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## **Govt to clear key deals with Israel ahead of Modi visit**

Ahead of PM Narendra Modi's first visit to Tel Aviv later this year, the cabinet committee on security (CCS) has begun to clear a slew of defence deals with Israel. The deals, some of which have been pending for long, are together worth well over \$3 billion.

Defence ministry sources on Tuesday said while the deals for Spice-2000 bombs and laser-designation pods have already been cleared by the CCS, the ones for acquisition of two more Phalcon AWACS (airborne warning and control systems), four more aerostat radars and the medium-range surface-to-air missile system (MR-SAM) for the Army are now on the anvil.

TOI had last month reported that most of these deals had reached the final stages of approvals, while the negotiations for the initial Rs 3,200 crore contract for 321 Israeli "Spike" anti-tank guided missile (ATGM) systems & 8,356 missiles were also making some headway after being stalled for months.

Both the 164 laser-designation pods (Litening-4) and 250 advanced "Spice" precision stand-off bombs are meant to arm IAF fighter jets like Sukhoi-30MKIs and Jaguars for greater lethality and accuracy .

The around Rs 10,000 crore joint development of the MRSAM for the Army , in turn, will follow the similar ongoing DRDO-Israeli Aerospace Industries projects worth around Rs 13,000 crore for the Navy and IAF .

The acquisition of two additional AWACS for over \$1 billion, in turn, will be a follow-on order to the three such "force-multipliers" already inducted by the IAF under a tripartite \$1.1 billion agreement inked by India, Israel and Russia in 2004.

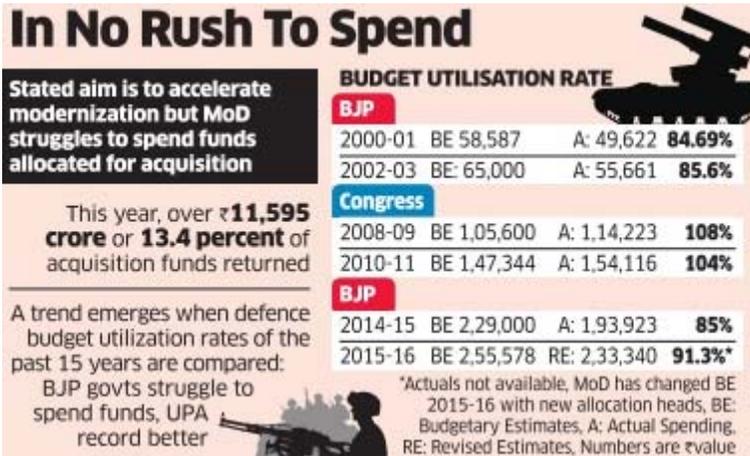
## **Defence Spending Slips When NDA Is In Power**

*This year too, the MoD has returned `11,595 crore earmarked for acquisitions*

At a time where Make in India is the buzz with the private sector looking at South Block for big-ticket procurements to kick start manufacturing, the defence ministry has returned a significant chunk of money reserved for modernisation of the armed forces.

This year, over `11,595 cr or 13.4% of funds earmarked for purchase of military equipment have been returned unspent, leaving several major contracts hanging. It is the second year in a row where a significant part of capital acquisition funds has been surrendered.

Even though the stated priority is modernisation of the armed forces and the most revered slogan of the government is Make in India, the defence ministry has been struggling to spend even allocated funds, let alone ask for more as big contracts like the Rafale fighter deal mature. A study of the utilisation rate of the defence ministry the percentage of funds allocated at the beginning and the actual spending in the financial year reveals that this is not an isolated case. In its ten years in power, the UPA government managed to exhaust most of its annual defence budget, returning less than five percent in some cases.



However, since coming to power in 2014, the BJP government has been struggling to spend. In the last financial year 2014-15, only 85% of the ₹2.29 lakh crore defence budget was used. This year has been marginally better at 91.3% utilisation, which could fall after final numbers are available in April.

This has meant that thousands of crores earmarked for major contracts Rafale fighter deal (₹60,000 cr), Selfpropelled howitzers (₹5,000 cr), M777 artillery guns (₹5,000 cr), Additional P8I aircraft (₹7,000 cr) have been surrendered. The surrendering of funds has resulted in a minutely small increment in the defence budget this year just over 1.16 %.

This utilisation pattern is not unique to this BJP government. In the past too, utilisation rates have been dismal hovering around 90% when the NDA was last in power. This dismal spending is leading to an increasing concern, especially within the private defence sector, on the government's ability to go ahead with major 'Make in India' projects that require firm orders and committed resources.

*The Pioneer*  
02 Mar, 2016

## Raw deal for Armed Forces in Budget

Modi's words alone will not ensure Defence modernisation. Let us get serious about addressing the man-machine mix. Never should a service chief have to ever say: "We will fight with what we have"

There are some firsts in this fiscal's Budget presentation by Minister for Finance Arun Jaitley: No mention of Defence allocation in the Budget speech, new formatting of Defence outlay (ordnance factories, DRDO taken out as also the NCC head removed from the Army budget); decrease in the capital account from the allocation of the previous year; and distinction between Plan and non-Plan expenditure deleted. Defence was considered non-Plan.

I have been observing the Budget presentation since 1990. Not once was Defence outlay excluded from the Finance Minister's speech, which would go something like this: "The Defence allocation is rupees 'x' crore, which is an increase of 'y' per cent over the previous year. Our brave jawans are doing a magnificent job from snowy heights of Siachen to the dusty deserts of Rajasthan. We salute their sacrifices (applause). If more funds are needed, these will be provided (applause)." This year, there was a blank and that too from a former Defence Minister. Noticing this omission of Defence from the speech, Prime Minister Narendra Modi made up for it in his post-Budget commendation. He made four points: The soldier is the sentinel of the nation's security; he requires to be armed with modern weapons and for this Make in India is vital; OROP (still incomplete) has been awarded to the ex-servicemen.

The Budget is growth-oriented, focusing on agriculture, hailing the kisan. Former Prime Minister Lal Bahadur Shastri coined the slogan, Jai Jawan Jai Kisan, during the 1965 war. Even with Mr Modi's focus on the need for modernisation, the Finance Minister has neglected this crucial aspect of military preparedness and deterrence. This Budget is certainly not 'Jai Jawan'. The marginal

increase to Rs2,49,099 crore from Rs2,46,727 crore is roughly five per cent and is mainly due to increase in the revenue head. It constitutes 1.65 per cent of the GDP, which is the lowest since 1962. India requires a minimum spending of 2.25 per cent to 2.50 per cent of the GDP for steady military growth.

Take a look at some broad figures. The revenue account in 2015-16 was base estimate: Rs1,32,540 crore; revised estimates was Rs1,25,808 crore. These figures presumably catered for the OROP and normal pension and the difference of nearly Rs1,6,000 crore would have been returned as OROP has not been disbursed. The revenue outlay for 2016-17 is base estimate: Rs1,48,498 crore, which is roughly Rs22,690 crore more than the last fiscal's revised estimates. The capital account for 2015-16 was base estimate Rs85,894 crore and revised estimate, Rs74,299 crore, resulting in nearly Rs12,000 crore being returned to the Government. The 2016-17 capital outlay is Rs78,586 crore, which is an unprecedented reduction of Rs7,308 crore from the modernisation budget of the previous year.

This would seriously imperil defence upgrade including state of operational readiness as existing shortfalls in ammunition (as pointed out in General VK Singh's famous letter of 'critical operational hollowness' in 2012 and which rocked Parliament) have still not been made good for a war-fighting contingency. Factoring in the depleted capital outlay, domestic inflation and the declining value of the rupee against the dollar would further decrease the reduction.

The surrender of unspent money of more than Rs15,000 crore is a bonanza for the Finance Minister managing the fiscal deficit. The Armed Forces are willing and obedient responders to the return of unutilised funds instead of parking them in a rotational modernisation account as suggested once by former Defence Minister Jaswant Singh. One Defence Secretary recently told me how he would get a call from North Block around January about performing this dutiful service to the state. No Government has ever bothered to seriously examine why, year on year, this dereliction of modernisation is condoned. The services are as culpable as the bureaucrats and politicians for the omission to keep sharp, the sword arm of the state.

There is immense expectation from the Armed Forces and ex-servicemen from the BJP-led Government on defence and national security. It has delivered reasonably satisfactorily on the OROP but must not let the anomalies of the Seventh Pay Commission go unrectified. The incremental diminution of the soldier in his Warrant of Precedence, salary and allowances compared to IAS/IFS and now the Police and Paramilitary services, is a travesty of justice. Extending the hardship allowance in excess of Siachen allowance to civilian services posted in Guwahati and Shillong is simply mind-boggling. Clearly, this is a case of the blind leading the blind. It is patently wrong to persistently test the tolerance of the soldiers. An article in The Times of India on Monday ran this headline on the royal mess in Haryana: "Why 50,000 cops can't do what 5,000 troops can'.

It is high time Governments and Parliament take defence and national security more seriously than they do. Our politicians work on the standard assumption that there will be no war. Do not forget 1962 or Kargil in 1999 when economic liberalisation reforms launched in 1991 had reduced the Defence budget for modernisation of the economy. At that time, the Army chief, Gen VP Malik, lamented: "We will fight with what we have." An SOS was sent to Israel to bail us out of a tricky situation. And Israel obliged by transferring precision-guided munitions and other stores from their inventory. Still, 600 precious lives were lost for failing to operationalise deterrence. In 2001, after the attack on Parliament, the Armed Forces were found by the Defence Minister to be ill-prepared to go to war.

If India has to grow at 7.6 per cent annually, it must be internally stable and strong no Rohtaks please and deter Pakistan including its cross border terrorism. And don't forget catching up with China. It would help to get a clearer fix on the Government's strategic priorities. If India is to lay down arms in fighting Pakistan-sponsored terrorism and not bother about tooth-aches (which is how Prime Minister Modi described the border issue with China) a Strategic Defence and Security Review needs to be undertaken afresh, like the tentative one done during the tenure of the Atal Bihari Vajpayee Government.

Mr Modi's words alone will not ensure Defence modernisation and Make in India (rather, Made by India). Let us get serious about addressing the man-machine mix. Never should a service chief have to ever say: "We will fight with what we have."

*The Hindustan Times*  
02 Mar, 2016

## **Notice to defence ministry for holding near-naked army test**

The Patna high court on Tuesday sought response from the defence ministry over reports on the Indian Army making candidates take a written exam in their underwear in Bihar to prevent cheating.

On the basis of photographs in newspapers, lawyer Deenu Kumar had filed a PIL on Monday, which a division bench converted into a writ and gave the order to the ministry of defence on Tuesday, seeking a reply by April 5.

According to sources, the zonal recruiting office of the Indian Army has already taken note of the incident and sent a detailed report to the army headquarters. The army headquarters had sought a detailed report as soon as the matter came to light.

Sources said the report has underlined that such examinations were conducted this way for a long time and there was nothing unusual. "In Bihar, one such exam had to be cancelled fully due to cheating. Thereafter, a decision was taken to conduct the one-hour examination in the open, which would also avoid frisking," the source added. The question that the army posed was if the conduct of examination in the open was to harass or humiliate anyone, according to other sources. "This is a practice since the British age. The candidates never had any objection to it. In fact, after the cancellation of February 2015 exam, some of the candidates wanted bare-body examination."

*The Tribune*  
02 Mar, 2016

## **Kerry asks Pak to cut nuke arsenal**

The US has pressed Pakistan to reduce its growing nuclear arsenal but Islamabad has refused to accept any curbs on it saying America must show "greater understanding" of its security concerns in South Asia.

Citing the example of the US and Russia which are working to further reduce their nuclear arsenals, Secretary of State John Kerry asked Pakistan to understand this reality and review its nuclear policy.

The nuclear issue was discussed during security talks held here yesterday as part of the US-Pakistan strategic dialogue.

“I think, it is important for Pakistan to really process that reality and put that front and centre in its policy,” Kerry said in an apparent reference to the reports that Pakistan has the fastest growing stockpile of nuclear weapons in the world.

His remarks come ahead of this month’s Nuclear Security Summit to be hosted here by President Barack Obama that would be attended by Pakistan Prime Minister Nawaz Sharif.

“We look forward to Prime Minister Nawaz Sharif’s participation in the nuclear security summit next month,” Kerry said, adding “non-proliferation” and “nuclear safety” is of obvious concern to both countries.

“I expect that we continue to discuss the obligation of being a responsible state with nuclear weapons in the coming year,” he said.

“As you know United States of America once had 50,000 (nuclear) warheads pointing at another country/entity the Soviet Union. Soviet Union had 50,000 pointing at us. It took two Presidents (Mikhail) Gorbachev and (Ronald) Reagan to decide that this did not make sense,” Kerry said.

“We have moved in a completely opposite direction. And today, Russia and the United States are operating under a treaty that has about 1500 or so nuclear warheads and we are seeking to reduce that,” said the top American diplomat.

On the other hand, Aziz sought nuclear mainstreaming of Pakistan. “Our engagement on non-proliferation and strategic stability will continue and Pakistan hopes to see greater US understanding of Pakistan’s security concerns and its desire to contribute actively as a mainstream nuclear power,” he said.

Pakistan has said that it will not accept any unilateral curbs on its nuclear programme and that any reduction should apply to India as well and the US should also consider its concerns on the growing weapons disparity.

*The Statesman*  
02 Mar, 2016

## **North must pay price for N-test: Park**

North Korea must pay the price for its latest nuclear test and rocket launch, South Korean President Park Geun-Hye said today, vowing to pressure Pyongyang into accepting denuclearisation as its only viable option for survival.

In a televised speech to mark the anniversary of a key date in Korea’s struggle against Japanese colonial rule, Park said failure to respond to the North’s “reckless provocations” would only result in further nuclear tests.

“If we leave them alone, they will continue,” said the president, who has significantly toughened her stance against Pyongyang in the wake of the North’s fourth nuclear test on January 6 and a long-range rocket launch last month that was widely condemned as a ballistic missile test.

“North Korea must clearly understand... that they can no longer maintain their regime through nuclear weapons,” Park said.

Her comments came as the UN Security Council heads toward a vote on a new US-drafted resolution that would impose the toughest sanctions yet on North Korea over its nuclear weapons programme.

The draft text would require countries to take the unprecedented step of inspecting all cargo to and from North Korea, impose new trade restrictions and bar North Korean vessels suspected of carrying illegal goods from ports.

*The Hindu*  
02 Mar, 2016

## **UN postpones N. Korea sanctions vote to Wednesday**

The UN Security Council delayed until Wednesday a vote on a new raft of sanctions on North Korea to punish the reclusive regime after its fourth nuclear test and rocket launch.

With backing from China, the council is expected to adopt a U.S.-drafted resolution that takes aim at North Korea's nuclear and ballistic missile programs by cutting off sources of hard currency and access to technology.

The council had initially planned to vote on Tuesday, but the meeting was delayed at Russia's request. Russia's UN mission declined to provide reasons for the delay, but spokesman Alexei Zaytsev said "we confirm that the vote will take place tomorrow" at 10:00 am (1500 GMT).

The United States has described the package of measures as the toughest sanctions yet to hit North Korea, but the impact will depend largely on China, Pyongyang's sole ally and main benefactor.

North Korea carried out its fourth nuclear test on January 6, which was followed by the launch on February 7 of a satellite-bearing rocket that the world viewed as a disguised ballistic missile test.

Both tests are banned under a series of UN resolutions that condemn North Korea's nuclear and ballistic missile programs as a threat to world peace and security.

The latest draft would require countries to take the unprecedented step of inspecting all cargo to and from North Korea, impose new trade restrictions and bar vessels suspected of carrying illegal goods for North Korea from ports.

*The Hindu*  
02 Mar, 2016

## **IS infiltrates Iraq army HQ, kills general**

Four Islamic State group suicide bombers infiltrated an army headquarters west of Baghdad, killing an Iraqi general and five other soldiers, police officers said on Tuesday .

The bombers attacked a regimental headquarters in Haditha area of Anbar province late Monday , killing Brigadier General Ali Aboud, Lieutenant Colonel Farhan Ibrahim and four others. Major General Ali Ibrahim Daboun, the head of the Al-Jazeera Operations Command, said one suicide bomber blew himself up inside Aboud's office, while the other three detonated explosives. Seven soldiers were also wounded in the attack, Daboun said.

Colonel Faruq al-Jughaifi, the Haditha police chief, said the bombers were dressed in military uniforms.

Iraqi tribesmen and security personnel defending Haditha have held off IS for more than 18 months with the help of air strikes by a US-led coalition.

## **Girl-next-door Sunita Williams bats for STEM education for girls**

She has witnessed the spectacle of 16 sunrises and 16 sunsets in a day while on her mission to space. Having achieved this feat and still hungry for more, Captain Sunita Williams believes nothing is impossible. At an interactive session on women's empowerment on the theme, Women's Empowerment through STEM (science, technology, engineering and mathematics) Education organised by FICCI Ladies Organisation recently, the NASA astronaut shared some of her life's valuable lessons. Here are some of them:

1. It is possible to achieve anything if a person is qualified and determined with the will to make the right decisions. A person should aspire to try out new things and explore new opportunities. Confidence, perseverance, persistence and knowledge play a key role in achieving the most challenging feats.
2. Calling herself a 'girl next door,' Captain Williams said there was no dearth of opportunities and one only had to grab and explore them.
3. It is important to be a good student as it opens doors of opportunities.
4. Young girls should be encouraged to pursue STEM education as it provides a whole lot of opportunities across the board. Studying STEM today offers a plethora of areas to learn, explore and understand, she said.
5. Captain Williams recalled that when she had joined the US Naval Academy, there were only 10% women in the school, a number which over the years has increased significantly. Now women occupy 20% seats at the academy. NASA was also looking out for young engineers and was keen on having young and feisty females in its midst.
6. Speaking about her experiences in a male-dominated field, Captain Williams said that she often found herself in a minority but it never deterred her or interfered with her goals. She knew her tasks well and was competent to take on any challenges. She added that every woman brought teamwork to the table and willingly took care of the team.

## **Silent Boom**

**NASA** says supersonic jets need not be noisy. They are now trying to build one that does not produce the disruptive sonic boom

### **The X-Planes**

**This week**, **NASA** awarded a contract for the preliminary design of a ‘lowboom’ flight demonstration aircraft - the first in a series of X-planes in its New Aviation Horizons initiative

**If successful**, **NASA** will move a step towards affordable supersonic passenger air travel

### **Quest Quest**

**Lockheed Martin** Aeronautics Company will make the preliminary design for the Quiet Supersonic Technology (QueSST)

**NASA’s aim** is to build a piloted test aircraft that can fly at supersonic speeds, creating a supersonic ‘heartbeat’ instead of the loud boom one hears when a plane breaks the sound barrier

### **What is a supersonic plane?**

**Supersonic planes are** those that can travel faster than the speed of sound — the speed of sound is about 768 miles per hour at sea level

**The first person** to fly an aircraft faster than the speed of sound was Captain Charles E. “Chuck” Yeager

**Capt Yeager** broke the sound barrier on October 14, 1947

**Superfast flights - In August** last year, Airbus won a patent for a hypersonic passenger plane called Concord 2.0 that will be able to fly between London and New York in an hour - or Mumbai and Delhi in 20 minutes

**Boston-based** Spike Aerospace is building a supersonic jet to fly from New York to London in three hours

### **Going green**

**\$20 MILLION - Is how much** Lockheed Martin will get over 17 months for QueSST’s preliminary design work

**The goal is to reduce fuel use**, emissions and noise through innovative aircraft design.

*The Deccan Herald*  
02 Mar, 2016

## **New images may solve mystery of Mars moon**

Nasa scientists are closer to solving the mystery of how Phobos was formed, by using the spectral images of the Mars' moon captured in ultraviolet by the MAVEN mission.

In late November and early December last year, Nasa's Mars Atmosphere and Volatile Evolution (MAVEN) mission made a series of close approaches to the Martian moon Phobos, collecting data from within 500 kilometres of the moon.

Among the data returned were spectral images of Phobos in the ultraviolet.

The images will allow MAVEN scientists to better assess the composition of this enigmatic object, whose origin is unknown, Nasa said.

Comparing MAVEN's images and spectra of the surface of Phobos to similar data from asteroids and meteorites will help planetary scientists understand the moon's origin - whether it is a captured asteroid or was formed in orbit around Mars.

The MAVEN data, when fully analysed, will also help scientists look for organic molecules on the surface.

*The Deccan Herald*  
02 Mar, 2016

## **Stretchable electronics soon**

Scientists have developed conductive tracks that can be bent and stretched up to four times their original length, and could be used in artificial skin, connected clothing and on-body sensors, reports PTI from Geneva.

Conductive tracks are usually hard printed on a board, but those developed by researchers at Ecole Polytechnique Federale de Lausanne (EPFL) in Switzerland are almost as flexible as rubber and can be stretched up to four times their original length.

They can be stretched a million times without cracking or interrupting their conductivity, researchers said.

Both solid and flexible, this new metallic and partially liquid film offers a wide range of possible applications. It could be used to make circuits that can be twisted and stretched - ideal for artificial skin.

It could also be integrated into fabric and used in connected clothing. And because it follows the shape and movements of the human body, it could be used for sensors designed to monitor particular biological functions.

"We can come up with all sorts of uses, in forms that are complex, moving or that change over time," said Hadrien Michaud, a PhD student at the Laboratory for Soft Bioelectronic Interfaces (LSBI) and one of the study authors.

Extensive research has gone into developing an elastic electronic circuit. It is a real challenge, as the components traditionally used to make circuits are rigid.

## **2D material may upstage wonder material graphene**

**Washington, PTI: A new one atom-thick flat material that could upstage the wonder material graphene and advance digital technology has been discovered by scientists led by an Indian-origin physicist in US.**

The material is made up of silicon, boron and nitrogen - all light, inexpensive and earth abundant elements - and is extremely stable, a property many other graphene alternatives lack.

"We used simulations to see if the bonds would break or disintegrate - it did not happen," said Madhu Menon, a physicist at the University of Kentucky in US.

"We heated the material up to 1,000-degree Celsius and it still did not break," said Menon, who worked with scientists, including those from the Institute for Electronic Structure and Laser (IESL) in Greece.

Using state-of-the-art theoretical computations, Menon and his colleagues demonstrated that by combining the three elements, it is possible to obtain a one atom-thick, truly two-dimensional (2D) material with properties that can be fine-tuned to suit various applications beyond what is possible with graphene.

Graphene with many unique properties has one downside: it is not a semiconductor and therefore disappoints in the digital technology industry.

Subsequent search for new 2D semiconducting materials led researchers to a new class of three-layer materials called transition-metal dichalcogenides (TMDCs).

TMDCs are mostly semiconductors and can be made into digital processors with greater efficiency than anything possible with silicon.

However, these are much bulkier than graphene and made of materials that are not necessarily earth abundant and inexpensive.

Searching for a better option that is light, earth abundant, inexpensive and a semiconductor, the team led by Menon studied different combinations of elements from the first and second row of the periodic table.

Although there are many ways to combine silicon, boron and nitrogen to form planar structures, only one specific arrangement of these elements resulted in a stable structure.

The atoms in the new structure are arranged in a hexagonal pattern as in graphene, but that is where the similarity ends.

*The Economic Times*  
02 Mar, 2016

## **Samsung's Chip has the Storage Power of a PC**

Smartphones could soon be getting PC-like storage capabilities after Samsung revealed it has started mass production of 256GB memory chips for mobile devices. The embedded chips are based on the Universal Flash Storage (UFS) 2.0 standard and offer speeds almost double that of SATA-based solid state drives (SSD) for desktop PCs, the company said. The new memory chip is capable of supporting seamless 4K Ultra HD video playback on a large-screen mobile device while multitasking.

*The Deccan Herald*  
02 Mar, 2016

## **Study links Zika to temporary paralysis**

A new study of 42 cases of Guillain Barre syndrome in French Polynesia offers the strongest evidence to date that the Zika virus can trigger temporary paralysis, researchers reported on Monday. But experts cautioned that more evidence from other locations was needed to be conclusive.

Since last year, doctors have noticed an unusual increase in Guillain-Barre cases in several countries with Zika outbreaks, including Brazil, El Salvador and Venezuela. But as the WHO reported on Friday , a large number of those patients have not yet been confirmed through laboratory testing to have Zika.

Guillain-Barre leaves patients unable to move, in extreme cases forcing them to depend on life support. In French Polynesia none of the patients, but 38% went to an ICU and 29% needed help breathing.

## **Bio-inspiration shows the way**

Getting droplets of water to form from vapour and then moving the water away has industrial importance. Whether it is water-harvesting, condensation in a steam turbine or fogging of a windscreen, there is the need for a surface that combines both the ability to form droplets as well as effectively drain the condensation centre.

Kyoo-Chul Park, Philseok Kim, Alison Grinthal, Neil He, David Fox, James C Weaver and Joanna Aizenberg, at Harvard University, in their report in the journal *Nature* say that existing approaches based on very fine-scale texturing of surfaces have not been able to simultaneously optimise both how fast a droplet grows and how fast it flows away. But the example of the structure and composition used by three different biological species, the authors of the paper say, has led them to design a surface that does a lot better than synthetic ones that have been tried out so far.

The inspiration for the drop-forming structure comes from the beetles that have evolved to squeeze water out of the nearly moisture-free air in the Namib desert on the Atlantic side of southern Africa, an area that receives as little as one centimetre of rain in the year. With no other source of water, these beetles are known to strike a pose with their wings and rear end exposed to the fog and the wind, to harvest precious drops of water that the wings' microstructure channel to the creature's mouth.

While the backs and wings of these beetles have a distribution of small bumps, most studies have attributed their water gathering property to the surface chemistry — of the bumps being “water attracting” while the surroundings are “water repelling”, rather than the topography of the surface, the *Nature* paper says. The emphasis has been on micro and nanoscale structure and pits or depressions have been considered to be better water gatherers than protuberances like the millimetre-sized bumps that the beetles have, the paper says.

The Harvard researchers, however, note that the entire bumpy surface has been found to be covered with water repelling wax, which means that it is not the surface chemistry that helps condensation. On the other hand, they say, even in the absence of a microstructure, the geometry of the millimetre-sized dome could be an agent of condensation by acting to concentrate the flow of vapour over the surface at the top of the dome.

To test this possibility, which was suggested by some members of the group in January 2015, an experimental bumpy surface of the same millimetre dimensions was created by pressing a thin aluminium sheet and treating the surface to be water repelling. The sheet, along with a bump-free control sheet, was then exposed to a temperature- and humidity-regulated environment where the convective movement of air close to the surface was negligible so that the main effect near the surface was a diffusion of air due to molecular movement. While there was a degree of droplet formation due to condensation, what was seen was that the largest droplets, which indicated concentration of vapour, occurred at the apex of bumps in the bumpy sheet.

A number of control trials were carried out to eliminate the role of roughness or chemical properties of the surface and it was established that it was the curvature of the bump that led to condensation, which increased if the bump was more pointed. There is, hence, an optimum size and even a variation in the shape to be rectangular for the most efficient condensation.

While this trial showed that bumps may be a good way to promote droplets, the next question was how to drain these away so that the water could be collected and was not lost to evaporation. Here again, nature showed an optimised design for drawing the water off, even against the force of

gravity. The method is by using capillary forces, the kind that make the water in a glass vessel creep up at the edges, as exemplified in the spines found on cacti.

Cacti are a category of plants found in desert and arid regions where the priority is conservation of water. Thus, cacti have thick stalks and leaves that have less surface area as a proportion of their volume, and they are partly covered by thin spines. These spines have little water content and so present no avenue for leakage but studies by Jie Ju, Hao Bai, Yongmei Zheng, Tianyi Zhao, Ruochen Fang and Lei Jiang showed, in a paper in the journal *Nature Communications* in 2012, that the spines had barbs with a conical shape, with microscopic grooves that got smoother as they approached the base, to help channel water that may condense from fog or as dew.

The Harvard researchers worked it out that when the bump had a non-symmetrical slope that grew wider as it descended, the drop that formed at the apex would move down the slope and keep moving even as it widened and grew in size as it coalesced with other droplets. The effect of guiding the droplet along the slope was regardless of even the force of gravity, if the bump was oriented so that the flow was upwards.

The effect is dependent on no friction or very little friction while the droplet moves. To simulate this property, the Harvard group relied on a stratagem of another optimisation in nature, a category of carnivorous plants that trap animal prey by luring them to the slippery rim of a deep cavity — the *Nepenthes* pitcher plants, so called because the insect trap is shaped like a pitcher. Following the lead, the Harvard group lubricated the bumps and the asymmetric slope so that droplets could move just as gravity and capillarity would drive them.

The result of trials with all three features — bumps, the slope and lubrication provided — was that larger drops formed faster and then slid down more effectively than with other surfaces that had not been constructed in this topography. “This combination of short response time and reliable, high-volume long-term performance are critical in numerous cases... such as heat exchange, dehumidification and desalination systems,” the authors of the paper say.

## **Remarkably constant**

Wherever adequate genetic data have been obtained, the general features of inheritance in both plants and animals have been found to be remarkably constant. This fact has, of course, enormously simplified the study of inheritance because the basic principles derived from experiments on favourable organisms can then be generally extended to the great majority of species that do not lend themselves to laboratory study. To be sure, differences exist, but in the main the physical features of meiosis-synapsis, crossing over and segregation are sufficiently constant to permit generalisations to be made from the cytological fact to the genetical interpretation, and vice-versa. Indeed, modern cytogenetic interpretation is a composite derived from the observations of many species. Cell division, whether mitotic or meiotic, is a series of events coordinated in both time and space (to give a reasonably predictable result: two genetically identical daughter cells if mitotic, a variety of gametes or asexual spores if meiotic). Thus, an organism heterozygous for a given gene produces gametes carrying each of the alleles with a frequency of 50 per cent. Mendelian ratios demonstrate this equality, as does the constancy of allelic frequencies from one generation to the next in normal diploid populations. Both, of course, depend on the regularity of the meiotic process. Mitosis, at both morphological and molecular levels, provides a mechanism for the maintenance of precise quantitative and qualitative genetic continuity; that is, the daughter cells are the genetic equivalent of the mother cell from which they arose. Meiosis, on the other hand, while providing for genetic continuity, also injects variation into patterns of inheritance through the segregation of alleles, the disruption of linkage groups by crossing over, and the union of gametes of dissimilar genotype. When meiosis is regular, however, these variations occur in predictable ratios, but we find also that additional variation can be introduced by other means. These departures from a regular inheritance have evolutionary significance. The constancy of the chromosome as a structural entity lies in its capacity to reproduce itself at each cell division with extraordinary precision. However, chromosomes can undergo change spontaneously even as genes mutate, and the newly constructed chromosome, like its original counterpart, is replicated exactly at each cell division thereafter. Under natural conditions, such changes in chromosomal structure are rare events; they can, on the other hand, be induced with relative ease by ionising radiations such as X-rays and by chemicals. Chromosomal aberrations leading to rearrangements in the linear order of genes may be grouped into four classes: deletions or deficiencies; duplications; inversions; and translocations. The first three, as a general rule, affect only single-chromosomes, whereas translocations may involve one, two, or more chromosomes. Their detection can be made both cytologically and genetically in favourable material; in less favorable material, certain aberrations can be inferred from the chromosomal configurations found at metaphase and anaphase of meiosis. If the chromosome numbers of a randomly selected group of individuals of a particular species were determined, in all likelihood they would be the same. This situation is to be expected, for species are reasonably constant biological entities and it is not difficult to appreciate that this stability is related to a constancy in the numbers and kinds of genes and chromosomes. Indeed, the chromosome number of a species is a significant biological datum. But even as the genes mutate or change in number through loss or addition, so also do chromosomes. The process is sporadic, for cell and chromosome divisions are remarkably regular phenomena, but variations do occur and are sometimes perpetuated to give rise to new chromosomal races. Variation in chromosome number produces two types of individuals or cells, namely those whose somatic complements are exact multiples of the basic haploid number characteristic of the species, and those whose somatic complements are irregular multiples of the basic number. Individuals or cells of the first type are termed euploid. They may be haploid (monoploid), diploid, triploid, tetraploid, and so on, with the higher multiple members

above the diploids being referred to collectively as polyploids. A tetraploid plant, for example, could produce diploid gametes and gametophytes in much the same manner as a diploid plant produces haploid gametes and gametophytes. However, an irregular meiotic distribution of chromosomes in polyploids due to irregular synapsis and metaphase orientation often leads to comparable irregularities in chromosome number in the gametes and resultant offspring. In many polyploid series, therefore, the initial point of reference is the basic haploid complement of chromosomes, and the term diploidy, for example, implies that each chromosome of the haploid set is represented twice, even though homologous chromosomes may differ from each other in gene content as a result of deficiencies or duplications.

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## **Zapping the brain may boost memory**

London: Brain stimulation, or delivering short bursts of low intensity electrical currents, may boost memory and mental performance, according to a new study that may lead to new treatments for conditions such as PTSD, depression and anxiety.

The breakthrough study by researchers from Catholic University Medical School in Italy involved the use of Transcranial Direct Current Stimulation ( tDCS) on the mice.

A non- invasive technique for brain stimulation, tDCS is applied using two small electrodes placed on the scalp, delivering short bursts of extremely low intensity electrical currents. Understanding how this technique works biochemically may lead to advances in the treatment of conditions like posttraumatic stress disorder ( PTSD), depression and anxiety, which affect learning and memory in otherwise healthy individuals, the researchers said.

The implications of this research also have great potential to strengthen learning and memory in both healthy people and those with cognitive deficits such as Alzheimer's.

“We already have promising results in animal models of Alzheimer's disease,” said Claudio Grassi, from the Catholic University Medical School in Italy, who led the research.