and produces more transgenic animals, the buyer is guilty of patent infringement. Nothing in the patent law provides a different result for humans. Someday a Dr. Genesplice will achieve insertion of a patented DNA sequence into a zygote that matures into a boy named Alex. When Alex grows to adulthood and fathers children, the conception and birth of Alex's children may copy the patented sequence. Without a license from the patent owner, that is impermissible. Even if Dr. Genesplice paid a royalty in connection with the birth of Alex, Alex and his wife will be infringers. Thus to characterize parents seems perverse.

HUGH. On that logic, infringement occurs during mitosis, the relentless process of cell replication in the fetus that becomes Alex and in Alex's body after birth. Each mitotic division copies Alex's genome.

IKE. Precisely. That makes yet more apparent the absurdity of allowing a patent on a human gene. Even on your theory, how could it serve the greatest good of the greatest number to visit liability on someone for copying genes in the course of making babies or for undergoing the normal process of cell division?

HUGH. When you put it that way, it is difficult to imagine a rule imposing liability in those cases that maximizes preference satisfaction. I suppose that we could agree to abjure any notion of human conception or birth as infringement.

IKE. Respect for the person, for individual autonomy in reproduction and life, demands that we insulate everyone from liability for patent infringement except insofar as they act in some commercial capacity with respect to bodies other than their own. Hence we should adopt this rule: no claim of patent infringement lies against a parent or child as such, or against any person as agent of mitosis. Inventors may claim infringement against unlicensed commercial parties or health care providers who

transfer genes or practice proprietary processes, but the foregoing rule eliminates infringement claims against the unownable beings into whom genes are integrated or on whom processes are practiced.

HUGH. I agree. Your proposed rule should effect no economic mischief. Patent infringement damages recoverable from consumers are trivial anyway. For this reason, owners of biotechnology and pharmaceutical patents do not sue individuals. They sue infringing companies.

IKE. If we resolve that no claim of infringement lies against any parent or child as such, or against any person as agent of mitosis, the only remaining reason for issuing a patent on a human nucleotide sequence is to carve out a monopoly for one commercial exploiter of the sequence *vis-à-vis* another commercial exploiter.

HUGH. Exactly. May we agree that we hazard no incursion into any person's autonomy by affirming patent privileges of commercial competitors? Or do you think it impossible to will as a universal law the availability to an inventor of a DNA patent privilege?

IKE. Even if there is no incursion into the autonomy of an individual, I put it to you that patents on life forms disrespect humanity. Not only do they put us all at risk of the whims and fortunes of monopolists, but they draw us into treating humanity less respectfully than we treat nature in general. This occurs as follows. Your reference to "inventor" begs a question. How can we without contradiction will, or for that matter maximize preference satisfaction by, a rule defying the fact that the sequences of complementary DNA ("cDNA") nowadays being patented are found on chromosomes (albeit interruptedly) and that their uninterrupted transcripts are found in messenger RNA ("mRNA")? As I understand it, patent law provides for patents only on what someone invents. That is to say that the set of patentable products and processes excludes natural objects. Though we may discover natural objects and phenomena, none of us invent them. This reasoning has been followed in the accumulated case law with respect to every scientific domain other than biology. For biotechnology, the standard has been relaxed. Now recognized as "inventions" are mechanically produced cDNA molecules whose sequences already exist, albeit interruptedly, in the chromosomes of organisms.

HUGH. In order to maximize preference satisfaction, it may be necessary to relax the rule that the patentable is only what is nowhere found in nature.

IKE. At least we have come round to making that explicit. But to ask us to stand still as someone claims to have invented a natural substance, that seems to ask us to accept a contradiction in terms. Our sense of contradiction might resemble that of the Murgatroyds in *Ruddigore* upon hearing from Sir Ruthven that he has forged his own will. On any plausible

construal of “invention,” one cannot invent what already exists. Thus it has long been held that one cannot obtain a patent on magnesium even if one was the first to find magnesium or the first to devise a way to extract it in pure form. Your utilitarian forbear Sidgwick observed that we should have to exert “a considerable strain” to conclude that the first to discover something has *produced* it (Sidgwick 1907, 280). As Sidgwick would have it, Locke reached that strained conclusion only by resort to a “desperate device of ethico-political construction,” i.e., the notion that the first person to appropriate something owns it. If we believed that notion, said Sidgwick, we should be led to condone “almost any arbitrariness in positive law.” Instead we would appropriately reward a discovery not with a property interest but with “not more than adequate compensation for the discoverer’s trouble.” A good reason obtains for forbearance here. We ought not cede a monopoly to the first to discover some corner of nature’s storehouse. We want to encourage everyone to explore every corner.

HUGH. A couple decades ago, a patent was sustained on an oil-eating bacterium. On the basis of this precedent, the authorities later declared the patentability of nucleotide sequences. On the expectation that patents are available as thus declared, biotechnology industrialists and their investors have relied.

IKE. I appreciate the predicament, but I do not know precisely what argument you imply. Do you suggest that an historical accident constrains what principled position we may adopt? It is altogether too easy to assert that one must possess the object of one’s expectations. It is incumbent on industrialists to adduce evidence for their facile claim that if patents on nucleotide sequences were not available, their firms would not develop and bring therapeutic compounds to market. For this conditional to succeed as a defense of such patents, the conclusion must be read to say that the entire biotechnology industry would fail to produce valued products, not just that some firms would fail. For some firms, policies that maximize collective welfare will effect wrenching dislocations. This we know from the theory of comparative advantage of Mill and Ricardo. In order for the industrialists’ defense of these patents to work, they must worry us about the survival of the biotechnology industry as a whole, and enough so that we choose to abandon the rule that nature is unpatentable. But you, you do not repudiate that rule, do you?

HUGH. In the case of biology, we must compromise intellectual purity for the hope that patents will hasten the advent of therapeutic innovations that improve human welfare.

IKE. Then you are an act utilitarian on this issue? I note that you began by endorsing patents on life forms no matter what harm they might effect in a given case. You sounded like a rule utilitarian then.

HUGH. I advocate a utilitarian social welfare function. Perhaps we need a rule peculiar to biology.

IKE. Rather than resort to special pleading, to advocating for biotechnology the inventability of nature, which seems self-contradictory, let me observe that we do not need patents to motivate scientists. Allow me to suggest a way by which to avoid self-contradiction while still providing incentives for developments fostering collective welfare. I propose that in respect of human DNA, we allow patents only on ingenious processes. This regimen would preserve DNA itself in the public domain.²

HUGH. Are you resolving a process-product ambiguity, as if to prevent an illegitimate slide from honoring a process of invention to honoring the invention itself?

IKE. No. I envision a process of invention that yields a patentable process but no patentable product. I refer to a set of processes—of manufacture, synthesis, recombination, and so on—each of which is sufficiently ingenious as to merit monopoly for its inventor. I assume that nobody has described with patentable specificity the general process of invention itself. Of course industrialists prefer patents on nucleotide sequences as products. With a product patent in hand, an inventor can recover for infringement by establishing that a competitor has sold a product described in the patent; the inventor need not show the process by which the competitor made the product. But mere strategic preference does not state a case for patenting what naturally occurs.

HUGH. I do appreciate that patents on DNA sequences seem to defy the uninventability, and hence the stipulated unpatentability, of nature.

IKE. I in turn am reassured by your point that, so long as we explicitly hold any parent or child immune from claims of infringement in connection with human reproduction, patents on molecules manipulated outside the body do not threaten the autonomy of any person as such. I can also see that we might maintain appropriate respect for humanity and yet grant privileges that foster efforts against illness and disability. I recognize that human afflictions are themselves assaults on human dignity.

HUGH. It seems that in the excitement about cloning genes, a generation ago many did not anticipate that patents would eventually encompass some significant portion of the human genome. Both from concern for respecting humanity, and for maximization of preference satisfaction, we seem to agree that with benefit of hindsight, it would have been better to allow patents only on new and ingenious processes. I suggest that in respect

of claims to have invented biological products, we revert to a rationale developed in organic chemistry. There the isolation and purification of a compound sustains a patent on it.

IKE. That would bring us back to the point that the cDNA sequences for which patents are now issued, and their mRNA transcripts, are naturally occurring.

HUGH. I assign significance to the presence of introns, noncoding nucleotide base pairs interspersed within the coding sequences of chromosomal DNA. Those introns are absent from the corresponding cDNA molecule. To this I add that mRNA is not the same molecule as DNA. Where DNA has thymine, mRNA has uracil.

IKE. But the information encoded by the cDNA molecule is the same, is it not, as that encoded by the naturally occurring DNA molecule from which it is made?

HUGH. Yes, but ideas are in general not patentable, although a patent was recently granted on an algorithm. Any correspondence between information associated with a putatively invented thing and information associated with a natural thing does not constitute an objection to the patentability of the putative invention.

IKE. Scientists sometimes create new nucleotide sequences, called “artificial genes,” that, at least to our knowledge, are not found in a living being. They would seem to be patentable.

HUGH. No cavil there. Those seem patently patentable.

IKE. But still it seems to me that the process of splicing out introns—which is all that is required to produce cDNA—is so perfunctory, so mechanistic that we ought to recognize the prior existence of sequences naturally occurring on chromosomes.

HUGH. If your view had prevailed in the past, then as I understand it, many patents on valuable antibiotics would not have issued. Many antibiotics are made from naturally occurring plant substances.

IKE. Antibiotics may be “made from” natural substances, but by virtue of modifications effected in the manufacturing process, the antibiotics presumably do not exist in nature. But the point you make again evokes the question whether patents are necessary to coax a satisfactory level of biomedical research and development. It exposes again the occasional apparent willingness, perhaps spawned by the excitement of discovery, to waive the rule that nature is unpatentable. Granted, we should clarify that despite this categorical form in which the rule is usually expressed, the rule applied in practice is couched in probabilities. Glenn Seaborg obtained a patent on curium and isotopes of americium. So far as we know, transuranic elements such as curium do not exist on the surface of the earth except

through human intervention, i.e., in accelerators. But transuranic elements doubtless exist in stars. The actually prevailing rule is that to be patentable matter, a thing must be such that there obtains only a very low probability that, without human intervention, the thing exists near the surface of the earth or on other bodies to which humans travel. It may be observed that in the confident way in which those who participate in the patent system speak of existence and nonexistence, we do not hear any sophisticated talk of probabilities.

HUGH. I agree with that clarification. In addition to the unpatentability of nature, the criteria of patentability are that a claimed invention is new, useful, and nonobvious. With respect to the perhaps improvident availability of gene patents, perhaps some future relief will lie in a more demanding view of what it is for a DNA sequence to be useful. The authorities might require that a sequence be fully explicated. To meet this requirement, a claimant would need to state the protein for which the sequence codes, or what the sequence regulates. The authorities could also require that the claimed sequence include all regulatory sequences needed for transcription of any exons into RNA and for expression of a gene.

IKE. By all means, such explication should be a precondition of a patent. The requirements that you describe would seem to dispatch any patent application citing trivial uses. It was once argued, with some support in patent precedent, that a patent applicant established usefulness of a DNA sequence by claiming that it could be used as a genetic marker. That seemed trivial since any DNA sequence may serve as a genetic marker—just as any spot on the highway may serve as starting point for a road race. In any case, a demand that a DNA sequence be fully explicated only brings one criterion of patent law to where it should have been long ago. It does not meet the objection that no one can invent what already exists.

HUGH. Thus far we have been discussing the consequences of patents for biotechnological innovation. Consider too the wider economic and ecological effects. To farmers, patented plant strains represent greater expense. Farmers feeling that burden may turn to cheaper unpatented strains. And the mere introduction of patented strains containing pesticides, though seemingly an unalloyed benefit, engenders worry about vulnerability to pests. When fewer strains grow, genetic diversity diminishes. Resistant pest strains are likely to develop.

IKE. I agree that we shall be short-sighted if we do not consider the ecological consequences of diminished genetic diversity for animals as well as plants. We humans may come to absorb the detriment of unwisely manipulating our environment. That problem is not peculiar to patents, but we should study patent incentives in respect of plants and animals.

HUGH. I see that study as part of the larger inquiry whether patents are beneficial. Surely on your view we must adduce some empirical information to tell us what we should do if, following Kant, we are to fulfill a duty to oneself to develop and increase “natural perfection,” an undertaking that encompasses “looking after the basic stuff (the matter) in a human being, without which he could not realize his ends” (Kant 1797, 6: 444–445). We should remember that a patent does not permanently confine exploitation of a given molecule. It only gives the patentee a twenty-year head start. After that, the invention enters the public domain.

IKE. Where we may differ is in our views of whether any detriments or indignities to humankind—such as exorbitant pricing or product suppression by monopolists—are tolerable because the patent system is believed to produce a positive net effect for humankind. To which one should add mention of avoidable suffering that may occur if, contrary to the predictions of biotechnology enthusiasts, some patents slow rather than hasten innovation. As I earlier noted, there also occur distortions in the practice of science, as when investigators feel compelled or induced to alter how soon, and sometimes whether, they share results.

HUGH. When we take account of the full effect of granting patents on human DNA sequences, who can predict what will maximize preference satisfaction?

IKE. Or what will maximize human welfare, however one conceives it.

HUGH. I now see beyond what has thus far been explicitly discussed by utilitarians. You and I have agreed that patents on DNA sequences contravene the unpatentability of nature. In the main, I have set against this the risk that we might damp biotechnological progress if we alter incentives. I concede that we have not quantified that risk by empirical observation.

IKE. Governments now unwittingly conduct another experiment, that which consists in allowing much or all of the human genome—there is no bound—to be claimed as property. History may count as a small mercy the fact that in the final spurt of the human genome project, many scientists contributed human sequence data to the public domain. In some cases they did so of their own volition because of concern about the problem that we have been discussing, and in other cases funding agencies required such contributions. The fortuitous effect was to thwart patentability of everything made public. The experiments that we ought now to conduct would explore the incentive effects of rewarding process innovations. Such experimentation is veritably invited by a system straddling the insecure boundary that has been drawn between nature and biological invention. This fine tuning does not exhaust our options. Our most overlooked and fruitful strategy may be to subsidize more nonprofit research. Nonprofit

institutions already contribute the basic science of biotechnological progress. At the public behest, nonprofit institutions could also contribute applications.

HUGH. Apart from obvious transitional problems, we ought to look before we leap. I am not sanguine that without a profit motivation, academic investigators will provide society what industrial researchers presently provide. Industrial scientists are willing to work in teams to pursue applications that academic scientists may disdain.

IKE. I imagine not only academic but nonprofit research in general. The subsidies that I have in mind would go not only to universities for basic and some applied research, but also to a new array of nonprofit biotechnological research centers whose remit includes the development of applications. I appreciate that if it were widgets in respect of which we wished to encourage innovation, we might coax more inventions by market incentives for entrepreneurs tinkering in their shops than by supporting laboratory research in institutions. But in our case, applications do not lie distant from research. Biotechnology as an industry is an offshoot of university-based work in molecular biology. To the extent that profit incentives contribute a distinctive kind of motivation, we could attach profit-like incentives to subsidized research. The government could undertake to reward grantees with bonus funding as the fruits of their work produce profits in the marketplace. We may still need the efforts of private firms; we may still need to motivate some entrepreneurs with patent privileges. Yet the more research we put into the public domain, the lower the social cost of indulging the fiction that humans have invented what they have only discovered.

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NOTES

¹ The natural isolate of erythropoietin was claimed in U. S. Patent No. 4,677,195 (to Genetics Institute, Inc.), the recombinant in U.S. Patent No. 4,703,008 (to Amgen, Inc.).

² Guenin 1996 proposes a hybrid process patent called a "human methods patent," and further studies the ramifications of construing human conception or birth as patent infringement.

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