

IN DEFENSE OF BIOTECH OPTIMISM

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Encouraged by my on-going affiliation with the Foundation for the Future, and prompted by the visionary 1000-year perspectives of Walter Kistler and Robert Citron, I undertook to speculate what new economic eras might hallmark this millennium. Among the five economic eras foreseen, one stands out – the Life Sciences or Biotech Era. An early paper describing some developments of that epochal era was the subject of my article published in the February 2002 issue of the Journal of Futures Studies. The editors invited commentaries on that article and asked for this response to them. Responding to them deserves responding to every point raised. Space limitations prevent such an exhaustive effort. I thank each of the contributors for their constructive responses. I will strive to address them in terms of general assertions and refinements.

My article described major milestones – tangible and measurable ones. It strove to be objective, rational, scientific, and based on fact -- “let the chips fall where they may.” My intent was to reveal where biotech has been and where it’s headed. My intent was to demonstrate how far biotech has advanced. I did not attempt to resolve the philosophical, theoretical and spiritual dimensions raised by these biotech change. Victor Hugo adeptly observed that “No army can stop an idea whose time has come.”

My approach is the upbeat, the positive, the optimistic one. I stick to that position. And, in response to comments put forward by other writers, I will add some additional explanations, further defend my own viewpoint, submit corrections and elaborations, and update quantitative data that already has been obsoleted in the swift forward movement of biotech change.

HISTORICAL PERSPECTIVE

Recounting milestone developments -- including facts, figures and dates – rankled one commentator to condemn the approach as “stagnant.” Where one sees a stagnant account, I see a compelling recount of historic milestones. Taken together the trendline of these developments not only reveal but also help to corroborate conclusions. Individuals who deeply immerse themselves in replete history of topics appreciate the significance of what is (and what isn’t) presented. What is past is prologue.

The reality of actual and real-world developments can be dismissed, denied and derided. Those assaults do not change the physical facts and reality of what has actually been demonstrated or implemented.

The longer the timescale of the baseline used to assess humanity, the more linear and incremental the trendline becomes. Society involves an accretion of accomplishments that continue to improve. Settling for second-best usually is merely a temporary waystation. Historical evolution is not a steady state. Things don’t stand still. The process, by its very nature, is dynamic.

Past, present and prospective possibilities provide powerful perspectives of what’s coming. Dealing in “snippets of time” and ignoring past chronicles is a formula for faulty projections or failure. History is a bore to many. For me, it provides all the answers.

TRENDLINE CONTINUITY

All things considered, the self-same set of some 40 generic constructs comprising the human condition and makeup of civilization – health, transport, communication, and so on – have remained fundamentally the same over the four million years hominids and their successors (us) have been around. Each generation continuously finds new and better ways, more efficient and more economic ways of accomplishing the same phenomena. What changes is the manner used to accomplish them.

Progression -- the march of progress -- simply involves “going one step better.” Human ingenuity, over time, makes incremental improvements and the timeline of any civilization are pieces of the same bolt of

cloth. That is the main point I want to get across. Perspective and realms of the possible are my avowed goals in provocative forecasts.

One terse paragraph describing human morphological changes of growing older, taller, heavier, and smarter is based on preliminary research involving thousands of data points. Entire books could be written on any one of those four anatomical changes. Projections are premised upon data sets spanning over 4 million years. Projecting those trendlines to 3000 AD are brash. They may be wrong. But the point of amassing the data sets and seeing where the trendline is headed is what's important. It's not the 6 foot-two inches in height nor the 180-210 pound body weight that matters. The approach used provides a rational basis upon which these changes can be premised. Without having conducted the painstaking research that went into those projections, casual readers would never have a glimmer of how complex and how complete (incomplete?) the foundation relied upon to reach those surmises was.

VERY LONG RANGE FORECASTING

Long range forecasts may seem foolhardy. They may be. Despite inevitable inaccuracies, these efforts are meant to set out some plausible aspects of the dimensions defining human destinies. Here and there, I strive to throw in short term realities that provide some reassurances that support both understanding and believability. Mentioning some immediate practical results of taller, heavier, bigger girth in my article is interjected for that purpose. Bigger chair sizes, overstuffing, already adopted by suppliers of furniture. Those responses indicate the kind of changes suppliers of human needs and wants must cope with in the here and now – with more yet to come.

Most every generation confronts problems as if nobody anywhere else had ever encountered them. In one sense that is right. Nothing remains the same. There is a tendency to think of genetics as something new and novel, it isn't. Modern history of genetics traces back centuries. The overall perspective framework for biotech involves evolution from the very beginning of lifeforms billions of years ago.

VALUE OF COUNTERVAILING VIEWPOINTS

Constructive criticism plays an important role in subduing over-zealous pursuits. Continuums of outlook and perspectives are part of the process of deliberating virtually any topic or concept. Nearly always there is a spectrum of opinion with which to contend. Viewpoints vary. One person's vital interest is a vexatious bane to another.

The critique in this set of biotech articles provides a framework for considering the pros and cons. This dialogue helps define guiding principles for assessing cost-benefit and risk analysis.

The clamor of most any interest group or sphere of influence plays an important role in maintaining balance. That's the key point. Extremes on either side of questions usually lead to a "balanced" position. Minority views, as one reviewer commented, leaven the loaf. Another critique stresses the importance of multi-disciplinary inputs to reach balanced judgments. Well said. Other comments got it exactly right when they underscored the importance of interdisciplinary interpretation of event fields.

Fortunately – or unfortunately, depending on one's perspective -- the delay in developing and moving new biotech drugs to market is a long and protracted process. An average of 14 years intercedes. This lead-lag provides plenty of time for informed dialogue. Expert regulatory officials and their associates provide a serious and sustained spirit of such inquiries. Voices of the concerned add to and temper runaway technocratic decision making.

OPTIMISM VERSUS PESSIMISM

Biotech can be characterized as the worst or the best thing afoot. It depends on viewpoint and perspective. Both views are part of the process of sizing up the new and novel.

Pessimists see limits. Optimists foresee limitlessness. I foresee biotech presenting an eternity of enormous promise. Hope, not despair, is my predisposition. I anticipate better and better conditions for humanity, not a descent into decadence, dystrophy and decay.

When it comes to being upbeat, I may rank among the penultimate optimists. My conclusions are based on more than dogmatic “rhetoric,” as charged by one commentator. Trend tracings are tracked by things past, present and prospective. These timelines provide a sense of the momentum and timing of on-going change.

Doomsday worries and fretting have stifled and stymied the introduction of new technologies throughout the course of history. Supposed experts, like Robert Thomas Malthus, have been proven wrong, time and again. Despite nearly two centuries of being shown wrong, Malthus’ clarion call still appeals to pessimists. Doomsday models of humanity’s scrapes with survival – imagined or real -- abound. Repeat a stereotype or cliché often and long enough and individuals may take things for granted. I vehemently disagree with Malthus, the Club of Rome, and all other gloom and doom peddlers.

Deep ecologists, incidentally, have been around for a very long time. Deforestation and overgrazing leading to soil erosion was assailed by Plato (c. 400 BC). Traffic congestion, dust and noise caused by chariots and carts in Rome led to forbidding use during daylight hours by Julius Caesar (45 BC). Parking chariots along processional ways was punishable by death in Assyria (c. 400 BC). The list could go on. Stewardship of nature’s resources is important. One thing for certain, it isn’t anything new, nor is it likely to lead to doom as some catastrophists contend.

Although I have not carefully studied any of the doomsday models recently, I would be amazed to find that adjustments for extraordinary productivity gains made possible by agbiotech are fully considered. Modest yield increases may be factored in. Agbiotech has the potential to boost food output tens of thousands times traditional production. I wouldn’t expect any model makers to consider yield boosts of a thousand-fold, let alone 54,000X! Yes, a recently developed sweetener has been discovered that is 54,000X sweeter than sucrose (table sugar). Such a highly potent sweetener could displace millions of acres now devoted to sugar cane and beets, corn, and other starch-based stock (such as potatoes) now used in producing sweeteners. It all comes down to doing more with less. Model makers may assail and ridicule my ambitious anticipations of what agbiotech is capable of doing. Bracketing a range of low, mid- and high estimates would help. Models, after all, are only so good as the factors used in making projections. There’s every good reason to challenge underlying assumptions that go into them.

Pessimism slows forging ahead. Optimism is a penchant for plunging ahead. Opposing or differing viewpoints help to fashion a consensus. Over time, balanced considerations are struck. The give and take of these confrontations is part of the process of progress. Several of the comments address this aspect and recognize the need for finding “balance.”

Pessimists typically intrude mere intermittent anomalies or aberrations in change trendlines. Occasional bursts of despair and downturn do occur in the course of human affairs. But they never create an all-consuming vortex of permanent decline. Long-term perspectives involve eternal upgrading. The course is onward and upward – not down into the depths of disaster and despair.

Collapse, when it does occur tends to be fleeting in the measure of time. Systems respond by readjusting and rebounding. The hallmark of humanity is to try and try again. Like the mythical Phoenix that arises anew from the ashes of destruction, humanity’s march toward a better tomorrow is unremitting.

Doomsayers do perform a most useful role – sounding the clarion call. Disaster breeds corrective responses. Problems are cured. Humanity forges ahead. That’s the way I see it.

It’s easy to curse the wind, but it does little good. It’s equally easy to sit back in our armchairs and recount why things shouldn’t happen; why further advance should be hindered, not helped; why we should hold off, not plunge ahead. For biotech, the genie is out of the bottle. It’s high time to figure out the best ways to accommodate this new wave of technology.

ROLE OF ECONOMIC EQUALITY AND FAIRNESS/EQUITY

Maldistribution concerns – of any and every kind – permeate the commentaries. The points are well taken. Individuals espousing this view are impatient to get on with providing more for less fortunates. Having taught social ethics for many years, I could easily write volumes in response to the scores of issues raised. Since time immemorial, questions of equity, fairness and justice have been contemplated. Debating wealth of the few is not the object of my paper. I leave the task of examining age-old ethical, moral, philosophical, spiritual and other abstract concepts to others better versed to pursue those complexities and conclusions.

Leading edge – and usually costly technologies – invariably are assailed for leaving the poor behind. Disparities involving have and have-nots will prevail. Equality is an elusive goal. Re-distribution efforts can -- and do -- help. Compassion leads to hopes that everybody gets and enjoys the fruits and benefits of the best of everything. That, of course, will never happen. Not everybody will enjoy a Beverly Hills mansion or an English castle. Nor will everyone be able to obtain services of the world's leading brain surgeon. Differences prevail. They always will. I appreciate that this sounds callous. Spreading ideas and benefits around takes time. Nothing ever happens in lock step. While there may be some 200 countries worldwide, only a tiny few are making the most of what they have or are capable of doing. The bigger and nagging question is why?

Over time – and it may take a long period of time – benefits will become available to most everybody. I hasten to add, that by the end of this millennium I foresee utopian abundance with nobody getting left behind. Time will correct most ageless questions. All in good time.

LEAVING NATURE ALONE?

Pleas for “returning to nature,” yearnings for “the good old days” and for “simpler times” are throwbacks to nostalgia. Nostalgia is a beguiling inducement. The fact is that the world and all its myriad aspects constantly change. Nothing remains static.

Nature isn't my enemy. Nature is my envy. My awe of its ordered arrangements that makes “things” happen is inspiring. But nature is not to be left alone and untouched. Humans over tens of thousands of years have learned to use (exploit) it to further their condition. That pursuit will never end.

Initially assessing nature's bounties by innate human senses, capabilities for probing and harnessing its benefits now delve into manipulating genes and sub-atomic particles. Though some commentators criticized reductionism – essentially breaking things down into their elemental basics – it is simply one way of considering what's involved. One commentator doted on retaining “nature” in its unsullied state. Scientific minded and practical minded generally see the situation differently. After all, biotech developments represent little more than what humans have been doing from their very emergence.

Humans could – but don't – take nature as we find it. We find a way to best utilize it for advancing the human condition. It's always been that way. It always will be. Biotech advances are little more than tweaking and coaxing a bit more from nature's stock and storehouse.

ANTI-TECHNOLOGY STANCE

One commentator assails the viewpoints expressed in my article for “techno-determinism,” “technophilia,” “bio-utopian,” and “bio-mania.” I plead *mea culpa*! Based on decades of research and 4 million years of hominid-human development, I ascribe innovation – technological and social -- as the pivotal determinants of human progress.

Frankly, I was surprised that little was mentioned about my assertion that genetic manipulation to create “designer babies” and clones -- organic lifeforms -- is only one-half the story. The other half deals with abilities to deconstruct and reconstruct inorganic matter to specification – “designer materials.” Advances in particle physics and quantum mechanics open the way for manipulating inorganic materials in similar manner to capabilities being developed to manipulate lifeforms to human will. Taken together these developments mean that humans are on the verge of controlling animate as well as inanimate, organic as well and inorganic matter. This means the ability to control reality -- of Being and Matter!

The enormity of these controls is awesome. Designer Being and Designer Materials involves the capacity to transform ostensible reality as we are able to sense it. As these technological capabilities come together, humans will be in control of Creation.

ECONOMIC GROWTH

Commentary castigating “never-ending economic growth” as objectionable runs contrary to my notions. The key to sustainable growth is centered upon jobs and economic livelihoods that provide the wherewithal for humans to make their keep and get along. Economic growth is driven by jobs. Attracted to job sites, population centers emerge. Housing then becomes a fundamental necessity, and once settlements are established a whole new skein of services and amenities emerge – utilities, roadways, healthcare facilities, schools, museums, and on and on. I maintain that jobs, livelihoods and economic wherewithal are the rock-bottom imperatives upon which humanity and civilization depend.

TOPICS SUITED TO “GRANDER” INQUIRIES

Targets of complaint dredged up by one commentator included virtually every shibboleth and scapegoat controversial in recent times: the US, Americans, capitalism, Wall Street, wealth, big business, Western society, globalization, colonialism, modernity, materialism, corporate opportunism, science-technology, patents, progressives, “third world debt slavery,” military industrial complex, “high finance and development,” “global treadmill of production,” mechanistic mindsets. These targets are derided for exploiting everything else. It’s a long and dreary list of time-worn concerns, many of them lingering on. This is a litany of complaints that obsess these times.

Achievement, change and progress always has its critics. The enormously wide gulf in East/West, poor/rich, have/have-not situations grips global cross currents to the point of war and mayhem at this very moment. Time, hopefully, will heal all. I don’t hold bio-tech responsible for all or any of these situations.

The importance of this litany of complaints and concerns is not to be denied. At bottom are roots of the rancor that rips apart and divides the current world confrontations. Some month’s back, Sohail Inayatullah’s marvelous coverage of Sarkar’s philosophical outlooks (*Situating Sarkar: Tantra Macrohistory & Alternative Futures*) plunged me into reconsidering “Western arrogance.” Events of the September 11th Twin Towers devastation goaded that pursuit. There’s a lot to be learned. I wish I had some answers.

AGBIOTECH ADVANCES – RACING AHEAD OR PUTTING THINGS ON HOLD

During Colonial days 90-95 percent of the workforce was engaged in food, fiber, forestry and fishery (agribusiness) undertakings. Currently about 1 percent of the US workforce is engaged in farming. So prodigious are production efficiencies that taxpayers actually have paid farmers not to grow crops. Today, over 50 percent of some major crops are exported. In addition, Americans consume 10-20 percent more calories than needed rendering 60 percent of adults obese or overweight. Furthermore, eating high on the food chain – lots of meat and dairy products – diverts basic grains to forage. As much as 12-20 pounds of grain may be required to yield one pound of meat. Beyond this, huge quantities of food are thrown away by consumers. Finally, pests and insects waste as much as 10-20 percent of some crops, most of which could be prevented. Considering that agbiotech can easily boost production 10-100, even 1,000-fold over traditional levels, as the saying goes: “You ain’t seen anything yet.” Obviously, there’s plenty of room to cut back farm production – at least in post-industrial economies like the US.

Think about what has just been stated here: it means that hardly any workers will be required to tend farms! Similar productive efficiencies eventually will grip other economic sectors. As they do, jobs will become highly coveted – just to relieve the monotony of not working or, perhaps, to provide a sense of accomplishment.

Global biotech hinges on outcome of the “Frankenfoods” fracas. European Union countries, along with other some other nations outlaw or otherwise discourage agbiotech. The US and other important food producing nations promote genetically-modified (GM) foodstuffs. EU intransigence gives US producers a 10-year lead and advantage. Ability to feed a growing global population hangs in the balance. My

conclusion would be “get on with it.” Saving lives and minimizing suffering hangs in the balance. Time will tell.

IMPORTANCE OF TIMING

For business, timing is crucial. Responding too soon, and although praiseworthy new innovations may be developed, financial disaster often follows. Anticipating things happening fast, hundreds of biotech startups and ventures have gone sour, and venture capitalism has shrunk. Responding too late allows others to lead the pack and gaining a major presence is unlikely.

My projection that the Life Sciences/Biotech Era becomes the major source of jobs and revenues by 2100 AD may seem too far off. Hurly-burly developments leading up to that point makes the onrush seem imminent. It isn't.

Over the past decade dates projecting biotech dominance as early as 2010 or 2020 have been suggested. *The Coming Biotech Age*, written by Richard Oliver and published in 2000 asserts: “By the middle of the 21st century, all companies will be biotech companies.” Perhaps. Business antagonist, Jeremy Rifkin's book published two years earlier – *The Biotech Century* – termed the forthcoming century a new era. A bit premature. Many other books hype onset of the new biotech era: *Century of the Gene*, published in 2000; *Biotechnology: A New Industrial Revolution*, published in 1984. Developments involving fundamental changes take time.

WHO WILL DEVELOP THE NEW TECHNOLOGIES?

Somebody has got to develop new possibilities – here and now. Who pays for these developmental activities? Taxpayers? Rarely, except for seed R&D efforts. Nobody? If so, next to nothing happens. With rare exception, new ideas are developed by risk takers who expect to be rewarded. Without reward, incentive to carry on ceases. Stakeholders in business who risked huge financial resources and major efforts to bring new wonder drugs to fruition, need to justify investments. Although questioned by at least one commentator, there is nothing illegal and little that is immoral in conferring intellectual property rights or patents on risk takers. Without this enterprises will become bankrupt and be forced out of business. Good intentions and noble efforts to give everything away will undercut chances for further efforts. Sometimes the rewards are exorbitant. For the most part, the efforts dissipate in clouds of despair and failure. Bear in mind for every 5,000-10,000 potential new drugs screened for development only one succeeds in being approved by regulatory authorities. From start to finish 14.1 years are invested in bringing a new drug to market -- at an average cost of \$802 million. If merely 1 of 10,000 potential drugs succeeds, the return should be hefty, not parsimonious.

There's an old saying, “Be not the first by whom the new is tried.” In other words, let somebody else bear the burden of proving and demonstrating the validity of a particular idea or technology. Wait and see attitudes are fine – so long as those sticking their necks out can afford to do so. Note that leaving the task to others to prove is not equitable. Such an approach is selfish.

IMPORTANCE OF TECHNOLOGICAL INNOVATION

The Grand Lesson of studying history involves “progress.” Human activities – hard and soft sciences alike – involve a continuing incremental developmental trend. Simply stated, new and improved ways of doing things are realized and implemented.

A few words about my findings being characterized as “inevitable.” Nothing is absolutely inevitable. I never asserted inevitability in my article. If I implied it, I didn't mean to do so. Fatalistic outcomes seldom make sense. I do ascribe, however, to a very strong sense of determinism. The force and effect of long and cumulative timelines of benchmark achievements and developments provide important clues as to what is likely to happen in the future. The longer the trendline and the more complete the data points logged, the stronger the sense of momentum and timing that can be gleaned.

There are, of course, certain kinds of physical phenomena that are inescapable – collisions with extraterrestrial bodies, dying out of earth's sun, volcanic activity, warming-cooling cycles, and so on. Timing for many of these events and inevitabilities can easily run into billions of years. Not to worry.

SCIENCE FICTION ROLE AND SELF-FULFILLING PROPHECIES

One commentator, famous for her science fiction writing, poses fascinating scenarios for what the biotech revolution holds. Science fiction conjures up plausible developments that set minds moving toward realizing them – self-fulfilling prophecies. What human minds can conceive, within the realm of physical laws and constraints – can be accomplished.

While we may poke fun at cloning God, science fiction stories have been written that involve taking artifacts of Jesus or Buddha, cloning him, and placing him as a “star” attraction in a theme park. Bringing Jurassic Park one step closer to reality, adventuresome types are prospecting for frozen woolly mammoths for the purpose of taking cells and cloning the beasts!

Consider capabilities for creating Star Trek replicators. Dot matrix type printers already have been used to build up layer upon layer of genetic materials to construct human tissue! It wouldn't be such a great jump to accomplish that feat at long-distance using a computer signal to trigger response by an appropriately primed photocopier/replicator.

Even closer to reality is the genetic boosting of brainpower. The famous genetically enhanced “Harvard mouse” demonstrated such potentials. Scores of other brain-boosting genetic tinkering is underway.

Indulge me here in one more flight of fancy. Consider the possibility of “human (dwarf) bowling” and the possibility of developing humans with the capability to “ball-up” like some insects. Science fiction can, and sometimes does become reality. Fortunately, not in every instance.

POPULATION GROWTH OR STABILIZATION?

Popular demographic notions capture rapt attention of futurists. After all, demography is destiny. Based on billions of actual cases, sound surmise about human longevity can be made. UN and other demographic data sets strive to cover a range of possibilities by arraying low, mid and high level projections. Well and good.

Traditional demographic projections foresee population leveling off as further growth comes to a screeching halt. That's a comfortable projection. It squares with Malthus, Club of Rome enthusiasts and others. While traditional demographers easily pierce the veil of tomorrow something less than 100 years into the future, I strive to break the mould by prognosticating ten times that dimension in time – a full 1,000 years on into the future. Lots can happen in such a long time span.

My belief, although premature at this point in my research for *The Chronology of Civilization* (forthcoming book I have been working on over the past five years), projects great increases in population. Though my projections may be off the mark, that is not the point. The intent is to stimulate fresh thinking. Doubtless, the biotech revolution will contribute to change in ways never imagined that will enable Earth's bounties to sustain far greater numbers of inhabitants.

Earth's carrying capacity may best be summed up by one of those quotes a person's favorite author instills in your memory. For me it was a few sentences from a book written by R. Buckminster Fuller, *Utopia or Oblivion: the Prospects for Humanity* (1969): “Man is physically miniscule and lives in scattered patches covering less than 5% of the earth's surface. As of 1965 – and despite all the hullabaloo about world population explosion – all of humanity could be brought indoors in the buildings of greater New York City – each with as much floor room as at a cocktail party. All of the cities of our planet cover sum-totally less than 1% of the earth's surface.” I've never let loose of that stunning observation.

Suggestive of the potential for accommodating big population increases involved comparing densities in Monaco -- now standing at 45,333 persons per square mile (2001) – with lower densities in places like the US – now numbering 77 persons per square mile (2001). Compare this to Australia with a population density of 6 persons per square mile.

In my initial article I should have gone on and cited what Monaco, comprising about one square mile of territory has accomplished: 33rd rank for GDP per capita, and 8th rank for life expectancy among all nations. Compare this to Tuvalu, a slightly larger country with 10 square miles, ranking 162nd in GDP per capita, and 127th in life expectancy. These comparisons may be unfair but they do highlight enormous differences that exist. How can Monaco prosper by these measures when other nations of similar size fare so poorly? There are plenty of answers. The purpose here is to highlight one fact: “It all depends on what one does with what they have.”

SPIRIT OF INTELLECTUAL DEBATE AND DISCUSSION

Intellectual discourse often seizes upon words and semantics to belabor and challenge. These diversions may or may not be helpful. They are, of course, an integral part of resolving controversy. Terms such as “bio-factories” – using animals/lifeforms to express bio-products – may conjure up provocative notions of “dark satanic mills” of exploitive early industrial enterprise in some. Not everybody is affected that way.

Advocates on one side or the other strive to coin words and evoke phrases that rile, rankle emotions, and get people worked up about something. I am guilty, as charged, of that approach in my writing. But, I hasten to add, so are opposing/differing comments that evoke similar response. Truth be known, we all are victims of our own biases. Hard as we may try to be objective, our conclusions are always (perhaps inescapably) ensnared by our own conditioning and biases.

Although the mete and measure of verbiage arrayed here may run hot and cold, none of it is tendered in anger but rather in the spirit of inquiry. I’ve stated my case, I’ve benefited from the constructive comments (as well as the stinging rebukes). I’ll submit to similar dialogue any time.

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Note: Sources relied upon by the author are far too numerous to specify. The author reads, clips and files material from 50 different magazines and newsletters. Research materials in this form – tens of thousands of individual clippings and articles on biotech alone – provide the source material for my on-going writing on this topic.

NOT USED.....Privacy matters involving genetics are awesome. Numerous books have been written on aspects of this important dimension of the biotech revolution. One comment doubted that privacy protections in Iceland's population profiling were sufficient. The strenuous efforts entailed to maintain individual privacy provide a strong foundation for others: initial permission required to gather personal information, cryptologic coding of obtained data, and stiff criminal penalties for violations.

Pharmacogenomics involving the ability to individually create drugs precisely fitted to a specific patient was simply mentioned in the article. Left unsaid was the fact that _____ patients die each year because of adverse complications. The immense blessing of avoiding unnecessary suffering and death that this one aspect of what genetic technologies can deliver is difficult to express. Tens of thousands of deaths amount to an interesting statistic, one death is a human tragedy beyond description.

Another surprise was that no comments focused on nanotechnological applications and developments that augment bio-tech interventions. Once again, reams have been written on this topic.

Yet another surprise was that no comments assailed human cloning. Update: a cloned human fetus, reportedly, is being carried to term (and already may have been born) as this response is being written. This development underscores how rapidly and how radically the dimensions of biotech change are developing.

I'm emphasizing in this response a convincing sense of further steps along the pathways of development – "progress" if you will allow me.

Models, particularly mechanistic mathematic and algebraic statistical arrays, may be elegant. Problem is that "lockstep" portrayals almost always prove dead wrong. Somebody's model somewhere may be closer to truth. Odds of somebody hitting the mark rise with the number of attempts. Why did "experts" miss out on timely warning of the current communication technology stock tumble?

What, exactly, is our destiny? Play it out. Carplings and complaints forge constrictive answers to tomorrow's problems. Optimistically, I foresee opportunities as far as the mind can reach.

It's an awesome ride – and I'm glad to be along for a short stint in this patch of the march for human progress.

Perhaps there is something to the contention that all companies will become "bioterial" firms by 2050. One commentator reports that IBM, given its new emphasis on bioinformatics, may become known as a "life sciences company within the next three years." What it all comes down to is what is counted and how and why.

Even the best of the best, frequently miss the mark in projecting future trends. Biotech experts striving to decode the human genome anticipated the job wouldn't be done until 2005. New approaches resulted in announcing completing the job by mid-2000. That date is the one casual observers believe concluded the task. Not so. Filling in gaps, eliminating mistakes, and finalizing sequences is not expected to be concluded for at least another year (at the time of this writing).

Perceptions are one thing, facts quite another. To underscore this point consider that the number of genes thought to comprise the human genome ranged from a low of 50,000 to a high of 150,000. Based on the first "rough draft" of the code, the number had dropped to 38,000. Widespread reports of that lower number probably are perceived as definitive. Wrong! Bill Haseltine, founder of Genome Sciences, calculates that the final count will be closer to 100,000. Widespread conjecture and calculations prevail. Soon we will be closer to the truth. That's the point of drawing out this commentary. Sorting through data requires great care and a whale of a lot of time can be consumed in pursuing minutiae.

No matter what one looks at or thinks about, there are leads and lags, leaders and laggards. Occasionally, the same idea -- coincidentally -- is discovered at about the same time. Simultaneous invention examples

abound. Without ruminating over it, the plain unvarnished truth is that somebody has got to be the first to try. That's just the way it goes.

From a practical standpoint, somebody has got to do the job. No nation, no people have a monopoly of ideas and innovation. The US has had a "go" for less than a century. China and India, to cite just two examples, were centers of culture and society for thousands of years. Thousands of years ago, similar trappings of dominance, capability and power were visited upon China, India, Egypt, Italy – different countries at different seasons in history. Recently, the trappings of affluence and influence, of power and capability rests in other hands.

Sometimes the darkside overwhelms. Problems are conjured up. Catastrophic disaster possibilities are posed in objection. Worse, one side or the other, can all too easily be characterized as "evil."

WORD COUNT: 5,724 (including 2 pp not used) = approximately 4,700 words

The section on science fiction also could be eliminated, bringing the word count into line with the 4,000 word count suggested by Sohail.