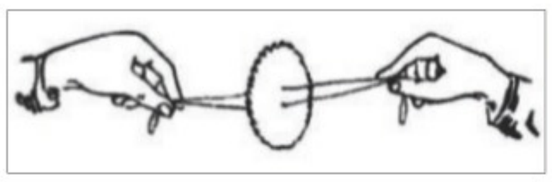
Going back to the basics

A CHILD'S PLAYTHING, KNOWN SINCE ANCIENT TIMES, MAY PROVIDE A WAY TO QUICKEN UP TESTS FOR MALARIA, HIV AND TUBERCULOSIS, WRITES **S ANANTHANARAYANAN**

An impediment in the treatment of many diseases is that the resources for detecting and identifying the concerned pathogen are not available. Even when there are microscopes and trained personnel, the equipment for preparing the blood sample is often absent. This is particularly true of malaria, which affects hundred million people and claims well over a million lives every year, mostly in Africa and South-east Asia.

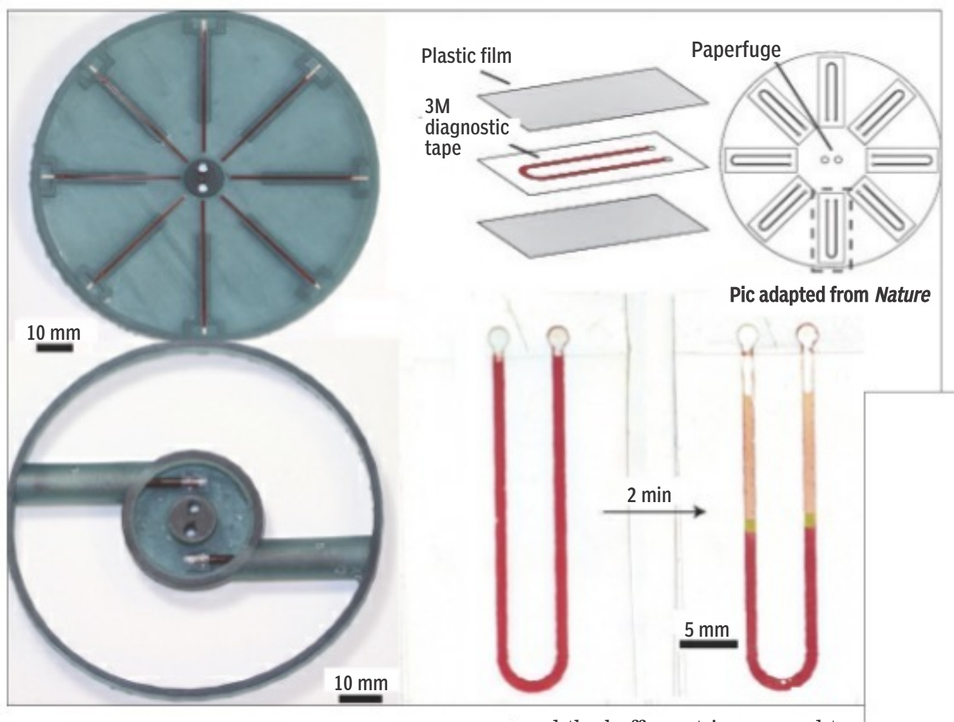
It is in this context that M Saad Bhamla, Brandon Benson, Chew Chai, Georgios Katsikis, Aanchal Johri and Manu Prakash, from Stanford University, report a basic, "low tech" device that concentrates blood samples to the required levels in minutes at trivial cost. Writing in the journal, *Nature Biomedical Engineering*, the team describes a toy used by school children that achieves better centrifuging speeds than any human-powered device so far.

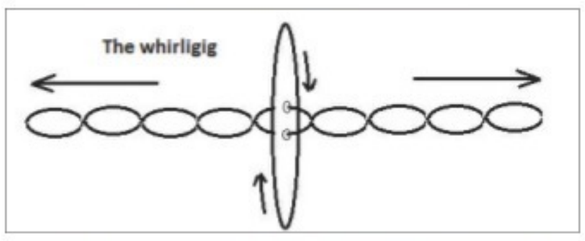
The symptoms of early malaria are not at all

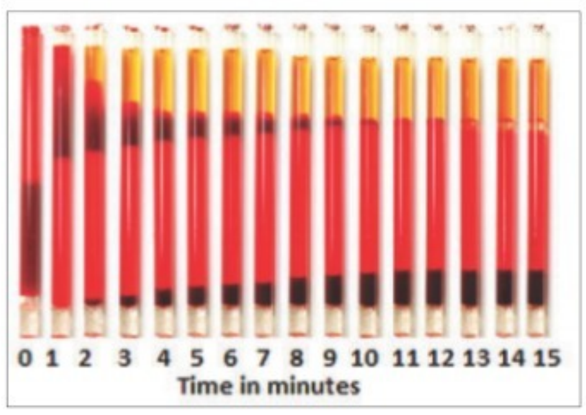


specific, and that is unfortunate, as correct diagnosis and prompt treatment are important for recovery. Screening of blood samples is hence urgent when there is an outbreak. A common method to identify malaria is to look for the parasite in blood smears through a microscope with the help of dyes and special light. A skilled technician can then detect parasites when 20-40 parasites are there in every microlitre of blood. The method, however, is laborious and it does call for skill and training.

A recent improvement is with the quantitative buffy coat, which is a component of blood, separated and concentrated by rapid spinning. The centrifugal or centre-fleeing forces that act when a substance is spun, collects the lighter part near the centre of the spin and throws the denser portions to the outer part. When a blood sample is centrifuged, the red blood cells are thrown to the outer part and a clear liquid, the plasma, stays towards the centre. And between the two portions, there is a thin, intermediate layer called the buffy coat, because it is buff in colour. That part contains white blood cells and platelets and can be examined for parasites present in the blood. The thin tube in which the blood sample is centrifuged also has a float that has the density of the buffy part. This settles at the same level, and the buffy coat is squeezed to occupy a greater length on account of the float.





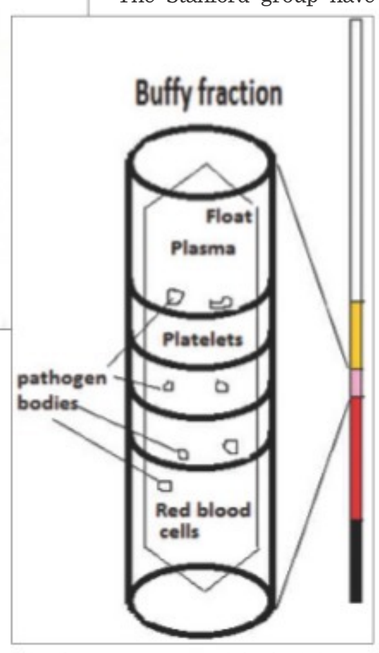


Microscopic examination of the buffy coat is then more sensitive and parasites can be detected even if there is only one in a microlitre of the sample. A crucial part of this process, however, is the centrifuge — equipment for spinning the tube containing the blood sample, some 12,000 times a minute. As the Stanford University paper says, the centrifuge is the "workhorse of any medical diagnostic facility." The machines, however, are bulky, expensive and they use electricity. They are hence typically not available in the field and samples have to be sent for analysis at a base station that may be a day's journey away.

Alternate methods that work without electricity are again bulky and can attain rotations speeds of only 1,200 times a minute, which is not good enough or time consuming. Crucial intervention in remote parts of poorer countries is thus either ignored or delayed.

The device developed by the Stanford group is based on the simple, "buzzer" or "whirligig" — a circular disc with a pair of holes in the centre. Two strings pass through the holes and their ends are joined. If the loop is stretched out and the disc given a few turns, the strings winds into a spiral and grow taut. Then, if the strings are pulled apart, they spiral unwinds and sets the discs spinning. The disc keeps spinning beyond the starting point and winds the strings into an opposite spiral. If the strings are pulled apart again, the disc spins back the way it came, but with more energy. In just a few seconds, the disc can be set whirling at feverish speeds, estimated by the Stanford group to go as high as 1,25,000 turns a minute.

Children use any kind of discs to create this plaything. In India it is common to flatten out the crowned cap of a soft drink bottle. Colourful discs of plastic are sold in toy shops. The Stanford group have devised and engineered a special paper disc, which they call the "paperfuge", with an arrangement to hold a set of radial glass tubes with blood samples. It is remarkably simple, just two paper discs kept together with Velcro strips, with the sample tube held in between.



The device has been tested by the group and the paper reports complete separation of RBC and plasma with 15 minutes of centrifuging. The RBC fraction could be used for testing for anaemia as effectively as with a commercial, electric centrifuge. The plasma fraction was also suitable for other rapid diagnostic tests. And as for the buffy coat, the region expanded by the float was easily used for identification of parasites of malaria and other diseases.

"A comparison of individual blood components, including platelets, monocytes and granulocytes, revealed good quantitative agreement between the buffy coat obtained with a 'paperfuge' and a commercial electric centrifuge," the paper says.

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HARNESSING SUNSHINE

THE FLEDGLING SOLAR POWER INDUSTRY IN ISRAEL IS TRYING TO MAKE A LEAP FORWARD WITH A LARGE-SCALE PROJECT BOASTING THE WORLD'S TALLEST SOLAR TOWER. **ISAAC SCHARF** AND **ALON BERNSTEIN** REPORT

In sunny Israel, solar energy supplies only a small percentage of the nation's power needs, leaving it far behind countries with cloudier and colder climates. Now the fledgling solar industry is trying to make a leap forward with a large-scale project boasting the world's tallest solar tower, as a symbol of Israel's renewal energy ambitions.

With Israel traditionally running its economy on fossil fuels, renewable energy has long been hobbled by bureaucracy and a lack of incentives. But the country is starting to make an effort, setting a goal of generating 10 percent of its energy from renewable sources by 2020, up from the current 2.5 per cent.

The Ashalim project, deep in the Negev desert, is made up of three plots, with a fourth planned for the future, each with a different solar technology. Together, the fields will be Israel's largest renewable energy project when completed by 2018. They are set to generate some 310 megawatts of power, about 1.6 percent of the country's energy needs - enough for about 130,000 households, or roughly five per cent of Israel's population, according to Israel's Electricity Authority.

"It's the most significant single building block in Israel's commitment to CO2 reduction and renewable energy," said Eran Gartner, chief executive of Megalim Solar Power Ltd, which is building one part of the project.

The centerpiece is a solar tower that will be the world's tallest at 820 feet. Solar towers use a method differing from the more common photovoltaic solar panels, which convert sunlight directly into electricity. Instead, towers use a solar-thermal method — thousands of mirrors focus the sun's rays onto the tower, heating a boiler that creates steam to spin a turbine and generate electricity.

Encircling the Ashalim tower are 50,000 mirrors, known as heliostats, in a shimmering blanket of glass over the desert. The tower is so tall because the panels were squeezed together to maximise use of the land - and the closer the panels are the taller the tower must be, Gartner explained. Another solar-thermal plot at Ashalim will be able to store energy even when the sun goes down. A third plot will use photovoltaic solar technology to produce energy.

Yaron Szilas, chief executive officer of Shikun and Binui Renewable Energy, the lead developer of the second solar-thermal plot, said combining the three technologies was a wise move because each has its own advantage. The amount of electricity it produces will be comparable to large-scale solar fields in California and Chile.

There are around a dozen solar tower fields around the world, the largest being the Ivanpah plant in California with some 170,000 heliostats around three 140-metre-tall 460 feet towers.

Israel has developed some of the world's most advanced solar energy equipment and enjoys a nearly endless supply of sunshine. But Israeli solar companies, frustrated by government bureaucracy, have mostly taken their expertise abroad.

Countries with cooler climates have outpaced Israel. Germany, for example, gets nearly 30 percent of its energy from renewable sources.

"Israel has a potential to be a sunshine superpower," said Leehee Goldenberg, director of the department of economy and environment at the Israel Union for Environmental Defence, a non-governmental organisation. Despite some steps in the right direction, "Israel's government hasn't really been pushing to reach its small goals regarding solar energy."

Israel has often been reluctant to hand out huge parcels of land, a necessity for large-scale solar power production, Gartner said. Large projects also demand access to state-owned infrastructure like gas, water and electricity, and connecting to those utilities out in remote plants in the Negev desert often takes time.

Israel's finance ministry said that the price of generating solar power has come down, and the ministry has pushed new laws to promote the industry. Recent legislation has also provided incentives and cut down some of the bureaucracy for Israelis wanting to install solar panels on their roofs.

The ministry said if Ashalim is successful, it will aim for more such facilities. The developers in the project say they want Israel to step up its renewable energy goals.

"With all the sun that we have and how progressed we are in technology, these goals are very, very, very modest," Szilas said. "But these are the goals that were set, and we are working toward it."

THE JAKARTA POST/ANN

Breakage and exchange

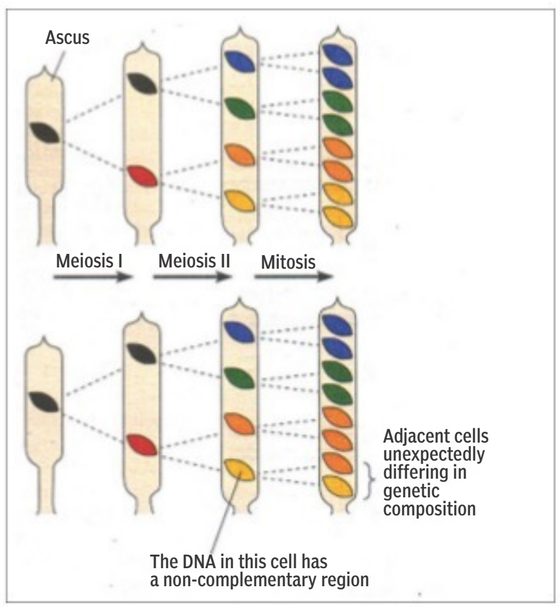
HOMOLOGOUS RECOMBINATION CAN LEAD TO GENE CONVERSION, WRITES **TAPAN KUMAR MAITRA**

The homologous recombination is based on DNA breakage-and-exchange but it does not in itself provide much information concerning the underlying molecular mechanisms. One of the simplest breakage-and-exchange models that might be envisioned would involve the cleavage of two homologous, double-stranded DNA molecules at comparable locations, followed by exchange and rejoining of the cut ends.

This model implies that genetic recombination should be completely reciprocal; that is, any genes exchanged from one chromosome should appear in the other chromosome, and vice versa. For example, consider a hypothetical situation involving two genes designated P and Q. If one chromosome contains forms of these genes called P1 and Q1, and the other chromosome has alternative forms designated P2 and Q2, reciprocal exchange would be expected to generate one chromosome with genes P1 and Q2, and a second chromosome with genes P2 and Q1.

Although this reciprocal pattern is usually observed, recombination has been found to be non-reciprocal in some situations. For example, recombination might generate one chromosome with genes P1 and Q2, and a second chromosome with genes P2 and Q2. In this particular example, the Q1 gene expected on the second chromosome appears to have been converted to a Q2 gene. For this reason, non-reciprocal recombination is often referred to as gene conversion.

Gene conversion is most commonly observed when the recombining genes are located very close to one another. Because recombination between closely spaced genes is a rare event, gene conversion is most readily detectable in organisms that reproduce rapidly and generate large numbers of offspring, such as yeast and the common bread mould, neurospora. Neurospora is an especially convenient organism in which to study gene conversion, because its meiotic cells are enclosed in a small sac, called an ascus, which prevents the cells from moving around and thus allows the lineage of each cell to be easily followed. Initially, each ascus contains a single diploid cell.



In the bread mould Neurospora, cells undergoing meiotic division are contained within a sac called an ascus. The ascus keeps the individual cells lined up in a row, making it easy to trace each one's lineage. The separation of homologous chromosomes during meiosis I generates two cells exhibiting different genetic traits. Cells produced during meiosis II may also differ from each other genetically because of the crossing over that occurred during meiosis I. The third division is a simple mitosis, and hence is expected to produce a pair of genetically identical cells for each cell that divides (top). Occasionally, however, this terminal mitosis generates a pair of non-identical cells (bottom).

Meiotic division of this cell produces four haploid cells that subsequently divide by mitosis, yielding a final total of eight cells. Since the final division is mitotic, it should produce two identical progeny cells for each cell that divides. Yet in a significant number of cases, this mitosis produces two cells that are genetically different. Such unexpected results are most often observed with genes that are close to a site of genetic recombination.

How can mitosis produce two cells that are genetically different? The most straightforward explanation is that a chromosome contains one or more genes in which the two strands of the DNA double helix are not entirely complementary. When the two DNA strands in such a non-complementary region split apart and serve as templates for DNA replication, the two newly forming DNA molecules will have slightly different base sequences in this region and will thus represent slightly different genes.

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PLUS POINTS

Beasts in the backyard

Giant black holes may be lurking "like monsters under your bed" behind smokescreens in our cosmic back yard, scientists have said.

Astronomers have discovered evidence of super massive black holes at the centre of two of our galactic neighbours. In each case, the powerful black hole is concealed behind clouds of gas and dust. Scientists now believe most large galaxies have super massive black holes at their cores, but many are hidden from view.

One, the galaxy NGC 1448, is "just" 38 million light years from our own body of stars, the Milky Way. The other, IC 3639, is 170 million light years away. Both are classified as "active" galaxies that emit intense levels of radiation. But they are still much too distant to pose any threat to Earth.

Black holes are places where gravity is so powerful that it traps light and distorts space-time. They can only be detected from the last-gasp emissions of radiation from objects falling into them.

The hidden black holes were spotted by the Nasa's Nustar — Nuclear Spectroscopic Telescope Array — orbiting observatory which is designed to see X-rays.

Astronomer Ady Annuar, from the University of Durham's Centre for Extragalactic Astronomy, said, "These black holes are relatively close to the Milky Way, but they have remained hidden from us until now. They're like monsters hiding under your bed.

"Their recent discoveries certainly call out the question of how many other super massive black holes we are still missing, even in our nearby universe."

Daniel Stern, project scientist for Nustar at NASA's Jet Propulsion Laboratory, said, "It is exciting to use the power of Nustar to get important, unique information on these beasts, even in our cosmic backyard where they can be studied in detail."

JOHN VON RADOWITZ/THE INDEPENDENT

Benefits of a *siesta*

Wandering off for an afternoon nap might not the best way to impress your boss but scientists say it could improve your performance while working.

Researchers at the University of Pennsylvania, US, found a short sleep in the afternoon improves people's thinking and memory skills and makes the brain perform as if it were five years younger.

The team studied 3,000 elderly Chinese people and looked at whether those who frequently took afternoon naps performed better on mental ability tests. The participants were given recall tasks and some maths problems, as well as being asked to copy drawings of shapes.

Scientists found people who took a nap after lunch did better on the tests than those who did not sleep in the middle of the day. In total, 60 per cent of people in the study slept after lunch, with the average nap time being 63 minutes.

The study suggested an hour was the best length of nap; people who had longer or shorter rests performed up to six time worse on the tasks. Taking an afternoon nap of the right length is so beneficial that it has the same effect as being five years younger, the researchers said. They concluded, "The results support the hypothesis that a moderate-duration nap taken during the post-lunch dip is associated with better overall cognition.

"Older adults who did not nap or napped longer than 90 minutes (extended nappers) were significantly more likely than those who napped for 30 to 90 minutes after lunch (moderate nappers) to have lower overall cognition scores."

The study, which was published in the *Journal of the American Geriatric Society*, confirms previous studies that have shown the benefits of napping, as long as the rest is not too long.

BEN KENTISH/THE INDEPENDENT