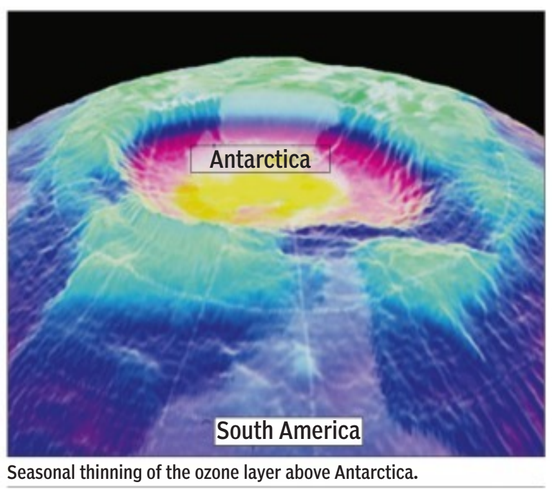
Lessons from ozone hole patching

A STUDY HAS PROVED THAT AN INTERNATIONAL PROTOCOL TO LIMIT ONE FORM OF POLLUTION HAS SUCCESSFULLY AVERTED AN ENVIRONMENTAL CONSEQUENCE, WRITES **S ANANTHANARAYANAN**

Great efforts are being made to see that the Conference of Parties21 — the international meeting to decide a course of action to manage global warming — in Paris later this year comes up with something concrete. As earlier conclaves have not yielded perceptible results, the earnest hope is that the performance will be a lot better this time. In the context, the finding that the Montreal Protocols on substances that deplete the ozone layer has led to a measurable reduction of the damage done is heartening and may suggest how we need to go about it in Paris.



Seasonal thinning of the ozone layer above Antarctica.

Containing global warming has been a major international concern since the UN-sponsored conferences in Rio de Janeiro in 1992, Kyoto in 1997 and again Cancun in 2010. The purpose was to chart out an international agreement where the world would agree to limit the way it was exploiting the environment to avert a global disaster. But over the last 23 years, there has been bargaining and negotiation, with the underdeveloped world claiming a right to progress even at the cost of the environment to match developed countries, which have got ahead at the cost of others.

Commercial and political interests appear to have prevailed and the build-up of greenhouse gases in the atmosphere has accelerated rather than slowed down. The meeting in Paris later this year is described as the last chance the world has to put on the brakes, but there are many who have grave doubts if the intergovernmental initiative, one more time, could be effective.

But these fears may be allayed in part by the review done by a group of scientists which says that further to an intergovernmental protocol of 1978 there has been a positive slowing of the build-up of pollutants that cause depletion of the ozone layer in the atmosphere, with the "ozone hole" in the Antarctic expected to disappear by 2050.

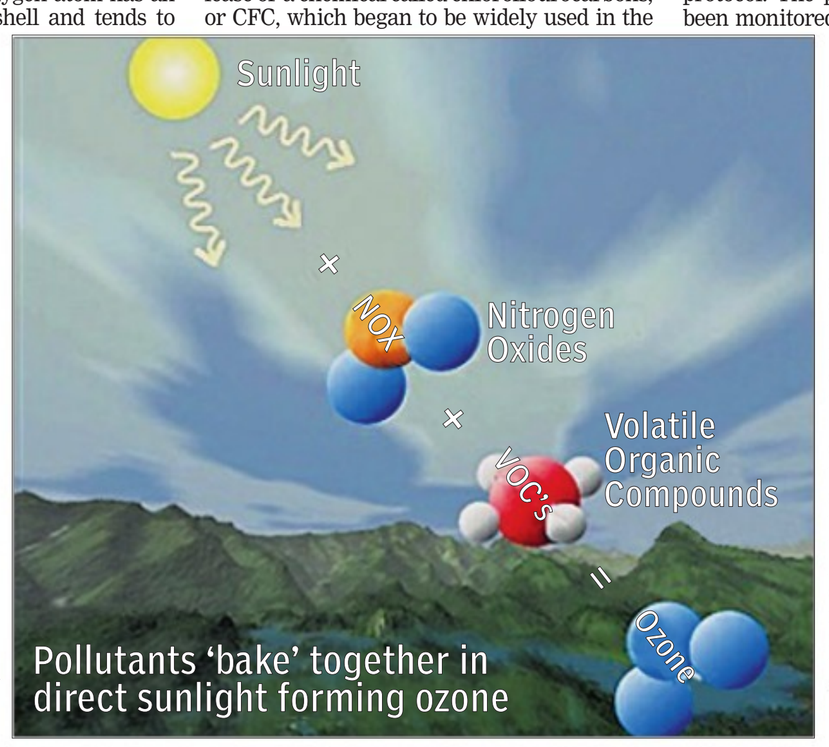
MP Chipperfield, SS Dhomse, W Feng, RL McKenzie, GJM Velders and JA Pyle, from the University of Leeds, Cambridge, the Netherlands and New Zealand, describe in the journal *Nature Communications* that modelling atmospheric chemistry shows that the protocol has prevented a 40 per cent increase in the depletion over the Antarctic, doubling over lower latitudes in the Northern Hemisphere and serious damage over the Arctic circle.

Ozone gas is a form of oxygen that builds up at higher altitudes and protects the earth by absorbing much of the Ultra Violet radiation that comes from the sun. The oxygen atom has an incomplete outer electron shell and tends to combine with other atoms. Oxygen gas consists of molecules made up of two oxygen atoms that share their outer shell electrons and form a stable unit. At higher altitudes, energetic photons of UV light split oxygen molecules into the component atoms. Lone atoms represent a higher energy state and they need to form bonds for stability. This they are able to with other oxygen molecules to form a three-atom molecule of ozone. The ozone molecules, again, readily absorb UV light and release "lone" oxygen atoms that then again combine with oxygen molecules to form ozone, and so on. The cycle keeps going till there are "recombinations" that end up with normal oxygen molecules, the state of the lowest energy.

There is, thus, a process of ozone generation that starts with UV light splitting an oxygen molecule and then reduction of ozone by recombination, leading to a balance of net ozone content at higher altitudes. This ozone content keeps up a pace of absorbing UV radiation and keeping it away from reaching the surface of the earth. Less UV radiation at the surface is pretty good for humans and other animals too.

But this comfortable condition of an average level of ozone always present can be disturbed by the presence of other substances that speed up the breakdown of ozone into oxygen. The most important of such substances is the negatively charged OH part of the water molecule, or the NO part of nitric oxide, or free chlorine or bromine atoms. These substances are able to pull the extra oxygen atoms away from ozone and then release oxygen atoms to form other compounds, and then get back to pull oxygen atoms from fresh ozone molecules — and keep doing this for a long time. Chlorine is the most important of these at high altitudes and a single chlorine atom stays active for as long as two years, reacting with 100,000 ozone molecules before it leaves the cycle.

There are no known natural processes that send Ozone Depleting Substances into the atmosphere, but serious depletion of the high altitude ozone layer has been observed since the 1970s and the cause has been pinned on the release of a chemical called chloroflourocarbons, or CFC, which began to be widely used in the easily evaporating coolants in refrigeration or in aerosol sprays. These materials diffuse to the high reaches of the atmosphere and release single atoms of chlorine, which then wreak havoc on the ozone layer.



Ozone and health

The ozone layer and containment of UV radiation at the surface of the earth have apparently been present for thousands of years while life forms have evolved. In fact, it is considered that low levels of UV radiation may have been a precondition for the origin of life itself. Reduction of ozone and, hence, increase in UV radiation has serious health implications, one being the increase in the incidence of *skin cancer*. This present study cites an estimate of two million cases of skin cancer avoided by 2030 as a result of checking CFC use.

This discovery of the bit of science that components in the air are changing way up in the rarefied stratoshpere appears to have been presented to the world in metaphor, like "ozone shield" and "ozone hole", that is friendly to the lay person, and the world was fast to react. The Montreal Protocol, which set up a timetable for stopping the use of CFCs was signed in 1978 and consumers stopped using aerosol sprays. Sales dropped by 50 per cent even before the protocol. The pace of reducing CFC use has been monitored and reviewed and, as of 2013, the researchers in *Nature Communications* report that the damage is fast getting undone.

Consumer control

In contrast, there is the sluggish reaction of the world to the elaborately publicised information about greenhouse gases and global warming. The success of the CFC control initiatives could, hence, well be studied for adapting for climate change. One helpful factor seems to be that consumers of products that contain CFCs had direct control over consuming those products and there was an incentive for manufacturers to shift technology. Such control may be difficult with greenhouse gases, but consumer education to seek sustainable living may go a long way in inducing governments and the industry to change course.

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CROSSING OVER

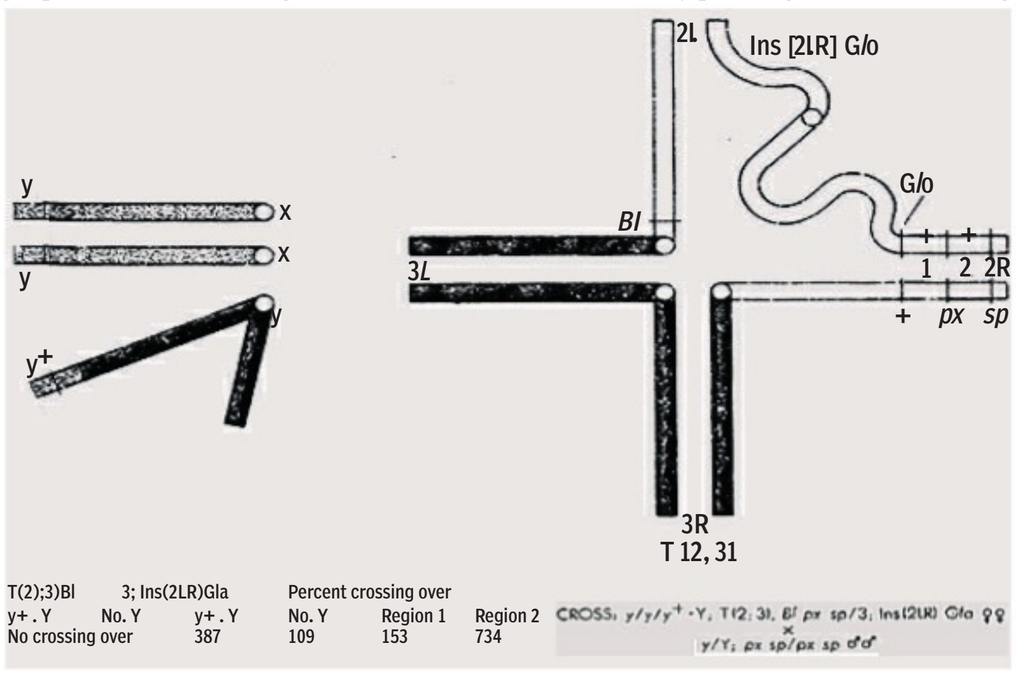
THE WHITEHOUSE HYPOTHESIS HAS OPENED UP A DEBATE IN THE FIELD OF GENETICS, WRITES **TAPAN KUMAR MAITRA**

The Whitehouse hypothesis is particularly applicable to recombination in fungal species such as neurospora and aspergillus. Whether the hypothesis can account for recombination in higher organisms is, however, debatable. A basic assumption is that the chromatid consists of a single double helix of DNA at the time of recombination but evidence suggests that this assumption is suspect and that recombination in this manner in a multi-stranded chromosome would produce considerable post-meiotic segregation — which does occur in fungal species but is absent in higher forms.

process of crossing over.

Grell has consequently interpreted these data in the following manner, exchange pairing between homologues occurs first. If the pairing is effective and crossing over takes place, the paired homologues remain together until disjoined at anaphase. If crossing over does not take place, the paired homologues fall apart and are free to synapse homologously or otherwise, with other free chromosomes for anaphase disjunction. When no crossing over takes place, both the Y and chromosome 2 are free, and the fact that they tend to segregate from each other rather than behave randomly indicates that they have paired and disjoined from each other. Grell has called this distributive pairing, and considers it distinct from and occurring after exchange pairing.

Edward Novitski had offered an alternate explanation to account for Grell's observations. He suggests that anaphase distribution in the mitotle division immediately preceding meiosis should bring



T(2);3)Bl	3; Ins(2LR)Gla	Percent crossing over			
y+ . Y	No. Y	y+ . Y	No. Y	Region 1	Region 2
No crossing over		387	109	153	734

CROSS: $y/y/y^{+}$-Y, T(2;3), Bl px sp/3; Ins(2LR) Gla ♀♀ × y/Y; px sp/px sp ♂♂

Experimental design used by Grell in females of *D melanogaster* to follow the distribution of the Y chromosome relative to the distribution of chromosome2. Two classes of viable offspring are produced: those possessing a normal chromosome 3 plus the inverted chromosome 2 and identified by the dominant gene Gla; and those possessing the two translocated chromosomes 2L:3L plus 2R:3R and identified by the dominant gene Bl. The presence or absence of the Y chromosome is determined by the fact that it carries the dominant allele of y at its tip. Crossing over is detected by the recombinational events taking place at the right end of chromosome 2, which is heterozygous for the linked genes Gla, px, and sp.

It is clear that crossing over, however brought about, accomplishes two things: first, it provides a means for the exchange of chromatin between homologues and, second, the act of exchanging binds the pair of homologues together until the metaphase and thereby facilitates their regular segregation to opposite poles in anaphase. However, recent studies by R Grell strongly suggest that these two events may be separated in time; that is, they may not occur simultaneously. The data in the accompanying table show that when crossing over takes place, the Y chromosome is randomly distributed (48:65; 53:53), but when crossing over does not occur it tends to segregate from chromosome 2 (387:109 for one class of offspring, 734:153 for the other). Also, when the Y chromosome is absent (control experiment), the rate of crossing over is the same as when it is present; the Y chromosome, therefore, exerts no influence on the all centromeres in close proximity to each other and non-homologous pairing of heterochromatic elements (differing only in intensity and duration from homologous pairing) should keep the chromosomes together until synapsis frees the pairs of homologues from the mass. Those not paired homologously would then tend to remain paired non-homologously until the end of metaphase, at which time they would disjoin and accomplish the same end result as the one observed by Grell. At present, it can only be said that both hypotheses offer solutions to a group of perplexing data and that our ignorance of meiotic events does not permit one to make an unequivocal choice yet.

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Automated employees

NAYSAYERS WOULD HAVE YOU BELIEVE ROBOTS WILL REPLACE HUMANS IN FUTURE WORKPLACES BUT REALITY MAY PROVE OTHERWISE, SAYS **ROB PRESTON**

We're always looking to pin our problems on a villain because it makes us feel better. When it comes to the ongoing debate about creating and protecting jobs, the villain has varied over the years: Japan Inc industrialists, dot-com flim-flam men, free-trade fanatics, the offshore menace, the Wall Street one per cent. However, in the 2015 jobs narrative, the villain is the robot, an adversary that literally doesn't have a heart.

Robots and their artificially intelligent kin, we're told, will eventually replace everyone from package deliverers, retail store greeters, airport baggage handlers and truck drivers to novelists, airline pilots, accountants and doctors. A rigorous 2013 University of Oxford study by Carl Benedikt Frey and Michael A Osborne argues that advances in computers, automation and Artificial Intelligence will put 47 per cent of US jobs at risk. But the prevailing pessimism reflects a fundamental lack of imagination. People are extrapolating the technological advances they foresee to a static version of tomorrow's economy and fail to imagine the possibilities that those advances could create.

When Bell Labs scientists invented the transistor in the 1940s, did most people imagine the myriad products, services, vendors, vendor ecosystems, offshoot industries and hundreds of millions of jobs that it would spawn? Or did they just see computers replacing jobs at abacus and typewriter manufacturers as the transistor was commercialised? Today's employment pessimists remind me of English scholar Thomas Malthus, who predicted two centuries ago that population growth would soon overwhelm man's ability to subsist, let alone prosper. Malthus, though, failed to envisage the productivity acceleration of the coming industrial and technological revolutions. Likewise, the pessimists of today cannot possibly know the nature of jobs that will be created.

Forbes writer John Tamny raises a critical point in a recent post on this subject, "It's in poorer countries that the nature of work is static. In rich ones, we constantly innovate away the toil of the past in favour of more prosperous work forms that are less back-breaking and consume less of our time."

This progress means that we, as a collective labour force, can spend fewer hours digging ditches, filing forms and more time doing work that really improves other people's lives: treating and curing diseases, creating new sources of renewable energy, improving education, growing food more productively, raising financial capital to start and expand businesses.

That deep disruption won't be a trivial matter; it's not to be dismissed. But let's not be so quick to kiss off most of today's jobs either. When we look towards even an AI-dominated future, we tend to underestimate the value and power of human presence, emotion, creativity and flexibility. It's as if we think musicians, teachers, counsellors, caregivers, coaches, clergy, trial lawyers, architects, writers, business strategists and entrepreneurs are only imperfect droids to be replaced with perfect (and less costly) ones.

People bring a lot to the workplace through their very humanity. Intelligent machines (like ones today that do predictive data analytics) are more likely to complement human activity and decision-making. Take healthcare for example, medical practices, clinics, hospitals, nursing homes and hospices do more than just run tests, render diagnoses and perform procedures. They provide total patient care. Technology promises to improve their efficiency and


Oracle chairman and CTO Larry Ellison noted that Japan in particular saw robots as a solution to its labour problems, not as a contributor.

accuracy — and we certainly need to figure out ways to keep rising healthcare costs in check — but total care requires human input, intervention, adaptability and empathy

Robotics and AI could very well become the transistor of the 21st century — the foundation for lots of new products, services, industries and career paths that are inconceivable today. And let's not ignore the demographic fact that low birth rates in Japan, Germany, Russia, Brazil and other industrialised countries signal a big labour shortage in future — translating to $10-trillion of lost GDP over the next couple of decades, according to a recent Boston Consulting Group report.

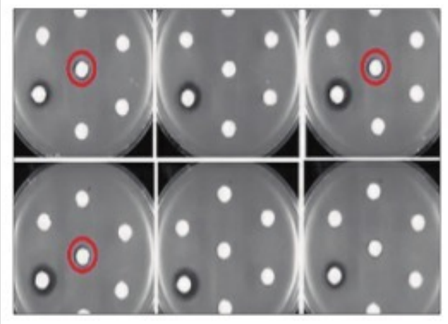
In his recent keynote address at CloudWorld Tokyo, Oracle chairman and CTO Larry Ellison noted that Japan in particular saw robots as a solution to its labour problems, not as a contributor.

The employment challenge ahead is less about surviving under the cold reign of robots and more about two other factors: improving education and training to prepare people for tomorrow's economy, reworking the tax and regulatory codes with an eye toward promoting growth and job creation.

Perhaps our robotic overlords will be able to help us there.

THE WRITER IS ATTACHED TO ORACLE, NEW YORK OFFICE, AND CONTRIBUTED THIS ARTICLE TO ASIA NEWS NETWORK

PLUS POINTS



New antibiotics

For decades, scientists have looked for ways to make alternate versions of antibiotics naturally produced by bacteria and fungi in hopes of expanding the activities of available drugs. In a study published on 29 May in *Science Advances*, researchers from the State University of New York at Buffalo report a technique that allowed them to make 42 new versions of the antibiotic erythromycin, three of which showed activity against drug-resistant bacteria.

"I was going into it thinking maybe we'd make a fifth of the number (of compounds) we actually made," said Blaine Pfeifer, a chemical and biological engineer who led the study.

To get to the point where they could alter the biosynthesis of erythromycin, Pfeifer and his colleagues worked to "transplant" its entire biochemical pathway into the lab-friendly species *E. coli*. Getting *E. coli* to express and use the enzymes correctly "took years of tinkering and optimisation," he said.

For the present study, Guojian Zhang, a postdoc in Pfeifer's lab, used this toolbox to build upon the system by introducing enzymatic pathways that could alter a sugar group added toward the end of erythromycin synthesis. To reconstitute these pathways in *E. coli*, Zhang borrowed genes from several other bacterial species. "He was kind of doing a Frankenstein thing, pulling all of these enzymes together," said Pfeifer.

Zhang designed 16 different pathways and introduced each one into a different *E. coli* strain. He then fed the bacteria an erythromycin precursor — which was also produced in *E. coli* — and analysed the resulting products using mass spectrometry. All of the pathways produced unique sugar groups that were successfully attached to the erythromycin precursor, forming 42 analog compounds.

Pfeifer said he was surprised at how well the technique worked.

THE SCIENTIST

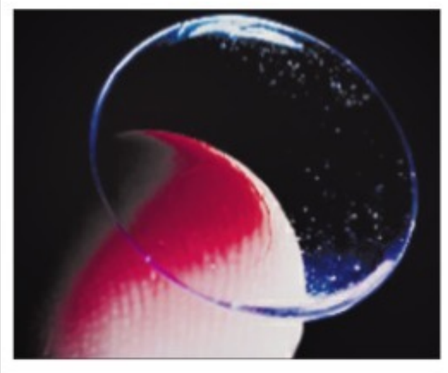
Contact lenses

Scientists who study the microbiome continue to find evidence that everyday products can influence the bacteria and other microbes that populate the human body. An unpublished study reported at the annual meeting of the American Society for Microbiology on 31 May has provided evidence that contact lenses can influence the microbiota of the eye.

"Our research clearly shows that putting a foreign object, such as a contact lens, on the eye is not a neutral act," said Maria Gloria Dominguez-Bello, a microbiologist at New York University Langone Medical Center, who worked on the study.

A survey of the microbiota living on and around the eyes of 20 volunteers showed differences in the microbial populations between those who wear contacts and those who don't. The nine individuals who wore contact lenses displayed a higher level of diversity on the surface of the eye called the conjunctiva. For lens-wearers, the composition of the microbiota on the conjunctiva closely resembled that found on the eyelid.

In addition, wearing contacts correlated with a threefold



increase in *Methylobacterium, Lactobacillus, Acinetobacter*, and *Pseudomonas* species. Although eye infections are commonly thought to be caused by the bacteria *Staphylococcus aureus*, the study found that lens-wearers harboured more *S. aureus* than those who did not wear contacts.

THE SCIENTIST