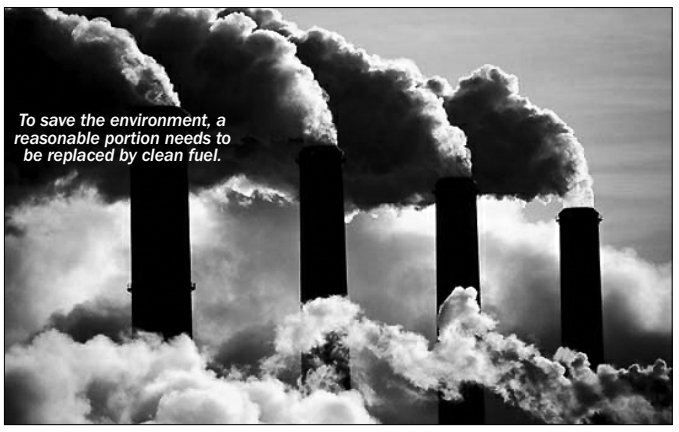
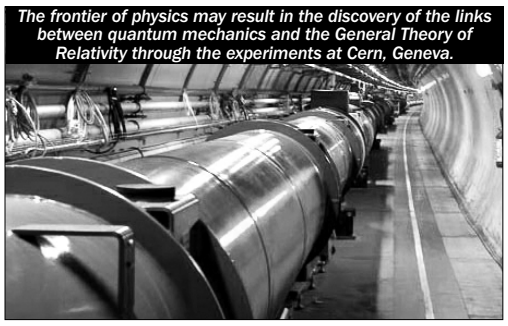
Can a way out be found?

At the end of the first decade of the new century, s ananthanarayanan examines the questions before science and how the answers will impact our lives in the next 10 years


To save the environment, a reasonable portion needs to be replaced by clean fuel.

THE crisis before humankind seems to be like it has never been before. In one full century, we have transformed the planet from a repository of unending resources to an organism under attack, beset by *anthropogenesis*, or the doings of mankind, and facing the disappearance of air, fresh water, fuel and territory. Does science have the answers, or is it the time for great changes of lifestyle, drastic reduction of population, which could be the only way? Clearly, it is the solutions provided by science that are practical. Ten key areas of interest may be the following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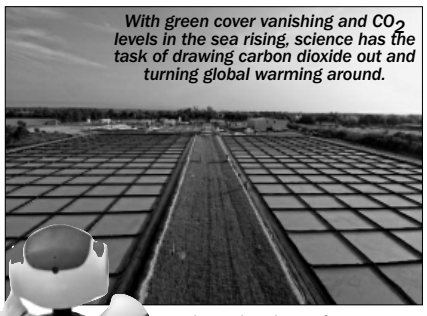
Superconductivity will impact a spectrum of devices, from transmission lines to powerful electromagnets to computer memories.

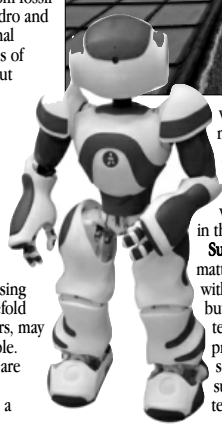
Fuel: Controlling emissions, saving the environment is the priority but people across the world seem to believe science will find a way, and we can go on consuming and creating waste like we are. Be that as it may, it certainly points out the job for science – find a source of clean fuel! The energy consumption of the world is about 16 billion kilowatts, or the energy of about16 billion tonnes of coal, in a year. About 14 billion tonnes' worth is from fossil fuels and the rest is equally from hydro and nuclear sources, wind and geothermal being negligible. The earth's reserves of fossil fuels are the equivalent of about 1,427 billion tonnes of coal. At the current rate of consumption, of 14 billion tones a year this can last 100 years, but that is not the issue.

To save the environment, a reasonable portion needs to be replaced by clean fuel. About a billion tonnes' equivalent, out of 14 billion tones, comes from each of nuclear plants and hydro power. While the scope is limited for increasing hydroelectric generation, even a fivefold increase in nuclear plants, in 20 years, may not be effective even if it were feasible. Wind, tidal and geothermal sources are then the remaining areas where a breakthrough in the next 10 years is a reasonable expectation.

Scrubbing the air: The world pumps 27 billion tones of carbon dioxide into the atmosphere each year. This is about twice the capacity of various mechanisms to absorb CO_2. The result is that there is a net addition of CO_2 to the atmosphere and increasing global warming. But green cover is vanishing and CO_2 levels in the sea, which is the largest absorbing agent, are rising. This sets a task for science – to draw CO_2 out and turn global warming around!

These are the areas vital for life to go on in the way that we have known for two millennia. But even if these are provided, there is need for and prospects of other technology, even academic advance, which would be the concern of science in the coming decade.


With green cover vanishing and CO_2 levels in the sea rising, science has the task of drawing carbon dioxide out and turning global warming around.



Superconductivity: A state of matter that transmits electricity without loss is routinely feasible, but at exceedingly low temperatures, which are not practical. The next few years may see new materials that are superconducting at reasonable temperatures, which is even that of liquid nitrogen. This would impact a spectrum of devices, from transmission lines to powerful electromagnets to computer memories.

Information Technology: With high speeds of computation and storage capacity already at hand, it is through software that positive aids to managing the planet will emerge. It has been observed that in the past, computers were used for massive computations, which were beyond the capacity of humans. Today, computations are routine, the challenge to computers is in *image recognition*, which, for humans, is routine! With complexity rapidly growing beyond human capability, it is machine capability that will see rapid increases. New memory devices that allow computers to shut down and restart without delays would make significant reduction in the power consumption by computers, which would rapidly take over and optimise the use of resources, including computer resources.

Genetics: A changing and overpopulated world needs many hands to run. Genetic engineering capability will get sophisticated and allow harnessing of life forms for different roles, with carbon sequestering, converting solar energy into clean fuel and agricultural developments being possible areas.

Nanotechnology: This upcoming area will mature, not just for miniaturisation but to make use of atom level assembly and manipulation that becomes feasible. From communications and electronics, chemical processes, lightweight materials, "nano" may be the important, new technology of the century.

Cancer: Medical research would touch new heights – cancers, Alzheimer's disease, ALS may see cures and prevention. Every area of technology impacts medicine. Longevity and productivity will increase, raising challenges of rising and ageing populations and further stresses for the community.

Exoplanets: While science mulls over tackling problems on terra firma, rapid progress has taken place in identifying planets around distant stars, where there could be life like ours, or where we could relocate! The idea or utility is pure fantasy, as the nearest star is several light years away and there is no conceivable way of reaching any habitable planet, even if one is found. But space research advances basic science and enables maturing of technologies that find application.

High-energy physics: The frontier of physics, which may be pushed back in the next decade, may be with the discovery of the links between quantum mechanics and the General Theory of Relativity, through the experiments at the Large Hadron Collider at Cern, Geneva. This arrangement, through *brute force* collision of sub-atomic particles accelerated faster than ever before, seeks to produce the energies that may have existed in the first few moments of the celebrated *Big Bang*. Dr Spenta Wadia of the Tata Institute of Fundamental Research, Mumbai, says the experiments are likely to clarify the models of the elementary particles and increase our understanding of the mysteries of the universe. This is basic research in the purest form, the results of which will give direction to further research and lead to technologies of more immediate relevance.

At a more practical level, Dr Wadia says we need better understanding of the turbulence of fluids. The subject is multidisciplinary and may lead anywhere, but he sees its value in understanding weather and climate.

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Nature's ways

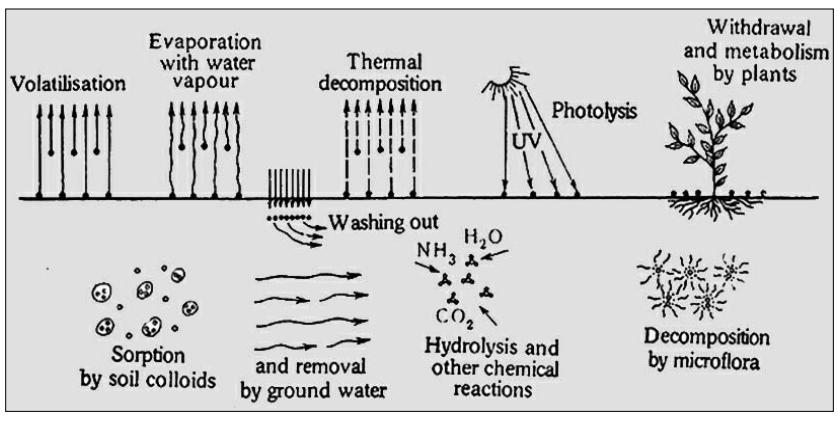
tapan kumar maitra highlights the role of physical factors in pesticide inactivation and soil decomposition

PESTICIDES incorporated into the soil lose a part of their activity because of their being adsorbed by soil colloids. The degree of adsorption of most pesticides largely depends on the humus content in soil. Most insecticides and soil herbicides are adsorbed to a large extent by humus soil than by loam and sandy loam. In the adsorption of pesticides, the adsorption surface of the soil and the degree of its affinity to a given pesticide (the magnitude of the surface energy) are of major importance. For example, triazine derivatives are easily adsorbed by negatively charged soil colloids owing to cation exchange. The affinity of the molecules of these herbicides to the organic matter of the soil is higher than to inorganic clay minerals. The origin of the organic matter is of importance here. In the humin, humic acid, and fulvic acid fractions of humus, the capacity of adsorbing pesticides diminishes in the order in which they are listed.

The dependence of the adsorption of some pesticides on the pH, pK, and hydrolytic acidity of the soil has been established. For instance, linuron, diphenamid, and picloram are adsorbed at a higher rate with an increase in the pH of the soil. Conversely, the adsorption of 2,4-D and MCPA grows when the pH of the soil solution decreases. Simazine is adsorbed more in soils with an increased hydrolytic acidity. In addition to the content and properties of the soil humus, of great significance for the adsorption of pesticides are the mechanical composition, the content of the clay and silt fractions.

The degree of adsorption of pesticides depends not so much on the content of the clay and silt particles in the soil as on the nature and origin of the clay minerals that are distinguished by the magnitude of the surface of the particles and the structure of their crystal lattice. Consequently, the nature of adsorption of a pesticide will vary depending on whether an anion or a cation is the active part of a pesticide molecule, or whether its molecule is ampholytic or electrically neutral and does not dissociate. For example, montmorillonite adsorbs many pesticides very well, which is the result of its property of binding ions and molecules not only on the surface of the mineral, but also in the intermolecular spaces.

The degree of adsorption of pesticides by the soil depends greatly on its moisture content. The larger the amount of water absorbed by the colloids, the smaller is the amount of free space remaining for the sorption of poisonous chemicals.



Detoxication of pesticides in soil.

The nature of adsorption depends on the chemical structure of the pesticide, its basicity, and on the properties of its functional groups to form hydrogen and dipole bonds. In herbicides that are triazine derivatives, the degree of adsorption by the soil increases in the following order: propazine, atrazine, simazine, prometryne; in urea derivatives - dichloralurea, fenuron, monuron, diuron, linuron.

When the adsorption of pesticides by clay minerals was studied, it was established that hydrogen bonds exist between the carboxyl, methyl, and methylene groups of the compounds and the surface of the minerals.

The adsorption of poisonous chemicals in the soil also depends on its temperature. This is of a practical significance because triazine herbicides incorporated into the soil in cold and damp weather are adsorbed in the top layer of the soil, which prevents their being washed out or decomposed. Becoming desorbed when the weather gets warmer, they again exhibit their activity.

Precipitation and elevation of the temperature facilitate the desorption of pesticides absorbed by the soil.

Evaporation with water vapor is one of the factors leading to the loss of toxicity in the soil of insecticides such as heptachlor. It has been established that non-polar pesticides evaporate to a greater extent than polar ones.

The losses of toxic chemicals in the soil because of volatility are mainly characteristic of pesticides with a high vapour pressure such as EPTC, pebulate, and trifluralin. The volatilisation of these pesticides depends on the moisture content of the soil. For example, in 15 minutes after treatment with EPTC, the losses of its vapour from dry soil amounted to 20 %, from moist soil, to 27%, and from wet soil, to 44%. The vapour of a volatile pesticide is adsorbed by dry soil to a considerably greater extent than by moist soil. This allows us to treat dry soil with volatile pesticides without any risk of lowering their effectiveness.

The incorporation of such substances immediately after treatment to a depth of 5-7 cm appreciably diminishes their losses in the vapor-ous form and is an obligatory procedure when volatile soil herbicides are being used.

Pesticides may also decompose in the soil under the influence of elevated temperatures. For instance, the activity of atrazine, simazine, diuron, monuron, and fenuron in soil experiencing the action of high temperatures (40-82 °C) diminishes by 40-97%. Such heating of the soil's surface layer is quite possible in field conditions on a very hot sunny day.

Pesticides become modified or completely decomposed in the soil as a result of physicochemical processes, microbiological decomposition, and the absorption by higher plants and the soil fauna. Many pesticides become detoxicated owing to their adsorption by humus and other colloids or to the formation of stable complexes in the soil. Poisonous chemicals are removed from the soil as a result of volatilization, evaporation with water vapour, migration beyond the root-habitat layer, washing out by rain water, melted snow, irrigation, ground, and soil water.

The basic criterion of the detoxication of pesticides in the soil is the rate and completeness of their decomposition into non-toxic components.

The determining role of individual processes in the inactivation of pesticides in the soil depends not only on the physicochemical properties of the pesticide and its formulation, but also on the properties of the soil, the climatic and ecological factors.

The writer is associate professor of botany, Ananda Mohan College, Kolkata

Brain shape 'shows political allegiance'

What began as a light-hearted experiment is now a serious effort. joe churcher explains

NEUROSCIENTISTS are examining whether political allegiances are hard-wired into people after finding evidence that the brains of conservatives are a different shape to those of left-wingers. Scans of 90 students' brains at University College London uncovered a "strong correlation" between the thickness of two particular areas of grey matter and an individual's views.


Geraint Rees.

Self-proclaimed right-wingers had a more pronounced amygdala — a primitive part of the brain associated with emotion, while their political opponents across the spectrum had thicker anterior cingulates. The research was carried out by Geraint Rees, director of the UCL Institute of Cognitive Neuroscience, who said he was "very surprised" by the finding, which is being peer reviewed before publication next year. It was commissioned as a light-hearted experiment by actor Colin Firth as part of his turn as guest editing BBC Radio 4's *Today* programme but has now developed into a serious effort to discover whether we are programmed with a particular political view.

Professor Rees said that although it was not precise enough to be able to predict someone's stance simply from a scan, there was "a strong correlation that reaches all our scientific tests of significance". He told the programme, "The anterior cingulate is a part of the brain that is on the middle surface at the front and we found that the thickness of the grey matter, where the nerve cells of neurons are, was thicker the more people described themselves as liberal or left-wing and thinner the more they described themselves as conservative or right wing.

"The amygdala is a part of the brain which is very old and very ancient and thought to be very primitive and to do with the detection of emotions. The right amygdala was larger in those people who described themselves as conservative. It is very significant because it does suggest there is something about political attitudes that are either encoded in our brain structure through our experience or that our brain structure in some way determines or results in our political attitudes."

The Independent, London

Divide and rule

ankur paliwal reports on how the malaria-carrying mosquito mutates into two different species

MALARIA-CARRYING carrying mosquitoes that kill two million people each year are evolving faster than expected. This can pose a challenge to eradication programmes currently under way to rid the world of these parasites. Scientists have found that *Anopheles gambiae*, widespread in Africa, has split into two species. Two studies published in the 22 October issue of *Science* report the findings.

"Mosquitoes are evolving more quickly and strategies effective against one may not work for the other," said Mara Lawniczak, lead author of one of the studies.


v The team studied two molecular strains of *A. gambiae*, M and S, which are morphologically similar but can be identified by their ribosomal DNA sequences. In the first study, scientists used comparative genomics to sequence the genomes. In the second, they compared 400,000 points in the genomes of the two and one more strain, Bamako, to see their evolutionary pattern and factors responsible for it.

The studies found differences in genes related to disease transmission, reproduction, longevity, insecticide resistance, aridity tolerance and larval habitat. As per the study, natural selection was the main factor that caused diversification. Other than this, response of the strains to their specific environments, like the presence of predators and pathogens in their larval ecology, also contributed to the speciation.

So, is there a possibility of such changes in Indian mosquitoes? T Adak, scientist at the National Institute of Malaria Research, said evolution was a dynamic process and not restricted to region or organism.

Nora J Besansky, a professor who participated in the study agreed. "*A gambiae* is a good model for many anopheline vectors worldwide, as it is highly adapted to humans and their environment." She noted that in India there were different species of the vector that, like *gambiae*, are members of cryptic species that are morphologically identical but belong to varied ecologies and show different behaviours.

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