

# *In Defense of Marxism: Dialectics and Modern Science*

*The Marxist method of Dialectical Materialism applies both to nature and science as well as to society and history. The book Reason in Revolt by Ted Grant and Alan Woods examines the contributions of Frederick Engels in the field of natural science and its confirmation of the ideas of dialectics. The following pieces further explain and prove the inter-connection between dialectical thought and the natural world. Engels anticipated the discoveries of modern anthropology, and the mapping of the human genome further confirmed the ideas of dialectics.*

## **The Role Played by Labor in the Transition from Ape to Man**

**By Frederick Engels**

Labor is the source of all wealth, the political economists assert. And it really is the source - next to nature, which supplies it with the material that it converts into wealth. But it is even infinitely more than this. It is the prime basic condition for all human existence, and this to such an extent that, in a sense, we have to say that Labor created man himself.

Many hundreds of thousands of years ago, during an epoch, not yet definitely determinable, of that period of the earth's history known to geologists as the Tertiary period, most likely towards the end of it, a particularly highly-developed race of anthropoid apes lived somewhere in the tropical zone - probably on a great continent that has now sunk to the bottom of the Indian Ocean.<sup>1</sup> Darwin has given us an approximate description of these ancestors of ours. They were completely covered with hair, they had beards and pointed ears, and they lived in bands in the trees.

First, owing to their way of living which meant that the hands had different functions than the feet when climbing, these apes began to lose the habit of using their hands to walk and adopted a more and more erect posture. This was the decisive step in the transition from ape to man.

All extant anthropoid apes can stand erect and move about on their feet alone, but only in case of urgent need and in a very clumsy way. Their natural gait is in a half-erect posture and includes the use of the hands. The majority rest the knuckles of the fist on the ground and, with legs drawn up, swing

the body through their long arms, much as a cripple moves on crutches. In general, all the transition stages from walking on all fours to walking on two legs are still to be observed among the apes today. The latter gait, however, has never become more than a makeshift for any of them.

It stands to reason that if erect gait among our hairy ancestors became first the rule and then, in time, a necessity, other diverse functions must, in the meantime, have devolved upon the hands. Already among the apes there is some difference in the way the hands and the feet are employed. In climbing, as mentioned above, the hands and feet have different uses. The hands are used mainly for gathering and holding food in the same way as the fore paws of the lower mammals are used. Many apes use their hands to build themselves nests in the trees or even to construct roofs between the branches to protect themselves against the weather, as the chimpanzee, for example, does. With their hands they grasp sticks to defend themselves against enemies, or bombard their enemies with fruits and stones. In captivity they use their hands for a number of simple operations copied from human beings. It is in this that one sees the great gulf between the undeveloped hand of even the most man-like apes and the human hand that has been highly perfected by hundreds of thousands of years of Labor. The number and general arrangement of the bones and muscles are the same in both hands, but the hand of the lowest savage can perform hundreds of operations that no simian hand can imitate - no simian hand has ever fashioned even the crudest stone knife.

The first operations for which our ancestors gradually learned to adapt their hands during the many thousands of years of transition from ape to man could have been only very simple ones. The lowest savages, even those in whom regression to a more animal-like condition with a simultaneous physical degeneration can be assumed, are nevertheless far superior to these transitional beings. Before the first flint could be fashioned into a knife by human hands, a period of time probably elapsed in comparison with which the historical period known to us appears insignificant. But the decisive step had been taken, the hand had become free and could henceforth attain ever greater dexterity; the greater flexibility thus acquired was inherited and increased from generation to generation.

Thus the hand is not only the organ of Labor, it is also the product of Labor. Only

by Labor, by adaptation to ever new operations, through the inheritance of muscles, ligaments, and, over longer periods of time, bones that had undergone special development and the ever-renewed employment of this inherited finesse in new, more and more complicated operations, have given the human hand the high degree of perfection required to conjure into being the pictures of a Raphael, the statues of a Thorwaldsen, the music of a Paganini.

But the hand did not exist alone, it was only one member of an integral, highly complex organism. And what benefited the hand, benefited also the whole body it served; and this in two ways.

In the first place, the body benefited from the law of correlation of growth, as Darwin called it. This law states that the specialized forms of separate parts of an organic being are always bound up with certain forms of other parts that apparently have no connection with them. Thus all animals that have red blood cells without cell nuclei, and in which the head is attached to the first vertebra by means of a double articulation (condyles), also without exception possess lacteal glands for suckling their young. Similarly, cloven hoofs in mammals are regularly associated with the possession of a multiple stomach for rumination. Changes in certain forms involve changes in the form of other parts of the body, although we cannot explain the connection. Perfectly white cats with blue eyes are always, or almost always, deaf. The gradually increasing perfection of the human hand, and the commensurate adaptation of the feet for erect gait, have undoubtedly, by virtue of such correlation, reacted on other parts of the organism. However, this action has not as yet been sufficiently investigated for us to be able to do more here than to state the fact in general terms.

Much more important is the direct, demonstrable influence of the development of the hand on the rest of the organism. It has already been noted that our simian ancestors were gregarious; it is obviously impossible to seek the derivation of man, the most social of all animals, from non-gregarious immediate ancestors. Mastery over nature began with the development of the hand, with Labor, and widened man's horizon at every new advance. He was continually discovering new, hitherto unknown properties in natural objects. On the other hand, the development of Labor necessarily helped to bring the members of society closer together by increasing cases of

mutual support and joint activity, and by making clear the advantage of this joint activity to each individual. In short, men in the making arrived at the point where they had something to say to each other. Necessity created the organ; the undeveloped larynx of the ape was slowly but surely transformed by modulation to produce constantly more developed modulation, and the organs of the mouth gradually learned to pronounce one articulate sound after another.

Comparison with animals proves that this explanation of the origin of language from and in the process of Labor is the only correct one. The little that even the most highly-developed animals need to communicate to each other does not require articulate speech. In its natural state, no animal feels handicapped by its inability to speak or to understand human speech. It is quite different when it has been tamed by man. The dog and the horse, by association with man, have developed such a good ear for articulate speech that they easily learn to understand any language within their range of concept. Moreover they have acquired the capacity for feelings such as affection for man, gratitude, etc., which were previously foreign to them. Anyone who has had much to do with such animals will hardly be able to escape the conviction that in many cases they now feel their inability to speak as a defect, although, unfortunately, it is one that can no longer be remedied because their vocal organs are too specialized in a definite direction. However, where vocal organs exist, within certain limits even this inability disappears. The buccal organs of birds are as different from those of man as they can be, yet birds are the only animals that can learn to speak; and it is the bird with the most hideous voice, the parrot, that speaks best of all. Let no one object that the parrot does not understand what it says. It is true that for the sheer pleasure of talking and associating with human beings, the parrot will chatter for hours at a stretch, continually repeating its whole vocabulary. But within the limits of its range of concepts it can also learn to understand what it is saying. Teach a parrot swear words in such a way that it gets an idea of their meaning (one of the great amusements of sailors returning from the tropics); tease it and you will soon discover that it knows how to use its swear words just as correctly as a Berlin costermonger. The same is true of begging for titbits.

First Labor, after it and then with it speech - these were the two most essential stimuli under the influence of which the brain of the ape gradually changed into that of man, which for all its similarity is far larger and more perfect. Hand in hand with the development of the brain went the development of its most immediate instruments - the senses. Just as the gradual development of speech is inevitably accompanied by a corresponding refinement of the organ of hearing, so the development

of the brain as a whole is accompanied by a refinement of all the senses. The eagle sees much farther than man, but the human eye discerns considerably more in things than does the eye of the eagle. The dog has a far keener sense of smell than man, but it does not distinguish a hundredth part of the odors that for man are definite signs denoting different things. And the sense of touch, which the ape hardly possesses in its crudest initial form, has been developed only side by side with the development of the human hand itself, through the medium of Labor.

The reaction on Labor and speech of the development of the brain and its attendant senses, of the increasing clarity of consciousness, power of abstraction and of conclusion, gave both Labor and speech an ever-renewed impulse to further development. This development did not reach its conclusion when man finally became distinct from the ape, but on the whole made further powerful progress, its degree and direction varying among different peoples and at different times, and here and there even being interrupted by local or temporary regression. This further development has been strongly urged forward, on the one hand, and guided along more definite directions, on the other, by a new element which came into play with the appearance of fully-fledged man, namely, society.

Hundreds of thousands of years - of no greater significance in the history of the earth than one second in the life of man\* [Engels note: A leading authority in this respect, Sir William Thomson, has calculated that little more than a hundred million years could have elapsed since the time when the earth had cooled sufficiently for plants and animals to be able to live on it.] - certainly elapsed before human society arose out of a troupe of tree-climbing monkeys. Yet it did finally appear. And what do we find once more as the characteristic difference between the troupe of monkeys and human society? Labor. The ape herd was satisfied to browse over the feeding area determined for it by geographical conditions or the resistance of neighboring herds; it undertook migrations and struggles to win new feeding grounds, but it was incapable of extracting from them more than they offered in their natural state, except that it unconsciously fertilized the soil with its own excrement. As soon as all possible feeding grounds were occupied, there could be no further increase in the ape population; the number of animals could at best remain stationary. But all animals waste a great deal of food, and, in addition, destroy in the germ the next generation of the food supply. Unlike the hunter, the wolf does not spare the doe which would provide it with the young the next year; the goats in Greece, that eat away the young bushes before they grow to maturity, have eaten bare all the mountains of the country. This "predatory economy" of

animals plays an important part in the gradual transformation of species by forcing them to adapt themselves to other than the usual food, thanks to which their blood acquires a different chemical composition and the whole physical constitution gradually alters, while species that have remained unadapted die out. There is no doubt that this predatory economy contributed powerfully to the transition of our ancestors from ape to man. In a race of apes that far surpassed all others in intelligence and adaptability, this predatory economy must have led to a continual increase in the number of plants used for food and the consumption of more and more edible parts of food plants. In short, food became more and more varied, as did also the substances entering the body with it, substances that were the chemical premises for the transition to man. But all that was not yet Labor in the proper sense of the word. Labor begins with the making of tools.

And what are the most ancient tools that we find - the most ancient judging by the heirlooms of prehistoric man that have been discovered, and by the mode of life of the earliest historical peoples and of the rawest of contemporary savages? They are hunting and fishing implements, the former at the same time serving as weapons. But hunting and fishing presuppose the transition from an exclusively vegetable diet to the concomitant use of meat, and this is another important step in the process of transition from ape to man. A meat diet contained in an almost ready state the most essential ingredients required by the organism for its metabolism.

By shortening the time required for digestion, it also shortened the other vegetative bodily processes that correspond to those of plant life, and thus gained further time, material and desire for the active manifestation of animal life proper. And the farther man in the making moved from the vegetable kingdom the higher he rose above the animal. Just as becoming accustomed to a vegetable diet side by side with meat converted wild cats and dogs into the servants of man, so also adaptation to a meat diet, side by side with a vegetable diet, greatly contributed towards giving bodily strength and independence to man in the making. The meat diet, however, had its greatest effect on the brain, which now received a far richer flow of the materials necessary for its nourishment and development, and which, therefore, could develop more rapidly and perfectly from generation to generation. With all due respect to the vegetarians man did not come into existence without a meat diet, and if the latter, among all peoples known to us, has led to cannibalism at some time or other (the forefathers of the Berliners, the Weletabians or Wilzians, used to eat their parents as late as the tenth century), that is of no consequence to us today.

The meat diet led to two new advances

of decisive importance; the harnessing of fire and the domestication of animals. The first still further shortened the digestive process, as it provided the mouth with food already, as it were, half-digested; the second made meat more copious by opening up a new, more regular source of supply in addition to hunting, and moreover provided, in milk and its products, a new article of food at least as valuable as meat in its composition. Thus both these advances were, in themselves, new means for the emancipation of man. It would lead us too far afield to dwell here in detail on their indirect effects notwithstanding the great importance they have had for the development of man and society.

Just as man learned to consume everything edible, he also learned to live in any climate. He spread over the whole of the habitable world, being the only animal fully able to do so of its own accord. The other animals that have become accustomed to all climates - domestic animals and vermin - did not become so independently, but only in the wake of man. And the transition from the uniformly hot climate of the original home of man to colder regions, where the year was divided into summer and winter, created new requirements - shelter and clothing as protection against cold and damp, and hence new spheres of Labor, new forms of activity, which further and further separated man from the animal.

By the combined functioning of hand, speech organs and brain, not only in each individual but also in society, men became capable of executing more and more complicated operations, and were able to set themselves, and achieve, higher and higher aims. The work of each generation itself became different, more perfect and more diversified. Agriculture was added to hunting and cattle raising; then came spinning, weaving, metalworking, pottery and navigation. Along with trade and industry, art and science finally appeared. Tribes developed into nations and states. Law and politics arose, and with them that fantastic reflection of human things in the human mind - religion. In the face of all these images, which appeared in the first place to be products of the mind and seemed to dominate human societies, the more modest productions of the working hand retreated into the background, the more so since the mind that planned the Labor was able, at a very early stage in the development of society (for example, already in the primitive family), to have the Labor that had been planned carried out by other hands than its own. All merit for the swift advance of civilization was ascribed to the mind, to the development and activity of the brain. Men became accustomed to explain their actions as arising out of thought instead of their needs (which in any case are reflected and perceived in the mind); and so in the course

of time there emerged that idealistic world outlook which, especially since the fall of the world of antiquity, has dominated men's minds. It still rules them to such a degree that even the most materialistic natural scientists of the Darwinian school are still unable to form any clear idea of the origin of man, because under this ideological influence they do not recognize the part that has been played therein by Labor.

Animals, as has already been pointed out, change the environment by their activities in the same way, even if not to the same extent, as man does, and these changes, as we have seen, in turn react upon and change those who made them. In nature nothing takes place in isolation. Everything affects and is affected by every other thing, and it is mostly because this manifold motion and interaction is forgotten that our natural scientists are prevented from gaining a clear insight into the simplest things. We have seen how goats have prevented the regeneration of forests in Greece; on the island of St. Helena, goats and pigs brought by the first arrivals have succeeded in exterminating its old vegetation almost completely, and so have prepared the ground for the spreading of plants brought by later sailors and colonists. But animals exert a lasting effect on their environment unintentionally and, as far as the animals themselves are concerned, accidentally. The further removed men are from animals, however, the more their effect on nature assumes the character of premeditated, planned action directed towards definite preconceived ends. The animal destroys the vegetation of a locality without realizing what it is doing. Man destroys it in order to sow field crops on the soil thus released, or to plant trees or vines which he knows will yield many times the amount planted. He transfers useful plants and domestic animals from one country to another and thus changes the flora and fauna of whole continents. More than this. Through artificial breeding both plants and animals are so changed by the hand of man that they become unrecognizable. The wild plants from which our grain varieties originated are still being sought in vain. There is still some dispute about the wild animals from which our very different breeds of dogs or our equally numerous breeds of horses are descended.

It goes without saying that it would not occur to us to dispute the ability of animals to act in a planned, premeditated fashion. On the contrary, a planned mode of action exists in embryo wherever protoplasm, living albumen, exists and reacts, that is, carries out definite, even if extremely simple, movements as a result of definite external stimuli. Such reaction takes place even where there is yet no cell at all, far less a nerve cell. There is something of the planned action in the way insect-eating plants capture their prey, although they do it quite unconsciously. In animals the capacity for conscious, planned action is proportional

to the development of the nervous system, and among mammals it attains a fairly high level. While fox-hunting in England one can daily observe how unerringly the fox makes use of its excellent knowledge of the locality in order to elude its pursuers, and how well it knows and turns to account all favorable features of the ground that cause the scent to be lost. Among our domestic animals, more highly developed thanks to association with man, one can constantly observe acts of cunning on exactly the same level as those of children. For, just as the development history of the human embryo in the mother's womb is only an abbreviated repetition of the history, extending over millions of years, of the bodily development of our animal ancestors, starting from the worm, so the mental development of the human child is only a still more abbreviated repetition of the intellectual development of these same ancestors, at least of the later ones. But all the planned action of all animals has never succeeded in impressing the stamp of their will upon the earth. That was left for man.

In short, the animal merely uses its environment, and brings about changes in it simply by its presence; man by his changes makes it serve his ends, masters it. This is the final, essential distinction between man and other animals, and once again it is Labor that brings about this distinction.

Let us not, however, flatter ourselves overmuch on account of our human victories over nature. For each such victory nature takes its revenge on us. Each victory, it is true, in the first place brings about the results we expected, but in the second and third places it has quite different, unforeseen effects which only too often cancel the first. The people who, in Mesopotamia, Greece, Asia Minor and elsewhere, destroyed the forests to obtain cultivable land, never dreamed that by removing along with the forests the collecting centres and reservoirs of moisture they were laying the basis for the present forlorn state of those countries. When the Italians of the Alps used up the pine forests on the southern slopes, so carefully cherished on the northern slopes, they had no inkling that by doing so they were cutting at the roots of the dairy industry in their region; they had still less inkling that they were thereby depriving their mountain springs of water for the greater part of the year, and making it possible for them to pour still more furious torrents on the plains during the rainy seasons. Those who spread the potato in Europe were not aware that with these farinaceous tubers they were at the same time spreading scrofula. Thus at every step we are reminded that we by no means rule over nature like a conqueror over a foreign people, like someone standing outside nature - but that we, with flesh, blood and brain, belong to nature, and exist in its midst, and that all our

mastery of it consists in the fact that we have the advantage over all other creatures of being able to learn its laws and apply them correctly.

And, in fact, with every day that passes we are acquiring a better understanding of these laws and getting to perceive both the more immediate and the more remote consequences of our interference with the traditional course of nature. In particular, after the mighty advances made by the natural sciences in the present century, we are more than ever in a position to realize, and hence to control, also the more remote natural consequences of at least our day-to-day production activities. But the more this progresses the more will men not only feel but also know their oneness with nature, and the more impossible will become the senseless and unnatural idea of a contrast between mind and matter, man and nature, soul and body, such as arose after the decline of classical antiquity in Europe and obtained its highest elaboration in Christianity.

It required the Labor of thousands of years for us to learn a little of how to calculate the more remote natural effects of our actions in the field of production, but it has been still more difficult in regard to the more remote social effects of these actions. We mentioned the potato and the resulting spread of scrofula. But what is scrofula compared to the effects which the reduction of the workers to a potato diet had on the living conditions of the popular masses in whole countries, or compared to the famine the potato blight brought to Ireland in 1847, which consigned to the grave a million Irishmen, nourished solely or almost exclusively on potatoes, and forced the emigration overseas of two million more? When the Arabs learned to distil spirits, it never entered their heads that by so doing they were creating one of the chief weapons for the annihilation of the aborigines of the then still undiscovered American continent. And when afterwards Columbus discovered this America, he did not know that by doing so he was giving a new lease of life to slavery, which in Europe had long ago been done away with, and laying the basis for the Negro slave trade. The men who in the seventeenth and eighteenth centuries labored to create the steam-engine had no idea that they were preparing the instrument which more than any other was to revolutionize social relations throughout the world. Especially in Europe, by concentrating wealth in the hands of a minority and dispossessing the huge majority, this instrument was destined at first to give social and political domination to the bourgeoisie, but later, to give rise to a class struggle between bourgeoisie and proletariat which can end only in the overthrow of the bourgeoisie and the abolition of all class antagonisms. But in this sphere too, by long and often cruel experience and by collecting and analyzing historical

material, we are gradually learning to get a clear view of the indirect, more remote social effects of our production activity, and so are afforded an opportunity to control and regulate these effects as well.

This regulation, however, requires something more than mere knowledge. It requires a complete revolution in our hitherto existing mode of production, and simultaneously a revolution in our whole contemporary social order.

All hitherto existing modes of production have aimed merely at achieving the most immediately and directly useful effect of Labor. The further consequences, which appear only later and become effective through gradual repetition and accumulation, were totally neglected. The original common ownership of land corresponded, on the one hand, to a level of development of human beings in which their horizon was restricted in general to what lay immediately available, and presupposed, on the other hand, a certain superfluity of land that would allow some latitude for correcting the possible bad results of this primeval type of economy. When this surplus land was exhausted, common ownership also declined. All higher forms of production, however, led to the division of the population into different classes and thereby to the antagonism of ruling and oppressed classes. Thus the interests of the ruling class became the driving factor of production, since production was no longer restricted to providing the barest means of subsistence for the oppressed people. This has been put into effect most completely in the capitalist mode of production prevailing today in Western Europe. The individual capitalists, who dominate production and exchange, are able to concern themselves only with the most immediate useful effect of their actions. Indeed, even this useful effect - inasmuch as it is a question of the usefulness of the article that is produced or exchanged - retreats far into the background, and the sole incentive becomes the profit to be made on selling.

Classical political economy, the social science of the bourgeoisie, in the main examines only social effects of human actions in the fields of production and exchange that are actually intended. This fully corresponds to the social organization of which it is the theoretical expression. As individual capitalists are engaged in production and exchange for the sake of the immediate profit, only the nearest, most immediate results must first be taken into account. As long as the individual manufacturer or merchant sells a manufactured or purchased commodity with the usual coveted profit, he is satisfied and does not concern himself with what afterwards becomes of the commodity and its purchasers. The same thing applies to the natural effects of the same actions. What cared the Spanish planters in Cuba, who burned down forests on the slopes of the mountains

and obtained from the ashes sufficient fertilizer for one generation of very highly profitable coffee trees-what cared they that the heavy tropical rainfall afterwards washed away the unprotected upper stratum of the soil, leaving behind only bare rock! In relation to nature, as to society, the present mode of production is predominantly concerned only about the immediate, the most tangible result; and then surprise is expressed that the more remote effects of actions directed to this end turn out to be quite different, are mostly quite the opposite in character; that the harmony of supply and demand is transformed into the very reverse opposite, as shown by the course of each ten years' industrial cycle - even Germany has had a little preliminary experience of it in the "crash"; that private ownership based on one's own Labor must of necessity develop into the expropriation of the workers, while all wealth becomes more and more concentrated in the hands of non-workers; that [... the manuscript breaks off here ...]

## Notes

<sup>1</sup> In the 1870s, when this was written, British zoogeographer Philip Lutley Sclater put forth the theory that a continent (he called "Lemuria") existed which reached from modern Madagascar to India and Sumatra - and this continent has since submerged beneath the Indian Ocean.

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# What the Human Genome Means for Socialists

By Alan Woods

## An Epoch-Making Discovery

Once every century or so great scientific breakthroughs grip the imagination of the world. With the publication of the results of the human genome project, we stand on the threshold of such a breakthrough. Science is now poised to understand the forces behind evolution, explode racial myths, change the way doctors diagnose disease, and try to help people live longer. The new approach - looking at systems of genes rather than individual genes - will transform biologists' view of the human body. It is approximately the equivalent of Mendeleev's periodic table in chemistry, or the breakthrough made by Watson and Crick 48 years ago, when they first described the double helix shape of DNA. "Before we were looking through a keyhole," says James Pierce, a professor of genetics at the University of the Sciences in Philadelphia. "Now, the door is open."

The scope of this project was

immense. Roughly 2,000 scientists world-wide took part in the sequencing effort. The research project was actually carried out by two different groups - one funded by the US government, the other by the UK based Wellcome Trust's Glaxo Sanger Centre. Both groups have come to the same wholly unexpected conclusion, which is that the number of genes in the human genome is less than one quarter of the anticipated result. One team, led by J. Craig Venter of Celera Genomics Corp., found strong evidence of 26,383 genes and weaker evidence for an additional 12,731. The other team said there are probably about 35,000 genes, but possibly as many as 40,000. The Celera team published its findings in the journal *Science*; the international team published in *Nature*. "It is good to have a rough agreement between the two sides," said Venter. "Certainly, it shows that there are far fewer genes than anyone imagined." Researchers also reported that each human gene can make two proteins or more, upsetting the long-held notion that one gene makes one protein.

These discoveries have profound implications for medical and drug research. They suggest that genes play less of a role in causing disease, and many of our other traits, than many researchers realized. And new approaches to treatment will not only have to focus on genes and how they function but also on how they interact. Even in the short term the practical implications are immense. Advances in medical science could follow from the identification of the genes responsible for non-inherited diseases, and scientists could eventually learn to predict the likelihood of someone developing a genetic disorder. Medicine could then tailor specific drugs for patients and there could be a gradual increase in the range of treatments for genetic diseases in the next few decades. Within five to seven years we may see this work bearing fruit in areas like diabetes, heart disease and major mental disorders. Major advances had already been made in schizophrenia.

The discoveries made by the Human Genome Project have dramatically confirmed the position of Marxism, as expounded in *Reason in Revolt* six years ago. For decades, a large number of geneticists have argued that everything from intelligence to homosexuality and criminality was determined by our genes. The most reactionary conclusions have been drawn from these assumptions: for example, that black people and women are genetically conditioned to be less intelligent than white people and men; that rape and murder are somehow natural, because they are genetically determined; that there is no point in spending money on schools and houses for the poor because their poverty is rooted in genetics and therefore cannot be remedied. Above all, that the existence of inequality is natural and inevitable, and that all attempts to abolish class

society are futile, since it is somehow rooted in our genes. This was a very good example of how science cannot be separated from politics and class interests, and how the most eminent scientists can be pressed - consciously or not - into the services of reaction. But leaving aside for a moment the social and political implications, in purely scientific terms this is a defining moment in history.

### **The Puzzle of the Missing Genes**

Despite the enormity of their discovery, the biologists who reported their first analysis of the decoded sequence were clearly as perplexed as they were enlightened. The chief puzzle is the unexpectedly small number of human genes. When they first screened the gene families likely to have new members of interest to pharmaceutical companies, "there was almost panic because the genes weren't there," Dr. Venter said. The problem is that the textbooks have long estimated the number of human genes to be far greater. The string of biological code present in humans was so long - some 3 billion units - that scientists had expected it to contain instructions to create anywhere from 50,000 to 150,000 genes.

This assumption was based on a comparison with simpler organisms such as fruit flies. It was argued that, if the humble fruit fly had 13,000 genes, then a human being - a far bigger and more complex entity - must have many times more. The estimate of up to 150,000 genes seemed reasonable after the first two animal genomes were deciphered. The laboratory roundworm, sequenced in December 1998, has 19,098 genes and the fruit fly, decoded last March, has 13,601 genes. Dr. Randy Scott, chief scientific officer of Incyte Genomics, predicted in September 1999 that there were 142,634 human genes. But the human gene complement has now turned out to be far closer to genetic patrimony of these two tiny invertebrates than almost anyone had expected. Instead, they have discovered that vast stretches of the code create very few genes. "We have about twice as many genes as a fly and the same number as corn," Venter says. "Think of that the next time you eat corn." Last week Dr. Scott said he accepted the rationale for the lesser number and now puts the human complement at around 40,000.

Celera's rival, the publicly funded consortium of academic centres, has come to a similar conclusion. Its report in this week's *Nature* puts the probable number of human genes at 30,000 to 40,000. Because the current gene-finding methods tend to over predict, each side prefers the lower end of its range, and 30,000 seems to be the more accurate estimate. The two teams found other contradictions, too. Most of the repetitive DNA sequences in the 75 percent of the genome that is essentially "junk" ceased to accumulate millions of years ago,

but a few of sequences are still active and may do some good. The chromosomes themselves have a rich archaeology. Large blocks of genes seem to have been extensively copied from one human chromosome to another, a fact which will encourage genetic archaeologists to work out the order in which the copying occurred and thus to reconstruct the history of the animal genome.

The small number of human genes poses a dilemma for scientists. As the modest number of human genes became apparent, biologists in both teams were forced to think how to account for the greater complexity of people, given that they seem to possess only 50 percent more genes than the roundworm. If humankind only has 13,000 more genes than *Caenorhabditis elegans* (a roundworm) or 6,000 more than *Arabidopsis thaliana* (a weed), what makes people so advanced by comparison? To quantify the position: the roundworm is a little tube of a creature with a body of 959 cells, of which 302 are neurons in what passes for its brain. Humans have 100 trillion cells in their body, including 100 billion brain cells. Despite the fashionable tendency to deny the existence of progress in evolution, it is surely reasonable to suppose there is something more to *Homo sapiens* than a roundworm like *Caenorhabditis elegans*!

The *Christian Science Monitor* posed the question thus: "If man is so advanced, how come his gene count doesn't look that much different from a weed's or a worm's?" And if, as suspected, the chimpanzee genome turns out to be very similar to the human genome, then scientists will still have to explain how one species has come to so dominate the world in the past 50,000 to 150,000 years while others are still climbing trees. This question, however, cannot be answered purely in terms of genetics. The great advantage of the recent discoveries is that they have moved away from the concept that everything could be explained in terms of individual genes. The human genome can now be approached as a complex totality. Genes have to be understood, not as a collection of entities but as a process of highly complex interactions. The further exploration of these interactions, their history and the resulting genetic "archeology" will eventually give us a true understanding of ourselves and our place in the nature of things. There can be no more important subject for human beings.

### **Biological Determinism Exposed**

Marxists have, of course, never ignored the role of genetics in shaping human behavior. It goes without saying that genes play a most important role. They provide to some extent the raw material out of which individual humans are developed. But they represent only one side of a very complex equation. The problem arises when certain people attempt to

present genes as the sole agent conditioning human development and behavior, as has been the case for quite some time now. In reality, genes (“nature”) and environmental factors (“nurture”) interact upon each other, and that in this process, the role of the environment, which has been systematically denied or downplayed by the biological determinists, is absolutely crucial.

The recent revelations of the human genome project have decisively settled the old “nature” - “nurture” controversy. The relatively small number of genes rules out the possibility of individual genes controlling and shaping behavior patterns such as criminality and sexual preference. It completely destroys the case of people like Dean Hammer who claimed to have isolated a gene on the human X-chromosome which allegedly disposes people to homosexuality. Similar claims have been made for a whole series of human traits from running ability to artistic taste and even political tendencies! In reality human behavior is extremely complex and cannot be reduced to genetics. The latest discoveries flatly contradict all the nonsense which has been put forward for years as irrefutable.

The biological determinists insisted that in some way genes are responsible for things, like homosexuality and criminality. They attempted to reduce all social problems to the level of genetics. In February 1995, a conference on Genetics of Criminal and Anti-Social Behavior was held in London. Ten of the thirteen speakers were from the United States where a similar conference in 1992 with racist overtones was abandoned because of public pressure. While the chairperson, Sir Michael Rutter of the London Institute of Psychiatry stated “there can be no such thing as a gene for crime,” other participants, like Dr. Gregory Carey of the Institute of Behavioral Genetics, University of Colorado, maintained that genetic factors as a whole were responsible for 40-50% of criminal violence. Although he said it would be impractical to “treat” criminality through genetic engineering, others said there were good prospects for developing drugs to control excessive aggression, once the responsible genes had been found. He suggested, however, that abortion should be considered when antenatal testing indicates a child is likely to be born with genes predisposing it to aggression or antisocial behavior. His view was endorsed by Dr. David Goldman from the Laboratory of Neurogenetics at the US National Institutes of Health. “The families should be given the information and should be allowed to decide privately how to use it.” (*The Independent*, 14th February 1995.)

There are many other examples. The notorious Bell Curve by Charles Murray, resurrected the old argument that genetics explains the gap between the average IQ of American whites and blacks. C. R. Jeffery wrote that

“Science must tell us what individuals will or will not become criminals, what individuals will or will not become victims, and what law enforcement strategies will or will not work.” Yudofsky reinforces Jeffery’s enthusiasm with his assertion: “We are now on the verge of a revolution in genetic medicine. The future will be to understand the genetics of aggressive disorders and to identify those who have greater tendencies to become violent.”

When we criticized these false theories in *Reason in Revolt*, we had no means of knowing that in a few years their unscientific character would be so clearly demonstrated. Now the revelation that the number of genes in humans is not more than 40,000 and possibly as few as 30,000 or less has shattered the case for biological-genetic determinism at a single stroke. Dr. Craig Venter, the US geneticist whose company Celera was one of the main groups responsible for the sequencing project, put the matter very simply: “We simply do not have enough genes for this idea of biological determinism to be right. The wonderful diversity of the human species is not hard-wired in our genetic code. Our environments are critical.” (Observer, 11/ 2/ 2001, my emphasis)

*The Observer* goes on to explain:

“It is only when scientists looked at the way these genes are switched off and on and made to manufacture proteins that they could see a significant difference between various mammalian species. The key difference lies in the manner in which human genes are regulated in response to environmental stimulation compared with other animals.”

That is to say, it is the environment - the external stimuli of both the physical world and the conditions in which we live - that condition evolution in a decisive way. The role of genes is important, but the relation between genes and development is not simple and mechanical, as maintained by the crude theory of biological determinism, but complex and dialectical, as argued by Marxism. Let us take one example of the dialectical interaction between genes and environment: perfect pitch. In his new book *The Sequence*, which describes the search for the human genome, Kevin Davies writes:

“There has been a recent study on perfect pitch, the ability to know the absolute pitch of a musical note, that strongly suggests that it is acquired through the inheritance of a single gene.

“This may sound like a clear-cut case of biological determinism. However, there is a crucial corollary - you have to be exposed to early music training for the ability to materialize. In other words, even in seemingly simple inherited abilities, nurture has a role to play.”

Thus, there is a complex interplay between the genetic composition of the organ-

ism and the physical conditions that surround it. In Hegelian language, the genes represent potential. But this potential is only activated by external stimuli. The genes are “switched on” by the environment, producing small changes, some of which prove to be useful from an evolutionary point of view, although in fact most genetic mutations are harmful or confer no benefit. Over a period, the beneficial mutations give rise to qualitative changes in the organism, giving rise to the process we refer to as natural selection.

*The Observer’s* Editorial drew the political conclusions:

“Politically, it offers comfort to the Left, with its belief in the potential of all, however deprived their background. But it is damning to the Right, with its fondness for ruling classes and original sin.” (*Observer* Editorial, 11/ 2/ 2001, my emphasis)

### “Race has no Meaning in Science”

The results of these investigations are highly significant from another point of view. The genome reveals the existence of unity in human diversity. They completely destroy the myth of racial superiority. The biological essence of human populations is the same. The absence of a race gene was confirmed from two different directions. Celera used DNA from males and females who described themselves as Asian Chinese, African American, Caucasian and Hispanic Mexican. Scientists could not distinguish one ethnicity from another. No gene by itself or together with others could predict the race of those studied.

The new research suggests that all individuals are 99.99 percent alike. And researchers are finding that the gene pool in Africa, where humankind is thought to have originated, remains more diverse than in the rest of the world. These findings completely undermine all notions of differences based on skin color. Svante Pääbo, a German researcher, noted in an essay published in *Science* magazine with the release of the draft genome sequence explains: “It is often the case that two persons who descend from the same part of the world, and look superficially alike, are less related to each other than to persons from other parts of the world who may look very different.”

Dr Eric Lander of the Whitehead Institute for Genome Research, and part of the international consortium, pointed out the fact that any two people were 99.9 per cent genetically identical still left room for considerable genetic variation. One tenth of one per cent of human genes account for hereditary differences. Basically, all human beings are the same. The research on the human genome has proved beyond doubt that while outwardly we may be different, genetically we are 99% identical. Only about 3 million of the 3 bil-

lion chemicals in the genome differ from one person to another, which makes distinctions such as race scientifically meaningless. Ethnic and cultural differences among different groups of humans undoubtedly exist, but these differences are insignificant at the genetic level where people are remarkably the same, regardless of race and gender. Racial hatred cannot therefore be justified and rationalized as arising from genetic differences.

*The Seattle Times* Editorial of February 13, points out:

“One bonus of the human genome project is to knock down bigots who have long strained to camouflage old-fashioned hatred with scientific prattle about genetic superiority. The road map of the human DNA sequence leads to one conclusion: Race has no meaning in science.” (my emphasis)

This will, of course, not put an end to racism, which is rooted in the contradictions of capitalism in the epoch of its decline. But at least it will rob the purveyors of racist poison of the fig-leaf of pseudo-scientific arguments. In future, any attempt of racists and bigots to appeal to science to support their views will be met with the contempt it deserves.

“If anything, such studies will have the opposite effect because prejudice, oppression and racism feed on ignorance,” Dr. Pääbo writes. Pääbo argues knowledge of the genome should foster compassion: “Consequently, stigmatizing any particular group of individuals on the basis of ethnicity or carrier status for certain (genes) will be revealed as absurd.”

## Creationism Exploded

The revelation of the genome's long and complex history, so long hidden from view, has prompted discussions about the nature of man and the process of creation. Incredibly, in the first decade of the twenty first century, the ideas of Darwin are being challenged by the so-called Creationist movement in the USA, which wants American schoolchildren to be taught that God created the world in six days, that man was created from dust and that the first woman was made out of one of his ribs, the Almighty presumably being on an economy drive that day.

The Creationist movement is no joke. It involves millions of people and is -incredibly - spearheaded by scientists, included some geneticists. This is a graphic expression of the intellectual consequences of the decay of capitalism. It is an extremely striking example of the dialectical contradiction of the lag of human consciousness. In the most technologically advanced country in the world, the minds of millions of men and women are sunk in barbarism. Their level of consciousness is not much higher than when men sacrificed prisoners of war to the gods, prostrated themselves before graven idols and burnt witches at the

stake. If this movement were to succeed, as one scientist recently put it, we would be back in the Dark Ages.

The latest discoveries have finally exploded the nonsense of Creationism. It has comprehensively demolished the notion that every species was created separately, and that Man, with his eternal soul, was especially created to sing the praises of the Lord. It is now clearly proved that humans are not at all unique creations. The results of the human genome project show conclusively that we share our genes with other species - that ancient genes helped to make us who we are. Humans share their genes with other species going far back into the mists of time. In fact, a small part of this common genetic inheritance can be traced back to primitive organisms such as bacteria. “Evolution no longer has time to make new genes. It must make new genes from old parts,” observes Eric Lander of the Whitehead Institute for Genomic Research in Cambridge, Mass. The two teams found an astonishing degree of gene conservation over the past 600 million years of evolution on earth: “In many cases we have found that humans have exactly the same genes as rats, mice, cats, dogs and even fruit flies, Venter continues. “Take the gene PAX-6. We have found that when it is damaged, eyes will not form. You can take a human gene, insert it into fruit flies, and the vision of their offspring will be restored.”

Scientists have now found some 200 genes that humans share with bacteria - a revelation which surprised James Watson, the discoverer of DNA and arguably the world's most renowned geneticist: “We knew that genes jumped between bacteria,” he commented, “but not that they jumped between bacteria and man.” In this way, the final proof of evolution has been established. In a fundamental way, these genetic “fossils” have helped over billions of years of evolution to make us what we are. “No doubt the genomic view of our place in nature will be both a source of humility and a blow to the idea of human uniqueness,” Svante Pääbo writes in a separate article in *Science* magazine. And, he continues, “the realization that one or a few genetic accidents made human history possible will provide us with a whole new set of philosophical challenges to think about.” For Marxists too, the human genome holds important philosophical implications.

## Science and Dialectics

At the London launch of research to decipher the genetic code, Sir John Sulston, former director of the Sanger Centre, described the drawing of the human gene map as “a remarkable, iconic event in the era of molecular biology”:

“It is remarkable that a living organism has got so smart and has made such clever

machines that it can think about what it is doing, that it has actually read out the code, the instructions, to make itself. It's the sort of thing that causes philosophers to disappear up their navels if they think too hard about it. It really is a superficial paradox . . . but it's true. We are understanding how we work,” he was quoted as saying.

Indeed, the spectacular march of science in our epoch makes the speculations of philosophy seem pale and uninteresting by comparison. The deeds of humanity have by far outstripped the general level of its consciousness, which remains largely mired in the barbarous past. The new discoveries provide the human race with inspiration and confidence in itself. It provides us with a vision of ourselves, who we really are, and where we have come from - perhaps also where we are going to.

Nevertheless, despite Sir John Sulston's disparaging remarks about philosophy, there are still a few areas where a knowledge of real philosophy would undoubtedly benefit scientists. Of course, there is philosophy and philosophy! Very little of what passes for philosophy in the universities nowadays is of any use to scientists - or anyone else. But there is one honourable exception, which is still awaiting the recognition that is long overdue: that is, dialectical materialism. Although many of the main tenets of dialectical materialism have re-surfaced in recent years, incorporated into the theories of chaos, complexity and, more recently, ubiquity, this debt has never been acknowledged. Dialectics in science is, to paraphrase Oscar Wilde, the philosophy that dares not speak its name. This is a pity, since a knowledge of the dialectical method would certainly have helped avoid a number of pitfalls into which science has occasionally strayed as a result of incorrect assumptions. The human genome is a case in point.

Of course, there is no question of any philosophy dictating to science. The results of science must be determined by its own methods of investigation, observation and experiment. Nonetheless, it is a mistake to imagine that scientists approach their subject matter without any philosophical assumptions. Behind every hypothesis there are always many assumptions, not all of them derived from science itself. The role of formal logic, for example, is taken for granted. It is an important role, but one that has definite limitations. Trotsky explained that the relationship between formal logic and dialectics resembles that between elementary mathematics and calculus. The great advantage of dialectics over formal logic is that it deals with things in their motion and development, and moreover shows how all development takes place through contradictions. Thus, Marx predicted that the line of evolution was not a straight line, but a line in which long periods of slow development (“stasis” in modern terminology) was broken by sudden leaps - breaks

in continuity that impelled the process in a new direction.

Let us take one instance. The dialectical method explains how quite small changes can, at a critical point, produce enormous transformations. This is the famous law of the transformation of quantity into quality - a wonderful and all-embracing law - that was first worked out by the ancient Greeks, and later fully developed by Hegel and placed on a scientific (materialist) basis by Marx and Engels. The importance of this law has only recently been recognized by science through chaos theory. The latest version of this ("ubiquity") has demonstrated that this law has a universal character and is of key importance in many of the most fundamental processes in nature. It has a crucial bearing on the present discussion.

What is the source of the error which led geneticists to conclude that humans possessed far more genes than is, in fact, the case? It is known in philosophy as reductionism, and flows from the mechanical assumption that nature knows only purely quantitative relations. This lies at the heart of biological determinism which approaches humans as a collection of genes, and not as complex organisms, processes, the product of a dialectical interrelation between genes and the environment. Their mode of reasoning is that of formal logic, not dialectics. And from this philosophical standpoint, their conclusions were quite consistent. Logical - but radically false. They reasoned that, since humans are bigger and more complex than fruit worms and roundworms, they must have vastly more genes. However, nature produces many examples to show how changes in quantity eventually beget changes in quality. In many instances, quite small modifications can produce huge changes. The apparent contradiction between the size and complexity of humans and the relatively small number of genes involved can only be explained by recourse to this law.

In *Reason in Revolt*, we subjected this method to a comprehensive criticism. Dealing with the method of Richard Dawkins in *The Selfish Gene*, we wrote:

"Dawkins' method leads him into the swamp of idealism, when he attempts to argue that human culture can be reduced to units he calls memes, which, apparently, like genes, are self-replicating and compete for survival. This is clearly wrong. Human culture is passed down from generation to generation, not through memes, but through education in the broadest sense. It is not biologically inherited but has to be painstakingly relearned and developed by each new generation. Cultural diversity is bound up not with genes but social history. Dawkins' approach is essentially reductionist."

In a commentary in *Science* magazine, Dr. Jean-Michel Claverie, of the French

National Research Centre in Marseilles, notes that with a simple combinatorial scheme, a 30,000-gene organism like the human can in principle be made almost infinitely more complicated. This is a perfect example of the transformation of quantity into quality. Dr. Claverie suspects humans are not that much more elaborate than some of their creations. "In fact," he writes, "with 30,000 genes, each directly interacting with four or five others on average, the human genome is not significantly more complex than a modern jet aeroplane, which contains more than 200,000 unique parts, each of them interacting with three or four others on average."

The initial scanning of the genome suggests two specific ways in which humans have become more complex than worms. One comes from analysis of what are called protein domains. Proteins, the working parts of the cell, are often multipurpose tools, with each role being performed by a different section or domain of the protein. Many protein domains are very ancient. Comparing the domains of proteins made by the roundworm, the fruit fly and people, the consortium reports that only 7 percent of the protein domains found in people were absent from worm and fly, suggesting that "few new protein domains have been invented in the vertebrate lineage."

The most important thing to grasp is that very small genetic mutations can give rise to huge differences. For example, the genetic difference between humans and chimpanzees is less than two percent. As the latest research shows, we have a lot more in common with other animals than we would perhaps like to admit! Most of the genetic material present in modern humans is very old, and identical with the genes which are found even in such lowly beings as fruit flies. Nature is inherently conservative and economical in its workings! Organic matter has evolved from inorganic matter, and higher life forms have evolved from lower ones. We share most of our genes, not just with monkeys and dogs, but with fishes and fruit flies. But merely to state this fact is insufficient. It is also necessary to explain the dialectical process whereby one species is transformed into another. It has recently become fashionable to blur the difference between humans and other animals, in what is obviously an over-reaction against the old idea of Man as a special creation, placed by the Almighty over all Creation.

It has become fashionable to deny the existence of any progress at all, presumably in the interests of an ill-conceived evolutionary "democracy". As a matter of fact, the genetic difference between humans and chimpanzees may be less than two percent, but what a difference that makes! It is a dialectical leap that transforms quantity into quality. But unfortunately, dialectics is subjected to a conspiracy of silence in the universities and consequently

remains completely unknown to most scientists. The most likely explanation for how to generate extra complexity other than by adding more genes is the idea of combinatorial complexity - that is, with just a few extra proteins one could make a much larger number of different combinations between them to produce a qualitative change. The matter has not yet been decisively settled, and much more research will be necessary. But there is little doubt that the final solution will be found somewhere along these lines.

## The Human Genome and Big Business

Scientists from the Human Genome Project described the mapping of the human genetic code as "a gift to the world" that could improve the ability to detect disease and encourage the development of new medicines. That is undoubtedly what it ought to be. But in the market economy, such gifts invariably carry a hefty price tag.

Mapping of the human genome is a historic achievement, but the task of clarifying the complex and dialectical process by which genes interact with environmental factors has only begun. Science has yet to discover the role of genes in complex diseases. The possibilities are limitless, but this immense potential for human progress immediately comes into collision with the narrow limits of the capitalist system where everything is subordinate to private gain. The new technology will be monopolized by the big multinational companies who will exploit it for themselves. The general interests of humanity will come a poor second. Already the issues of privacy, social and legal impacts, regulation and ethical research are generating heated controversy.

The human genome project has naturally attracted the attention of Big Business, scenting the prospect of big profits. The result, however, has caused consternation in the board rooms of some of the big pharmaceutical companies that were looking forward to using it to make money out of the new cures that will hopefully emerge from a deeper knowledge of the behavior of genes. Initially it was assumed that there were about 120,000 to 150,000 genes involved. The drugs companies made their investments accordingly. So when Craig Venter and his team issued a preliminary report, indicating that the number of genes would be "only" about 80,000, he received an angry phone call from the head of a leading biotechnological company:

"He was cursing and swearing and using all sorts of obscenities about my company and about myself." When asked by Venter to state his problem, the unnamed chief replied: "You've just announced there are only 80,000 human genes and I've just done a deal with SmithK-line Beecham. I've agreed to sell them 100,000 genes - where do you suppose

I am supposed to get the rest, you bastard." It is perhaps just as well that this capitalist died before he learned that the real figure was not 80,000 but around 30,000!

This little exchange casts an amusing light on the relation between Big Business and scientific research. Scientists - at least the good ones - are interested in pursuing knowledge for its own sake, of breaking new ground and pushing forward the horizons of science. Big Business is interested only in making money. In this case, they have been prepared to invest because they see the prospects for juicy profits. The biotechnological industry is based on isolating genes that go wrong in our bodies in order to create new drugs which they can sell for a profit. Even 30,000 potential new drugs spells a lot of money - for some.

The International Human Genome Sequencing Consortium is a multinational, publicly financed project that makes its findings available to all. But Celera Genomics, a private, for-profit venture, is keeping its findings closely held, hoping to make its investors wealthy. With its map of the human genome in its pocket, the Celera Genomics Group is hoping to cash in as drug and biotech companies pay to look at the genetic information that could help them develop new medicines and treatments. Although the Human Genome Project offers the mapping and readers' guides free of charge, research firms such as Immunex have already been using the genome database, paying a reported US\$15 million to get their gene mapping from Celera. Analysts say the company, which has a market capitalization of around \$3 billion, is positioned to move from a genetic librarian role to developing drugs and treatments that will be made easier by the genome map. Shares of Celera were trading up 10 cents to \$47.85 in trading on the New York Stock Exchange on Tuesday 13th, after rising 15 percent the previous day. Already Celera is reportedly using the genome mapping to develop drugs and treatments on its own. It is said that Celera may become as big as drug and health giant Pfizer.

Because companies usually want to have secure ownership rights to genes before investing the millions of dollars it takes to develop drugs from them, doubts about patent rights could have far-reaching effects. Some researchers have said this suggests that two scientists or companies, while researching different proteins involved in different diseases, are likely to have sought to patent portions of the same gene. The result could be a series of clashes over patents that would block one or both companies from continuing their research, producing a drug or developing a genetic test for disease. "I think there are lots of suits to be filed, and this [the low number of genes] will make it more so," said Dr. Robert H. Waterston, a DNA-mapping specialist at Washington University in St. Louis.

Many others agree. "I think it could inhibit research," said Arthur Caplan, a bioethics professor at the University of Pennsylvania and an advisor to Celera. "The question that will face companies is: What does corporate responsibility require that you do in terms of sharing access, making the information you own available? They're going to have a stewardship responsibility, because they work in health. This is not like patenting Coke." If a flare-up of patent clashes "hasn't happened yet, it's going to happen soon," said Dr. Lee Hood, a molecular biologist at the University of Washington in Seattle. "I think there will be genes with 10 or 50 different [protein] forms. . . . You will have patents for every splicing and, how that gets untangled, God only knows."

The patent office estimates that it has issued patents on about 1,000 full-length human genes, but it has tens of thousands of applications pending. The vultures are already circling! The prospect for chaos and endless lawsuits is clear and will work to the detriment of science and, ultimately, the millions of people who are desperately in need of new medical treatments, made possible by the genome project. Even when two valid patents are issued, one owner may be able to win a lawsuit blocking another from moving ahead with research or with a drug. Critics have already complained that Human Genome Sciences had been granted patent rights for the gene's role in AIDS without sufficient proof that it understood that role. This is only the beginning.

g the use of this technology under capitalism. It could usher in a new era of genetic discrimination. For example, if scientists create diagnostic tests that can determine an individual's predisposition to certain diseases, should that person's insurance company or employer know about it? "Without adequate safeguards, the genetic revolution could mean one step forward for science and two steps backwards for civil rights," write United States Senators James Jeffords and Tom Daschle in an article in *Science* magazine. "Misuse of genetic information could create a new underclass: the genetically less fortunate." Dr Venter and Dr Collins, the leading pioneers in this field, have both deplored attempts by companies to test workers secretly and discriminate against them on the basis of their genetic profiles. Recently, for the first time ever, the federal Equal Employment Opportunity Commission sued an employer - Burlington Northern Santa Fe Railway - for discrimination based on genetic testing. In a survey of 2,133 employers last year by the American Management Association, seven said they are currently using genetic testing for job applicants or employees, according to *Science* magazine.

Like genetically modified food, or any other technological discovery, the human genome in the hands of greedy and irresponsible capitalists can be changed from a blessing

on humanity to a curse. The latest marvellous discoveries in genetics, which were only made possible by the collaboration of men and women from every continent and nationality, and which go to the heart of that most profound question: who we are, cannot be monopolized by a handful of profiteers. The Labour Movement everywhere must demand the nationalization of the big bio and pharmaceutical companies, as the first step to nationalizing all the big banks and monopolies that dominate our lives and subject every aspect of our existence to the dictatorship of Capital. Only in a rationally planned socialist economy can the new discoveries achieve their full potential and be placed where they belong - at the service of humanity.

### Limitless Possibilities

The mapping of the human genome has carried us one step nearer to the goal of developing our physical and intellectual capacities to the fullest extent. This process is as yet in its earliest infancy. The next great challenge is to understand how genes are regulated. Genes turn on and off in patterns. Understanding how this process works will be critical for developing new drugs for lingering diseases. That work is just beginning, but it promises to transform medicine. "In the 20th century we treated symptoms of diseases," Lander says. "In the 21st, we're going to treat the causes."

The tantalizing prospect opens up before us of a world free from the scourge of disease, the obliteration of cancer and AIDS - those modern equivalents of the Black Death, the eradication of malaria and all the other illnesses that spell misery, suffering and death for millions of the poorest people on earth. We have the realistic prospect of curing the mentally ill and the helpless victims of genetic disorders. All these are now practical propositions that can be realized within years or decades. But these things pale in insignificance before the longer term prospects that open up before us. In the long run, it is not inconceivable that human beings can attain mastery over the blind workings of natural selection itself. In the hands of private capitalists who put personal gain before all other considerations, genetic engineering poses a deadly threat even to the future of life on earth. But in a rationally ordered society, the new technology can pave the way to the most tremendous achievements yet seen. In the pages of the Bible, the blind saw, the deaf heard, the lame walked and the dead were raised. Now all these miracles can be achieved by science without recourse to the supernatural.

Of course, men and women will never achieve the kind of tedious immortality held out by religion. We should not desire to live forever, but to live this life - the only one available to us - to the full. The Bible promises

us a life span of “threescore years and ten”. Yet in the period of capitalism’s senile decay, for countless millions, this is a dream. Life for the overwhelming majority of our planet in the first decade of the 21st century, in the celebrated words of Hobbes, remains nasty, brutish and short. Yet there is no reason why this should be the case. The potential of modern industry, agriculture, science and technique is more than enough to solve all the pressing needs of humanity and create a paradise for men and women, not in the cloudy realm of the Hereafter, but right here and now - a paradise in *this* world.

By making use of the benefits conferred upon us by science and technology, the ordinary human life span can be extended far beyond its present “natural limits”. It is entirely possible to foresee a world in which it would be considered normal to live a healthy and active life beyond a hundred years: to live life to the full, to add to the total store of human achievements in art, science and all other fields of social activity, to raise ourselves up to the fullest potential permitted by Mother Nature, and then, when we have given all that we have to give, to retire from this world in good heart to make way for the new generations who will continue and extend our life’s work. Such a perspective - essentially modest in the context of what we now know to be possible - could be considered “utopian” only by second-rate intellects and people who have become so demoralized and dehumanized by the decay of capitalism that they have lost all hope and all sense of human dignity, and have persuaded themselves that the present miserable state of affairs is all we can hope for.

What these wonderful achievements of science reveal to us is the limitless potential of the human race. And what it should also do is to make us all the more painfully aware of the criminal waste that is the most horrific feature of the so-called market economy. Until now, the defenders of the present system could hide behind the pseudo-scientific argument that the social inequality that condemns the majority of men and women to the rubbish heap was the result of “iron necessity”, that it was “all in our genes”, just as in the past it was all “written in the stars”. No longer! The criminal injustice of class society now stands condemned at the court of the very science whose aid it attempted to enlist.

The implications of this are truly staggering. In the course of human history, there have not been many geniuses. It is clear that Albert Einstein had the (genetic) potential to become a world-famous scientist. But it is equally clear that the same Albert Einstein, if born in a Glasgow slum or a village in Ethiopia, would never have become such. The potential would have existed as a bare possibility, but would have simply been wasted. And such is the fate of a very large number of

potential Einsteins, Darwins and Beethovens, whose potential is crushed and wasted by this infamous system of capitalism. This terrible waste of human talent has long been reflected upon by the finest minds and noblest spirits. In the 18th century the English poet Grey wrote in his celebrated *Elegy Written in a Churchyard*:

“Full many a gem of purest ray serene  
The dark, unfathom’d caves of ocean bear.  
Full many a flower is born to blush unseen  
And waste its sweetness on the desert air.”

Trotsky put the same idea less poetically but quite effectively when he asked: “How many Aristotles are herding swine? And how many swineherds are sitting on thrones?” Now this is a very good question, and one which until now the defenders of the established order answered - using the pseudo-scientific arguments so generously supplied from the genetics departments of American (and English) universities: it’s all in our genes. It was like a “scientific” version of the old English religious Hymn All Things Bright and Beautiful, from which we used to sing:

“The rich man in his castle; the poor man at his gate;  
He made the high and lowly and ordered their Estate.”

Though men and women have frequently questioned the injustice of class society, their voices have always been drowned by the chorus of voices of the defenders of the status quo, who had a vested interest in demonstrating that this was the natural order of things. Once they affirmed that it was the Will of Gods. Then they said that the slaves lacked an immortal soul. Later they argued that Absolute Monarchy was the product of an inevitable and divinely inspired Order. When driven from these positions, they finally took refuge behind a screen of pseudo-scientific arguments allegedly derived from genetics. Now all this has been blown to smithereens. The difference between the rich man in his castle and the poor man at his gate, in terms of their human potential, is negligible. The difference is not that they are born with different genes, but that one is born into a world of riches and privilege, and given every incentive and opportunity to develop whatever potential he or she possesses, while the other is driven down by poverty and despair. Human potential is ground down just as surely as a seed that is crushed under the heel of a boot. .

According to the Celera team, of the two or three billion DNA letters that make up our genes, only 10,000 of them account for any difference between any two individuals. “Really we are just identical twins,” says Venter. “But like all twins and brothers and sisters, we are all really different in the way we respond to the environment.” The implications

are perfectly clear. By changing the material conditions of existence, we can create a favorable environment in which every individual can develop their personal potential to the full. This would mean a new Renaissance - a literal rebirth of humanity - on a far higher plane than anything seen hitherto. That, and nothing less, is the real meaning of socialism. In *Reason in Revolt* we wrote the following:

“The potential of a human brain is limitless. To allow a human being to fulfil this potential is the task of society. Environmental facts can greatly restrict potential or enhance it. Bring up children in bad social conditions, and they will be disadvantaged in comparison with those brought up with all their needs provided. Social background is extremely important. If you change the environment, you change the child. Despite the claims of the biological determinists, intelligence is not fixed or genetically predetermined.”

Marx explained long ago that “social being determines consciousness”. So-called human nature is not something fixed and immutable. In fact, it has changed many times in the course of millions of years of human evolution. The idea that evolution has reached an end, that men and women have already reached the pinnacle of their physical and mental powers will not be accepted by any minimally cultured person with the slightest knowledge of how our species has struggled to reach the present point of its development. Far from ending, as Francis Fukuyama has suggested, human history has not yet begun. Nor will it begin until men and women finally take their destinies consciously into their own hands.

Ancient Greek mythology has handed down to us the story of Tantalus, the giant who was condemned by Zeus to suffer the torments of hunger and thirst while an abundance of food and drink lay just beyond his grasp. In this myth we have a direct analogy with capitalist society in the period of its decadence. All the material means exist for achieving the goal of socialism - a classless society in which humans will control their own lives instead of being the blind objects of unseen forces beyond their control or understanding. The next great step on the role of human evolution demands that we finally put an end to the degrading social apartheid of class society, that we put an end to the modern equivalent of slavery, and replace capitalist anarchy and the law of the jungle with genuinely human relations. Once we create the necessary conditions for human development, freeing the vast potential that exists in industry, agriculture, science and technology - and above all the virtually infinite potential for development that slumbers inside every human being - the sky would be the limit.

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