Remaking Eden: Selected U.K. & Commenwealth Book Reviews

New Statesman

January 30, 1998

Authors: Colin Tudge

Book Review: Remaking Eden

Lee M Silver Weidenfeld & Nicolson, 20 [pounds sterling]

If we leave it to market forces, we will accept cloning, just as we have accepted test-tube babies. We may even have to come to terms with two distinct human species

For all the presidential edicts and emergency "ethical" committees, human cloning will happen, probably in the US, and for the reasons Lee Silver identifies. For some people cloning is the only means by which they can produce offspring that carry their own genes: huge profits can be made from meeting their demands, and in the US the market rules -- not simply for the crude reason that money talks, but because "free market" is equated with freedom per se, sanctified in the constitution. Many liberals are repelled by cloning, yet feel compelled to defend the rights of fellow Americans to do as they will.

Is the prospect really so bad? Some speculate that cloned babies might be psychologically disturbed; but the 1,50,000 or so "test-tube babies" already born by in vitro fertilisation (IVF) suffer no particular traumas. Many envisage a monstrous regiment of Saddam Husseins. But any technology can be misused: television for propaganda, medicine for germ warfare. Nasty people may use any technology nastily, so should all be banned? Hard cases make bad law.

In truth, cloning and its accompanying technologies might reconstruct the physical form of dead children for parents whose own fertility is already lost; or, more modestly, clone blood tissues to cure leukaemia. Is this inhumane? Is it humane to deny such therapies? Outcome and motive are what matter, as in all other medical technologies. Adoption already provides a set of principles: those who seek to adopt are assessed to ensure they are motivated by love. By this existing, simple, humanitarian criterion the tyrant who seeks to multiply himself through vanity, or the intellectual driven by curiosity, would be ruled out of court. So what's the difference and where's the problem?

The difference is that cloning is perceived to be unnatural, and although all medicine is "unnatural" in a sense, this is deemed to be in the realms of the hubris[tic and the blasphemous. These are essentially religious objections and in western societies (thank God) religious feelings no longer translate directly into law. Indeed, terms such as "blasphemy" and "hubris" have lost their resonance. So people in modern, secular societies are in a cleft stick. They feel in their bones that cloning and its ilk are wrong, but have no vocabulary or formal structure to express those feelings; which is why they fall back on Saddam Hussein and speculate with cod psychology that cloned children might feel unhappy.

Silver, rationalist and scientist that he is, runs rings around such misgivings. He is surely right to suppose that the market, wearing its benign face, will override such flimsy arguments; first perhaps in some beleaguered country that would welcome a new cottage industry, then everywhere.

Cloning, after all, is only one of many reproductive technologies that have been developed in the past few decades, and all of them -- artificial insemination, embryo transfer, IVF- were condemned at first by liberals and zealots alike but are now big business. In the US alone, about 300 clinics offer IVF. Rhetoric cannot withstand market forces.

Silver speculates further. Gene therapy -- correcting the damaged genes that underlie such diseases as cystic fibrosis and sickle-cell -- is already welcomed in principle even if not yet practicable. In a few decades or less, gene therapy will shade into "genetic enhancement", which will sneak in through market forces just as cosmetic plastic surgery has done. Cloning complements genetic engineering: it can provide indefinite numbers of early embryos to work on. Embryo selection is almost with us: embryos can be produced in vitro from selected sperm and eggs and then frozen until some couple -- or liberated single woman -- has one that meets her specification implanted into her womb.

In a century or So, Silver suggests, human beings will be divided into those who can afford genetic enhancement ("GenRich") and those who cannot ("Naturals"), and the former will dominate every field of human endeavour. His forecast superficially resembles Brave New World except that Aldous Huxley saw the technologies driven by a totalitarian state while Silver's are led by the market. Eventually, Silver suggests, the GenRich and the Naturals will diverge to form two human species. I find this implausible -- but only just.

In reality, Silver abhors such a prospect but in the book he appears to contemplate it with equanimity. Where the market leads, he seems content to follow. I suggest instead that such technologies reveal the limitations of unfettered

markets, which do not guarantee justice or good sense, and readily deviate from both. Thatcher and Blair, please note: we cannot allow the free market to frame our ethics or indeed to determine the biology of the human species;

Gina Kolata's Clone is more modest: a brisk account of the science and technologies that, in July 1996, led to the first mammal to be cloned from the body cell of an adult. As such it is excellent. But Kolata, like Silver, is a child of the market, measuring "reality" in dollars.

We know we're good at technology: anything that does not affect to break what Sir Peter Medawar called "the bedrock laws of physics" must be considered do-able, given time. Control of technology is the issue for the 21st century. Silver is right to suggest that the secular arguments are inadequate. And since the deepest objections to cloning are religious in nature, perhaps the ultimate framework of control must be rooted in religion. We first need, though, to rethink what we mean by religion. But that's another story.

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(http://www.findarticles.com/cf_0/m0FQP/n4370_v127/20772472/p1/article.jhtml)

New Scientist

January 24, 1998

SECTION: Review, Pg. 41 LENGTH: 674 words

HEADLINE: Babies without sex

BYLINE: Jon Turney (Jon Turney teaches science communication at University College London. He is the author of "Frankenstein's Footsteps", to be published later this year by Yale University Press)

BODY: " Remaking Eden: Cloning and Beyond in a Brave New World" by Lee Silver, Avon Books/Weidenfeld & Nicolson, pounds 20,

YOU must have been a beautiful zygote, 'cos . . . well, because we made you that way. Lee Silver wants to get us all up-to-date on the many new ways we have of making babies, now that sex is unnecessary for human reproduction. Louise Brown, the first test-tube baby, will be 20 this year, and the technology has moved on apace.

The range of techniques already proven in humans or animals is impressively wide. Silver covers cloning, of course. But the ability to transfer cell nuclei, which made possible the creation of Dolly the sheep last year, is probably more significant. This and other laboratory tricks mean that virtually any combination of biological, social and genetic parenting is now possible.

And, Silver argues, they will all be used. Individual freedom is the American way, and that commitment, along with commercial imperatives, is likely to override any objections to particular applications. Then combine the virtuoso manipulation of embryos with our burgeoning knowledge of human genetics, and we are taking the first steps down a new evolutionary path. Unnatural selection will supplant the much slower natural variety.

This vision has been put before us increasingly often during the past few decades, but it is still striking to see the technical details being outlined as (mostly) accomplished facts. Silver, a Princeton biologist, is an excellent guide to the properties of human germ cells, and to the many procedures which prospective parents may now adopt to tip the odds in the reproductive lottery in their offspring's favour.

He is also a stimulating guide to the possible consequences of this reproductive revolution, up to a point. His basic assumption - what he sees as the rational as opposed to the emotional view - is that there is nothing special about human reproduction. That being so, there is no reason not to apply any of these technologies, provided there is no obvious harm to the individuals involved. And he is quite inventive in offering scenarios - real or imagined - in which someone feels they benefit enough to make use of every technique described, cloning included.

He is also consistently optimistic about individual outcomes. Yet he sees them adding up to a less appealing result, a class society defined by its genes. Eventually, like H. G. Wells's Eloi and Morlocks, the gene-rich and gene-poor will become separate species, unable to interbreed.

Working out the consequences of this would require a novelist of Wellsian powers, and Silver does not really try. Instead, he tops and tails the book with a much longer-term evolutionary story. It begins with a rather commonplace discussion of the origins of life, and ends with a grand, Dysonesque vision of new, genetically enhanced subspecies of our descendants spreading out through the Galaxy.

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Scotland on Sunday

February 1, 1998, Sunday

SECTION: Spectrum; Pg. 25

LENGTH: 833 words

HEADLINE: Natural optimist

BYLINE: Brian Morton

BODY: REMAKING EDEN: CLONING AND BEYOND IN A BRAVE NEW WORLD by Lee M Silver Weidenfeld & Nicolson, L 20

ONE night about a month ago, I let three sharply suited Americans into the foyer of the BBC in Edinburgh where they had a booking for a lunchtime (their time) news

bulletin. They were, they said, scientists and they had come in to talk about "Dali".

Given that Ian Gibson's biography of the great Surrealist had just been published, this seemed perfectly logical and in order. Having had a couple of quick shandies prior to the night train I felt confident enough to regale them with a few personal observations about Surrealism, the psychology of the 'paranoid-critical method' and my favourite anagram, Avida Dollars, coined by Ernst or Duchamp for the increasingly acquisitive S Dali. For a few minutes they listened with the polite smiles Americans reserve for the clinically insane before revealing that they had actually come to talk about "Dahlly the sheep".

No overseas scientific initiative since the Russian A-bomb and Sputnik has so alarmed American public opinion, especially in the South, where fundamentalist anxieties are currently buzzing. Lee M Silver's job spec - professor of molecular biology and evolutionary biology at Princeton - is one guaranteed to reinforce them. Remaking Eden describes a scientific and technological future that has already caused a furore that far outstrips the notorious Scopes 'monkey' trial in Tennessee for its clash of belief systems; it also sketches in a world as surreal, even grotesque, as anything in Dali and as potentially lucrative as anything dreamt of by Avida Dollars.

America is a country of hyper-surrealism and a country already, and for all its suspicious resistance, innately attracted to genetic manipulation. One of the examples Silver adduces is a gridiron football team of the future in which each and every position - wide receiver, quarterback, kicker - could be genetically selected. Similarly, families might choose, as in Silver's opening tableau, to have children screened for negative traits, like one cousin's obesity or another's predisposition to drink, or armed with positive ones like blonde hair and an athletic build.

Silver promptly and correctly identifies a desire to maximise the life-advantages of one's children as a perfectly natural and extremely powerful one. In doing so, he also demystifies the process of genetic engineering, pointing out that it is no more than a moral whisker distant from such nowadays readily-acceptable procedures as in vitro fertilisation or, one might go on to say, antibiotic treatment and the surgical removal of genetically-determined tumours or deformities, both of which in some way confound natural selection.

Silver looks forward to a world divided according to reproductive provenance into Naturals and the GenRich, and divided not necessarily by class and wealth, but also, arguably, by residual ethics and even religious prohibitions.

There are beliefs which deny even children the benefits of transplantation, blood transfusion and penicillin. There is, though, an even greater distance between that species of dogmatic fatalism based on faith and a deliberate decision to refuse a reliable (if it should turn out so to be) prescriptive technology which takes unborn children out of the hair-raising lottery of birth and life.

Most parents will nowadays accept some measure of antenatal testing, even if they are unprepared to take action based on unwelcome results. What constellation of fears, prejudices and beliefs would persuade prospective parents not to take action that would eliminate the treacherous genes that lead to cystic fibrosis or even alcoholism? The rub comes immediately.

Who would define what were "undesirable" traits? Or would parents also be able to predetermine respectful obedience, a dislike of rap and hip-hop music and a collateral enthusiasm for washing dishes and cleaning cars? Or heterosexuality? Silver's book is a brave and honest survey of an ethical minefield. The dedication to his parents "for creating me the old-fashioned way" might point to a profound, if latent, loyalty to nature over culture, and certainly his approach to the subject is closer to the wonder of Miranda (herself a "miracle") discovering a "brave new world" of "beauteous" and "goodly" creatures than to Huxley's dystopia.

The "Dali/Dahlly" conversation limped on for some time and grew steadily more surreal. I was told that "Gahd" had given us dominion over the animals but that didn't - and try to stay with us here - give us any right to tamper with them, or indeed to make our own. That was a "si-yun." In the face of implacable logic, or indeed illogic, always fall back on Holy Writ.

As the taxi squealed outside, I pointed out that Genesis 1 promised dominion over the fish of the sea, the birds of the air, and indeed every creeping thing. Not so much as a mention of mutton. So that's all right then.

Sunday Telegraph (London)

January 18, 1998, Sunday

SECTION: BOOKS; Pg. 07

LENGTH: 835 words

HEADLINE: Better babies for the better off Deirdre Janson-Smith on the possibilities revealed by the new reproductive technologies

BYLINE: By DEIRDRE JANSON-SMITH

BODY: Remaking Eden: Cloning and Beyond in a Brave New World by Lee M. Silver Weidenfeld & Nicolson, pounds 20, 317 pp

IMAGINE visiting a maternity ward 10 or 50 years' hence. What kind of child, what kind of parents will you visit? Parents happy that they have selected the "perfect"

embryo? A gay couple who have had their own child? A mother who has borne her clone, her identical twin? Fast-forward another 300 years - will you be celebrating the birth of a "GenRich" (gene-enriched) baby, evolved by unnatural selection via new reprogenetic technologies?

This is the Brave New World that Professor Lee Silver takes us to by the end of his opening chapter and, I have to say, it made my heart sink. Was his book just going to be a scare-story, which would shed little light on the important issues surrounding the new reproductive technologies? Thankfully, Remaking Eden turns out to be an authoritative and thought-provoking analysis by a scientist who is not only at the forefront of research in this field, but also one of the growing group of scientists who actively engage in public debate. We have great need of them.

Professor Silver presents a lucid account of recent developments in the science and technology of reproduction, taking us from the very basics - what science has to tell us about the beginnings of life - to the frontiers of reproductive experimentation. His book is enormously helpful in describing the development of techniques such as artificial insemination, IVF and cloning, and the science that underpins them.

Professor Silver's concern is not merely to inform, but to alert us all to the potential applications of what he terms "reprogenetic" technologies, which combine techniques for creating and manipulating embryos outside the human body, with other techniques for diagnosing, selecting and altering the embryo's genetic make-up. These will allow us to guide the genetic destiny of our children. And, he writes, "this is what I really fear . . . with genetic engineering it is possible that those who have money will be able to provide genetic advantages to their children and those who do not have money will not be able to use this technology".

Unlike Huxley's Brave New World, Silver's future is determined not by governments but by the power of the market. This market, he says, is driven by the instinctive biological need of individuals of our species to procreate, no matter what it takes. A powerful example is IVF. In 1978 the birth of the first "test-tube baby", Louise Brown, was greeted with considerable alarm. Today, how many of us know at least one couple who have been helped by this technique? And how many of us now find the idea so strange or abnormal? Why then, Silver suggests, should it be any different for the other technologies? As long as we yearn for our own children, we will demand whatever will help us to bear them.

Two major changes are poised to take us far beyond IVF. The first is cloning from adults - suddenly catapulted from science fiction to science fact with the arrival of Dolly the sheep in February 1997, and more recently by the alarming claims of a maverick research scientist in Chicago. The second is genetic engineering - the ability to manipulate our genetic make-up directly to eliminate or to enhance characteristics.

As Professor Silver points out, we already manipulate our genetic make-up indirectly, for example through selective abortion. It is now possible to select out the embryos with particular genes for a few major genetic diseases, such as Huntington's Disease and cystic fibrosis. But, as we identify more and more genes, the possibility of positive selection becomes a greater reality. What if we can select for height, leanness, intelligence or athleticism? What then? And what if we can add new, "better" genetic material? Should we do this? Is it ethically acceptable to do so?

Professor Silver takes us all the way down the slippery slope to the designer child, provoking us to consider "what's the problem?", "what's the harm?". He asks repeatedly if there is anything to choose between giving your children a good start genetically and helping them through careful nurturing and a good education? If not, and the market-place prevails, then genetic selection will arrive, whenever it is feasible to do so.

For me, his book is a guide to, but not a guide through the moral maze. It is immensely valuable in clarifying the science and painting possible futures, but Silver tends to limit himself to posing challenging questions about the ethical issues raised rather than providing possible answers? If I have a reservation it is that - though the issues this book deals with are vitally important - the science is not always easy to follow. A lay readership would probably be helped by additional appendices on the basics of genetics and embryology. At the very least, we need a clear guide to the voluminous endnotes.

Deirdre Janson-Smith is a science consultant at the Natural History Museum.

Sunday Times (London)

January 18, 1998, Sunday

SECTION: Features

LENGTH: 1102 words

HEADLINE: Putting all our eggs in one basket

BYLINE: Steve Connor

BODY: STEVE CONNOR reads a controversial new study which claims that human cloning and genetic enhancement will eventually become the norm.

Bokanovsky, the fictional scientist in Aldous Huxley's Brave New World who discovers how to clone humans, finds that his invention has one limitation. He can stimulate only a maximum of 96 embryos to bud off from a single fertilised egg. "Alas, we cannot bokanovskify indefinitely," says the Director. Even science fiction, it seems, has its boundaries.

The reality of cloning, however, is another matter. Nobody knows what the true limits of the new reproductive technology will be for humans, although Lee Silver, a geneticist at Princeton University and the author of Remaking Eden: Cloning and Beyond in a Brave New World (Weidenfeld Pounds 20), believes there may be none at all. Silver has voiced some of the most extravagant claims about the likely direction of human reproduction.

In the aftermath of Dolly the sheep (the first clone of an adult mammal), many scientists have been eager to ridicule suggestions that human cloning is around the corner. Pundits have said that it is unlikely in any guise, because there is no clinical need for it, because it is technically too difficult or impossible and because people will not stand for it. Silver thinks otherwise. Not only does he believe that human cloning is inevitable, he argues that it will be combined with genetic enhancement to produce a super-race of intelligent, athletic and disease-free people. He calls them the GenRich, a gene-enriched class of DNA aristocrats. The 90% of the population who cannot afford this genetic enhancement he dubs the Naturals (no prizes for guessing how they reproduce).

One repercussion of a breeding apartheid being imposed on the human population is that eventually (after many tens of thousands of years) it could lead to the development of two separate species that would be incapable of cross-breeding even if they wanted to. This scenario has not had time to come about through Darwinian evolution. But once we start tinkering with human chromosomes directly it is easy to envisage a situation in which the GenRich and the Naturals quickly diverge. One will look upon the other with as much romantic interest as a man now views a female chimpanzee.

Such a nightmare is not as outlandish as it might seem, according to Remaking Eden. The technological framework is now being put in place for the new "reprogenetics" (as he calls the amalgam of genetics and in vitro fertilisation), to change human nature forever. "We, as human beings, have tamed the fire of life. And in so doing, we have gained the power to control the destiny of our species," he writes.

In July, it will be 20 years since the birth of Louise Brown, the world's first test-tube baby. Since then, IVF has become almost routine, and hundreds of clinics around the world have acquired the skills to perform it with varying degrees of success on thousands of infertile couples. There are still some people who rail against test-tube babies, but the vast majority of the public is in favour of the technology because it so evidently helps men and women who are desperate to have a baby.

This was not always the case. When Robert Edwards and Patrick Steptoe announced that they had "created" a baby by fertilising a human egg and sperm outside a woman's body, they were met with a wave of public outrage. Newspaper editorials called for the abandonment of IVF; the Americans thought the whole idea so bizarre that they assumed nobody would ever want it. The initial condemnation, however, gave way to gradual curiosity and grudging acceptance. Now, the idea has become almost mundane.

Silver believes that the same will happen with human cloning and genetic enhancement. Nine out of every 10 people surveyed in the week following the Dolly announcement said that human cloning should be banned. Leading ethicists, scientists and politicians were quick to condemn any suggestions that the Dolly technology could be applied to humans. Even if it was technically possible, no doctor would do it: there would be no clinical need.

"That's not what science, history, or human nature suggest to me. The cloning of Dolly broke the technological barrier. There is no reason to expect that the technology couldn't be transferred to human cells," writes Silver. There are thousands of IVF scientists with the necessary skills to apply cloning to humans, and Silver has come across at least two who privately say they are prepared to do it.

Some scientists have pointed out that Dolly was the one successful lamb out of 277 attempts. They have used such a failure rate to argue that it is too inefficient for it to be applied to humans. But Silver argues that the failure rate was, in fact, far higher in the human IVF treatment that eventually led to the successful birth of Louise Brown. Steptoe and Edwards had worked on hundreds of human eggs over more than a decade to perfect IVF, and the number of embryos they had inserted into women and had failed to implant far exceeded those that had failed in the Dolly experiment.

Silver envisages other, even more frightening ideas for tinkering with human reproduction. One, called foetal mating, involves taking the immature sex cells (those that give rise to sperm and eggs) from aborted foetuses and growing them until maturity in a test-tube. These might then be fertilised to produce a viable embryo that can be implanted back into its genetic grandmother. The result would be a baby whose mother and father had never been born. Another idea is to merge the early embryos of two mothers to create a chimera, a person with a mixture of cells from both women. Human chimeras are known to come about naturally; they are caused by the fusion of two embryos resulting from the fertilisation of two eggs ovulated simultaneously by a mother. It would be relatively easy to do this experimentally, although why anyone should want to is unclear. Silver suggests that two lesbians could use chimera technology in order to produce a baby who shares the genes of both women.

Although such concepts appear abhorrent and far-fetched at the moment, they may not always remain so. Huxley made an inspired guess over the future direction

of human reproduction but, as Silver points out, he was wildly wrong about who drives the changes. Governments will not bring about cloning, it will be people, and their overwhelming desire to produce babies in their own image.

Steve Connor is the science correspondent of The Sunday Times

Financial Times (London)

March 28, 1998, Saturday

SECTION: BOOKS; Pg. 06

LENGTH: 815 words

HEADLINE: Why alien genes can run amok: Genetic engineering can seriously damage your health, argues Moyra Bremner: GENETIC ENGINEERING: DREAM OR NIGHTMARE? THE BRAVE NEW WORLD OF BAD SCIENCE AND BIG BUSINESS by Mae-Wan Ho

BODY: If timing is everything, Mae-Wan Ho's Genetic Engineering: Dream or Nightmare? has it. This month the UK National Consumer Council's report highlighted the dangers of genetically modified (GM) food, and America held the first international conference on the alarming increase in new infectious diseases. One "nightmare" in Dr. Ho's impassioned expose is that genetic engineering can foster the rise of new diseases and spread more severe, and antibiotic resistant, strains of old ones - threats which help to make genetic engineering "the biggest single danger facing mankind today".

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Apart from sharing the theme of genetics, Professor Lee Silver's Remaking Eden: Cloning and Beyond in a Brave New World could hardly be more different. Where Ho offers commitment, Silver tiptoes through the moral minefield of human reproductive science and genetics as if the Angel of Mons was guiding him.

His trick is to use science fiction to present the more controversial points. Page one, "Dateline 2010", sees Barbara nursing a newborn baby selected "from an embryo pool" to ensure that it isn't "overweight or alcoholic". But, before we warm to such benefits, Silver whisks us forward to 2350 AD, to a society split between the dominant "Gene-enriched" and the poor "Naturals". And eugenics, which - but no, that would spoil the ending.

The factual body of the book details the seemingly harmless, extraordinary, and often beneficial, steps in reproductive science which, from the first artificial insemination to Dolly the sheep, have been leading inexorably to some of the greatest moral dilemmas mankind has ever faced. And, as Silver points out, all this has consistently been deemed impossible, and therefore we are morally and legally unprepared. He offers no easy answers: simply disquieting facts about what is, and may soon be, possible in human fertility treatments and genetic engineering - facts which provoke very uncomfortable questions.

Of course, if Ho is right, few characteristics can be traced reliably to single genes, and genes are too interactive, and childhood too formative, for scientists to be able to cut out an alcoholic gene, splice in a musical one and give parents a Mozart, not a drunk. Yet will that be what people want to hear? As Silver points out, sperm banks for "superior" genes already exist and, faced with a crowded planet and rising medical costs, governments (and insurance companies) may prefer to believe that screening is infallible: pressure may grow to abort foetuses carrying even a small potential for health, or other, problems.

These thought-provoking books are worth reading in tandem. For, between them, Silver and Ho raise questions not just about genetic engineering, fertility treatment and eugenics, but even about the extent to which the law lets us own our own bodies and the cells, sperm, ovum, and embryos that stem from them: about what it is to be alive - and human.

The Sunday Star-Times (New Zealand)

February 15, 1998

SECTION: FEATURES; OPINION; Pg. 6

LENGTH: 676 words

HEADLINE: Cheating in lottery of life

BYLINE: PHILIPS Graham

BODY: IF YOU have a problem with cloning you won't want to know about Lee Silver's vision of the future. In his new book Remaking Eden the US biologist from Princeton University described how next century's parents will be making babies. Needless to say it won't involve any sex. In vitro fertilisation will be the method of choice, he says, even for fertile couples. But rather than creating just a handful of embryos, as happens with IVF these days, the 21st century version will involve putting together at least 100 eggs and sperm.

Full genetic testing will be carried out on all of them and a computer profile made showing how each potential baby would turn out. The mother picks the child she would most like to have, that embryo is implanted and nine months later she gives birth.

It's not hard to imagine what such a computer programme might look like. There would be 100 little icons, each corresponding to a fertilised egg. Click on embryo No 1 and a picture of a dark-haired, brown-eyed teenage girl pops up. She has her father's chin, mother's high cheek bones and, according to the caption underneath, will grow to between 160 and 170 centimetres tall.

Any genetic diseases such as cystic fibrosis and sickle anemia are listed. There is a whole file of possible health problems that, while not completely determined by genetics, are influenced by them. The risks are estimated for each potential child. The likelihood of developing various cancers, for example, heart disease and even bad habits such as tobacco addiction and over-drinking.

Across the 100 embryos there would be an enormous variety of vital statistics. Some would be male, some would have blonde hair, some would be tall and some short. Some would have a greater than average chance of being good at sport while others would be more likely to be musically talented. Some would have serious genetic defects, others merely predispositions to lesser health problems such as allergies.

The computer profile would even reveal likely personality traits based on the genetic information. Parents could choose between a fiery temperament or a more even one. Between a child who is likely to have good analytical abilities and one who is more creative.

When making the choice, compromise would be the name of the game as there is no such thing as a perfect child. No doubt there would be arguments and many lists of good points and bad points. Of course there are no guarantees either.

The environment the child grows up in will have an enormous influence. But the parents will at least be satisfied they've given junior the best possible start.

Lee Silver thinks something like this scenario will be up and running before halfway through next century. In fact a simplified version of it is already in operation. Some IVF mothers have had embryos tested for particular genetic conditions then chosen the one that will develop into a disease-free child.

Preimplantation Genetic Diagnosis (PGD), as it is called, raises deep ethical concerns. Like IVF today, the technology is likely to be expensive. Will only the wealthy create a class of children who are mentally and physically superior? Probably. After all, at the moment, we seem happy for the rich to give their children an extra boost with expensive private schools and large inheritances.

And is disease always that bad? A surprisingly large number of very creative people suffer manic depression, for example. Are there going to be fewer Schumanns and Edgar Allan Poes if PGD allows this mental disorder to be avoided? Maybe, but how many parents would choose to have a child suffering such a sickness on the off chance it may lead to genius.

The trouble with reproductive technology is that there are also deep ethical problems with not using it. If a parent has a choice between bringing a child into the world who is predisposed to cancer and one who's not, is it right to play Russian Roulette and not to deliberately choose the healthy one?

I think Lee Silver's future is certain to happen.

Designer genes and legal briefs

Remaking Eden: Cloning and Beyond in a Brave New World
by Lee M. Silver
Avon/Weidenfeld and Nicolson: 1998. Pp. 315. $25, £20

John Cairns


KOBAL

Nice body work: products of engineering as foreseen in the film *Brave New World*.

In the nineteenth century, most of what was going on in the sciences was accessible to the whole of the reading public. George Eliot, it is said, was engrossed in the proofs of Darwin's *Origin of Species* on the day it was published; and doctors in the United States had built their own X-ray machines for the treatment of breast cancer within a few months of reading about Röntgen's discovery of X-rays. During the past century, however, science has become so weighed down with facts that most of us can understand it only through the use of some kind of intermediary.

At the same time, science has become increasingly important. Political changes dominated the nineteenth century; science promises to dominate the twenty-first. Because democracy has proved to be, in the long run, the safest political system, it is very important that everyone, not just an intellectual élite, should have access to reliable guides to the science underlying what is happening to the human condition.

Nowhere is this more important than in the matter of genetic engineering, where opportunities for irreversible mischief seem almost limitless. So it is a great pleasure to report that Lee M. Silver's book about the genetic engineering of humans is very good indeed. He has first-hand knowledge of his subject and writes clearly and skilfully. His book covers the ways in which we are now able, or may soon be able, to decide the genetic constitution of our children. The description is in the form of a series of little family histories, some real, some imaginary. Each serves to introduce some particular technology and is accompanied by an account of the relevant sector of molecular biology or developmental genetics.

Some of the problems have already come to light. For example, what should be done with frozen embryos if both parents are killed in an accident? Is it right for a woman to decide to have a second child so that it can provide the marrow transplant that may save the life of a first child who is dying of leukaemia?

Other problems are just around the corner. Should a woman be allowed to bear a daughter who is a clone of herself (and, I might add, if the woman later dies, should her widower be allowed to marry the clone on the grounds that he is, in effect, remarrying his wife)?

Some of the case histories discussed by Silver promise to be as divisive as the issue of abortion. He seems particularly worried that genetic manipulation may eventually be able to offer general benefits, such as increased intelligence and resistance to disease. Because of the expense, these benefits will be available only to the rich, and he fears that, after many generations of manipulation, the human population may find itself divided into two distinct species (he calls them 'GeneRich' and 'Naturals') that cannot interbreed. Of course, the separation into rich and poor has been with us since the beginning of civilization, but has been partly relieved by a steady flow between the two groups owing to the fluctuation in people's fortunes. A division based on artificially enhanced intelligence might be far more destructive. (I understood that the British Labour Party, when it came to power after the Second World War, decided to leave untouched the so-called public schools because it felt that an oligarchy based on wealth was bound to be less entrenched than one created by extra education for the cleverest children.)

The book deserves to be widely read, not least because it gives such a lucid account of the science. But I am less worried than Silver about the genetic engineering of humans. Far more important, I think, is the danger if we come to rely exclusively on highly engineered crops, and the danger posed by new microorganisms that terrorists can now design using equipment as compact as the apparatus of the nineteenth-century physicist that could have been brought in by his butler, on a tray. Surely, if there is a forbidden apple in the new Eden, it is most likely to be found in the genetics of plants or microbes.

I hope that Silver will now look at these other fruits of genetic engineering. In some ways they are harder subjects because they do not concern simply the morality and legality of what can be done. But they are a more likely way for mankind to get into trouble than just by meddling with the genes of some of the richer members of the richer nations. □

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Spin doctors

Paul Dirac: The Man and his Work
edited by Peter Goddard
Cambridge University Press: 1998. Pp. 124. £12.95, $19.95

The Story of Spin
by Sin-itiro Tomonaga, translated by Takeshi Oka
University of Chicago Press: 1997. Pp. 258. $50, £39.95

Ian Aitchison

On the left, leaning elegantly backwards at an angle of 30 degrees to the vertical (but supported by solid stonework), head attentively inclined, is the slighter and older figure; on the right, vertically framing the space left by his listener's tilt, hands persuasively moulding the shape of the argument, is the handsome younger one. The old master and the young; the old world and the new; it is (as the caption says) "Dirac and Feynman discussing Physics".

The photograph, one of my favourite