Never in the history of the human race has science given us so much power to alter our destiny. The genetic revolution allows us to create life and food to our own design and even to alter the nature of human beings. Gene technology can cure disease and help feed the world and is accelerating faster than most people understand. (text of article for Economic Times India November 2000).

In the last two years alone, over a million mutant animals have been artificially created in British laboratories alone, each of which is a strange mix of the genes of two or more different species. Sheep with human genes, fish with mouse and human genes, pigs with sheep genes and so the list goes on. It all works relatively easily because all life uses exactly the same "computer language" in its cells. So genes from one species function in another.

Sometimes the results are obvious and hugely beneficial. For example, in the early 1980s, scientists found the gene for human insulin, and inserted it into common bacteria, which learned how to make it. Brewing human insulin is in a way as simple as brewing beer. Just add water and food and these bugs will go on producing perfect human insulin forever. The result is good news for people with diabetes. A huge industrial complex costing 10 billion dollars has been shrunk to the size of a single cell.

However, such success stories so far have been rare, and most are just bizarre. Take for example the goat and spider mix - which created a goat that makes spider web in its milk. If you collect the web and spin it you can perhaps create a new material for surgeons to use in sewing up wounds. Often there are also issues of safety as in the case of a new cabbage created by adding scorpion poison genes. The cabbages kill caterpillars but what about the people? Nobody knows because no company dares to do the testing.

Then there is the global race to produce the world's first human clone. The human cloning debate is at the heart of the reaction in many countries against gene technology. Expect to see the first human cloned baby in the next three years. If you don't see it, assume the reason is that it has been born, as with so many cloned animals, with such gross malformations that the creators fear to talk about it.

A secret human cloning laboratory run by Clonaid is said to be based in the Nevada desert, with the first human cloned baby expected by them to be born in 2001 with the first embryo transfers

very soon. The plan is that the human cloning experiment will produce a replacement copy of a 10 month old girl who died last year. Clonaid says five British couples, including two pairs of homosexual men have asked to be cloned. The technique is becoming routine in animals: take an egg and remove the genes. Place an adult skin cell next to it and fire a spark of electricity. The two become one and the egg starts to divide, developing into the adult's identical twin.

Clonaid is registered in the Bahamas and was founded by the Raelian movement who claim more than 50,000 members in 85 countries. They believe that humans are all cloned from alien scientists who visited earth. More than 50 surrogate mothers have been selected to carry the human cloned foetuses throughout pregnancy. America has no laws preventing human cloning research, although no public funding is available. The work continues despite huge concerns in most countries of the world.

Human cloning is often justified as a (very) expensive treatment for infertility, but has huge risks. In addition to the danger of malformation and other defects there are great emotional hazards. A daughter grows up and one day looks at her mother and realises she is actually looking at her twin sister, that her "father" is really her brother in law and that her "grandparents" are her biological parents. What does that do to a child? People tell me they want to replace a dead child - but what does it do to the new twin, knowing in later life that he or she was only created as a replacement, not because valued in his or her own right?

Other scientists want to make the clones but not implant them, using them as experimental material to get embryonic stem cells. These cells can be triggered to develop into tissue such as nerve or heart cells but cannot be used to develop whole organs. To do that you would need to clone a whole human being and then cull it for spares - a horrific thought - but one already being pursued in cases where, say, bone marrow is removed after birth, allowing the donor to carry on living.

New research shows that stem cells from adults also have the potential to grow a wide variety of replacement tissues so the argument that we need to allow cloning for so-called therapeutic purposes is already becoming out of date.

Then there is the urgent issue of genetically modified food. Here companies have created crops which are immune to their own poisons. Farmers then have to buy not only the seed each year (many of these crops do not breed true) but also the weed killer. A powerful business model but what does it do for the environment? These weed killers can wipe out every other life form

across large areas, killing not only every wild flower but also the insect population that depends on them. Next to go are the birds and small mammals that depend on this food chain for food.

GM crops themselves can be toxic to wild-life - which is hardly surprising since some are created to grow their own fungicides or insecticides in the sap of the plant. They are billed as the ultimate green crops since no artificial sprays are needed. The reality however can be different. The Monarch butterfly is a splendid insect, and a state emblem for Texas, but has been shown to be killed by pollen from GM Maize according to a recent study published in Nature.

Pollen from GM crops is blown by the wind or carried by creatures from one field to another so these new genes can spread in a way impossible to control fully. In parts of the US and Britain it is already becoming difficult for "organic" farmers to ensure their own crops are uncontaminated. Genetic spread cannot be undone. What would happen if GM salmon were accidentally released into the sea - made with human and mouse genes and growing to four times normal size in a year? How can you contain such an event? How can you sure it will not affect the balance of life in the oceans in fifty years time?

Matters have been made far worse for those worried about GM grain risks because American farmers and grain merchants have deliberately mixed GM crops and natural crops in the same silos. After recent GM food scares in Britain many food manufacturers wanted to boycott GM grain but found the mixing created big problems. Food manufacturers will certainly have some interesting new products to sell: perhaps a banana that contains a low dose anti-malarial, or a tomato with enriched vitamins.

Seed producers have tried to justify the creation of new crops by telling us that they will solve the world food shortage. They promise crops able to resist pests and drought, and able to survive in salinated soils damaged by over-irrigation. But we must remember they are speaking as businesses. They did not help their cause by inserting "terminator" genes into the first generation of crops. That meant that low income farmers would have had to go back every year to buy more grain because their harvest was sterile.

The greatest steps forward in medicine over the next decade are likely to come from genetics. As we continue to match genes with disease patterns we will be able to make ever more accurate forecasts about an individual's health, which will allow prevention and earlier diagnosis. In practice it may also encourage yet more parents to abort a foetus because they

are worried about its genes. This has started already with sex selection, and also with some diseases but where will it stop? Parents in future may be able to look for genes which are linked with the chance of higher than normal intelligence, aborting all who don't have them.

Gene technology will allow "magic bullets" to hunt and destroy cancer cells by detecting bad genes. It will allow correction within five to ten years of gene defects such as cystic fibrosis, where an inhaled spray will be used to reprogramme the lining of the lung.

Gene technology will also be used to produce new generations of complex drugs at low cost, as well as vaccines for diseases like malaria, and perhaps one day an effective treatment or vaccine for AIDS, perhaps the greatest medium term health threat to India's future.

There is no doubt that the genetic revolution will present us with the greatest moral questions in human history. Take the humanised monkey: how many human genes does a monkey have to have to win human rights? Since monkeys differ only 3% in their genes the answer is that if the right 1.6% of human genes are added, it is likely the courts would recognise that the creature was more human than animal. Thus gene technology strikes to the very heart of our humanity, raising not only philosophical and moral questions but also spiritual ones. Is it right to add human genes to a cow? How many?

In conclusion, we urgently need gene technology - to fight disease and feed the world, but we do need to proceed carefully, and to ask what kind of world we want to live in, now we have the ability to change the very basis of life itself.

* Dr Patrick Dixon is a futurist, a physician, an international lecturer on global trends and director of Global Change Ltd. http://www.globalchange.com