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Renewable Energy for Rural India

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

We should not oversimplify science communication

Dr. R. Gopichandran

I revisited the deliberation announced by the three academies I cited in my last month's editorial[1]. I found all I expected to. The specific thrust on science literacy in informal settings wanted a deeper understanding of three important facets of science communication. They pertained to the relationship between science communication and science literacy; outcomes expected of effective science communication, including its impact on science literacy. The other question was about the value of enhanced science literacy.

The nature of questions reflects the rigour expected to be imbibed while developing communication strategies and implementing them. On the other hand, communication efforts that do not apply this rigour/are oversimplified to meet short-term goals will generate poor quality outputs/outcomes. They cannot also be verified for such impacts as literacy gains or improved preparedness to act for collective good. This clarity is needed especially when programmes on development increase in number. They may also have mutually reinforcing impacts on communities. It is therefore absolutely essential to ensure the outcomes do not contradict each other.

I came across a report about a classic communication exercise[2] that can be seen as partly aligned with the above stated. It is about the Biodiversity Collection Network 2015 in the USA. Please visit the cited site to gather information about the four major issues they wished to tackle and the seven recommendations for action that followed. I will not repeat them or paraphrase them here. However the logical framework they used to represent their recommendations was truly inspiring. Each recommendation had its respective clearly stated goals. Actions to be undertaken to meet the goals were defined. Most importantly the relationship of the goals with each other was also clearly stated. This could help with synergies duly recognizing unique challenges and the justification for reinforcements.

Baruch Fischhoff recently deliberated on "Communicating Science and Science Communication" as part of the APA Public Interest Leadership Conference November 2015. I tend to agree with his idea that communicating science is more about stories on frontiers and developments. Science communication could be about helping citizens decide. Stories could be a part of the latter. He defines six important reasons that could influence success of communication. The most important take away for me as a communicator is the call for detailed investigations about the circumstances that determine the dominance of each or many of these reasons. These will also remove biases in my own mind about people I interact with. Importantly I will then refrain from passing a judgement on their willingness/preparedness to learn/change. I will become scientifically better tempered and not thrust my own agenda on others.

1. http://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_171086.pdf
2. https://bcon.aibs.org/wpcontent/uploads/2016/03/BCoN_Communications_Workshop_Report.pdf

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Fun With Magic Squares

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Magic squares are quite ancient. They first found mention in a manuscript from the time of Emperor Yu in 2200 B.C. Lot of works related to magic squares have been done in connection with recreational mathematics. By the year 1693, Bernard Frenicle de Bessy, an amateur French mathematician and one of the prolific researchers in magic squares had created as many as 880 Order-4 magic squares. Indeed we have come a long way. From magic squares we have transcended to magic cubes, four dimensional magic hypercubes and these have been explored world over. The world of magic square is now very vast. In this article some interesting and apparently lesser known features about magic squares are presented.

Magic Square of Order-3

The most fundamental magic squares is of Order-3 (Fig.1). It is also the oldest magic square. It has 3×3; that is, nine squares and contains all numbers from 1 to 9, used only once. The sum of the numbers in each row, each column and each of the two diagonals is same, here it is 15. This sum is called the *magic square constant.*

4	9	2
3	5	7
8	1	6

Fig.1. A magic square of Order-3

The magic square of Order-3 can be the one shown in Fig.1. It can also be its three rotations by 90° or a mirror image of one of the four positions obtained by way of rotation. In case of mirror image one should not consider the issue of lateral inversion in the strict sense of the term, which means that the image of each number is a replica of itself; '6' does not become '9' or *vice versa*.

Now, we shall do an interesting analysis as to which number would appear in the central cell. Will it always be 5? Let us see. Let us call the numbers $n_1, n_2, n_3, n_4, n_5, n_6, n_7, n_8$ and n_9 (Fig. 2)

n_1	n_2	n_3
n_4	n_5	n_6
n_7	n_8	n_9

Fig.2. To find the number in the central cell

According to the condition of a square being a magic square,

$n_1 + n_4 + n_7 = S$ - (1)
$n_3 + n_6 + n_9 = S$ - (2)
$n_1 + n_5 + n_9 = S$ - (3)
$n_3 + n_5 + n_7 = S$ - (4)

where S is the magic square constant.

From the above equations we get

$n_4 + n_7 = S - n_1$
$n_6 + n_9 = S - n_3$
$n_5 + n_9 = S - n_1$
$n_5 + n_7 = S - n_3$
$\therefore\ n_4 + n_7 = n_5 + n_9$ - (5)

and

$\therefore\ n_6 + n_9 = n_5 + n_7$ - (6)

Adding (5) and (6), we get

$n_4 + n_6 + n_7 + n_9 = 2n_5 + n_7 + n_9$
$n_4 + n_6 = 2n_5$

To each side of above, we add n_5 to get

$n_4 + n_5 + n_6 = 3n_5$
or $S = 3n_5$
or $n_5 = S/3$
Here $S = 15$
$\therefore n_5 = 15/3 = 5$

So, the number in the central cell will always be 5[1]

In a magic square of Order 'n'; that is, the square is (n×n), if the elements are all integers from 1 to n^2, as has been the case with the magic square of Order-3, then the magic square constant is the sum of all integer from 1 to n^2, divided by n. So, the constant works out to be,

$$\frac{1}{n} \times \frac{n^2}{2}(1 + n^2) = \frac{n}{2}(1 + n^2)$$

For n = 3, it works out to,

$$\frac{3(1+3^2)}{2} = \frac{3(1+9)}{2} = \frac{3}{2} \times 10 = 3 \times 5 = 15,$$

which corroborates with our analysis.

Magic square of Order-4

Magic square of the Order-4 means a 4×4 square. Here we shall discuss such a magic square which consists of the numbers 1 to 16 with each number appearing only once (Fig. 3). The magic constants will be $2(1+4^2) = 2\times17 = 34$

However, the features are a lot more than what we saw in case of the Order-3 magic square.

1	14	15	4
12	7	6	9
8	11	10	5
13	2	3	16

Fig.3. A (4×4) Magic Square

Let us study the features:

It can be observed that the sum of all rows, all columns and the two diagonals is '34'.

Now, there are six more properties.

a) *The sum of the numbers at the corners = 1+4+16+13=34*

b) *There are five 2×2 squares, four at the corners and one at the centre. The sum of the numbers therein is 34 in each case. It can be seen as under.*

1+14+7+12 = 34
15+4+9+6 = 34
10+5+16+3 = 34
8+11+2+13=34
7+6+10+11=34

Going back to the fact that the sum of each of the row is again '34', we also find that,

c) *In each row, the sum of one pair of adjacent number is 15 and the sum of other pair is 19.*

Now, let us take up the sum of squares of the numbers in each row.

For the first row, it is $1^2 + 14^2 + 7^2 + 12^2 = 1+196+49+144 = 438$

For the fourth row, it is $13^2 + 2^2 + 3^2 + 16^2 = 169+4+9+256 = 438$

Such sums for the second and third rows are,

$12^2+7^2+6^2+9^2 = 144+49+36+81 = 310$,

And, $8^2+11^2+10^2+5^2=64+121+100+25 =310$

d) *In other words, the sums of squares of the numbers in the two outer rows are equal and those in the two inner rows are also equal. The same happens with the inner and outer columns.*

The sums of the squares of the numbers on the two outer columns are,

$1^2+12^2+8^2+13^2 = 1+144+64+169 = 378$
And $4^2+9^2+5^2+16^2 = 16+81+25+256 = 378$

Again, the same for the two inner columns are:

$14^2+7^2+11^2+2^2 = 196+49+121+4 = 370$
And, $15^2+6^2+10^2+3^2 = 225+36+100+9 = 370$

Now, let us draw on the square, as shown in Fig. 4, a smaller square (notional) using broken lines.

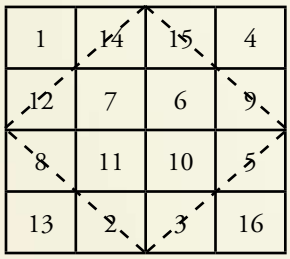

Fig.4. A square with broken lines inside the original magic square.

Let us take pairs of opposite sides in the new square. The sums of the numbers are,

12+14+5+3 and 15+9+2+8; i.e., each is equal to 34.

Again let us check the sums of the squares and of the cubes of these numbers.

We find,

$12^2+14^2+3^2+5^2 = 144+196+9+25 = 374$
And, $15^2+9^2+2^2+8^2 = 225+81+4+64 = 374$

Again,

$12^3+14^3+3^3+5^3 = 1728+2744+27+125 = 4624$

And, $15^3+9^3+2^3+8^3 = 3375+729+512+8 = 4624$

e) *So, the sums of the numbers on the opposite sides of the broken squares, their squares and the cubes are equal.*

Now, referring to Fig. 5, *the rows and columns still add up to 34, but the main diagonal numbers do not. It is a semi-magic square.*

12	7	6	9
1	14	15	4
8	11	10	5
13	2	3	16

Fig.5: A semi magic square with the first two rows of the original magic square interchanged

We can make further modification to this magic square and obtain more striking features. The original magic square is as under (Fig. 6)

Now, let us move Row-b to the position of Row-a; Row-d to position Row-b; Row-a to position Row-c and Row-c to Position Row-d. So, we have the square as we see in Fig. 7.

a	1	14	15	4
b	12	7	6	9
c	8	11	10	5
d	13	2	3	16
	I	II	III	IV

Fig.6. The original magic square, with rows marked as a, b, c, d and columns as I, II, III, IV

12	7	6	9
13	2	3	16
1	14	15	4
8	11	10	5

Fig.7. The square after some modification of the original.

Now let us exchange the second and the third columns, so that we get Fig. 8.

12	6	7	9
13	3	2	16
1	15	14	4
8	10	11	5

Fig.8. The modified magic square

Now, the numbers along the diagonals are 12, 3, 14, 5 and 9, 2, 15, 8. We know that their sums of squares and the cubes are the same.

Speaking about Order-4 magic square, no discussion can be complete without making reference to the (4×4) magic square created by Srinivasa Ramanujan (Fig. 9 and Fig. 10)

Fig.9. Srinivasa Ramanujan

Let us now explore the properties; the numbers are not in a sequence. Srinivasa Ramanujan was a wizard of numbers. The magic square at Fig.10 is an outcome of his rare genius.

We see that the sum of the numbers in each row, each column and each diagonal is

22	(12)	(18)	87
[88]	17	9	[25]
[10]	24	89	[16]
19	(86)	(23)	11

Fig.10. The Ramanujan magic square

'139'. It can be verified as under:

For the rows,

22+12+18+87 = 139
88+17+9+25 = 139
10+24+89+16 = 139
19+86+23+11 = 139

For the columns,

22+88+10+19 = 139
12+17+24+86 = 139
18+9+89+23 = 139
87+25+16+11 = 139

And, for the diagonals,

22+17+89+11 = 139
87+9+24+19 = 139

In other words, the magic square constant is '139'.

'139' was quite a favourite number of Srinivasa Ramanujan. The digits are '1', '3' and '9'; i.e., 3^0, 3^1 and 3^2.

Now, let us see the other properties,

The sum of the numbers at the corners is,

22+87+11+19 = 139

Again there are five (2×2) squares, four at the corners and one at the centre. The sums of the numbers are,

22+12+88+17 = 139
18+87+9+25 = 139
10+24+19+86 = 139
89+16+23+11 = 139
17+9+24+89 = 139

There are two sub-squares (2×2) along the second and the third rows. These consist of the numbers, 88, 17, 10, 24 and 9, 25, 89, 16. The respective sums are,

88+17+10+24 = 139
And 9+25+89+16 = 139

Then, let us consider the encircled numbers which are at symmetrically similar positions. The sum of the numbers is,

12+18+86+23 = 139

Again, we have similarly and symmetrically disposed numbers, given within boxes. Their sum is,

88+10+25+16 = 139

We redraw the magic square (Fig. 10) to explore the other features.

In Fig. 11, let us look at the circles which are at similar positions. The sum is,

88+12+23+16 = 139

22	(12)	[18]	87
(88)	17	9	[25]
[10]	24	89	(16)
19	[86]	(23)	11

Fig.11. Ramanujan's magic square redrawn with circles and boxes at different places

Again, the sum of the numbers at the positions of the boxes which are also at similar positions, is,

10+86+18+25 = 139

The story is not yet over. We shall now go to the climax. Let us go back to the first row. The numbers are 22, 12, 18, and 87. Removing the first two commas by dots and removing the last comma altogether, we arrive at 22.12.1887, which indicates 22nd December 1887, the birthday of Srinivasa Ramanujan!

From Ramanujan we move to the another great talent, Benjamin Franklin (Fig. 12), who was one of the founding fathers of the United States, a renowned author, politician, postmaster, scientist, inventor, civic activist, statesperson and a diplomat.

Fig.12. Benjamin Franklin

Among several of his creations, there was also a (8×8) magic square with a difference (Fig. 13)[3] Here, the sum of all numbers in each row is 260. For example, for the first row, the sum is,

52	[61]	4	(13)	(20)	29	[36]	45
[14]	3	(62)	(51)	(46)	(35)	30	[19]
53	(60)	(5)	12	21	(28)	(37)	44
(11)	(6)	59	(54)	(43)	38	(27)	(22)
(55)	58	(7)	(10)	(23)	(26)	39	(42)
9	(8)	(57)	56	41	(40)	(25)	24
(50)	(63)	2	[15]	[18]	31	(34)	(47)
(16)	1	[64]	49	48	[33]	32	(17)

Fig.13. Benjamin Franklin's (8×8) magic square

52+61+4+13+20+29+36+45 = 260

Again, for the first column, the sum is,

52+14+53+11+55+9+50+16 = 260

The reader may verify the same for other rows and columns. The additional interesting features of this magic square are its bent rows. A bent row can be traced by following an array of eight (four plus four) circled numbers. Let us take one such starting with '11'. The sum is,

11+60+62+13+20+35+37+22 = 260

Again starting from '16' at the left bottom corner, we get the sum as,

16+63+57+10+23+40+34+17 = 260

Every such other bent row sum is 260. It may be verified by the reader.

A typical bent row can be obtained by tracing the numbers in the boxes with bold-type borders, the sum, again is,

14+61+36+19+64+15+18+33 = 260

Several other curious results can be found. For example, if we add the numbers at the four corners and the four numbers at the centre, the sum is,

52+45+16+17+54+43+10+23 = 260

The sum of the numbers at the corner is '130', i.e., half of '260'.

Again, the sum of the numbers at the centre (2×2) sub-square is also '130'. Likewise the sum of the numbers within any (2×2) sub-square is '130'. The reader may verify this. Again, the sum of any four numbers equidistant from the centre, such as (57+5+28+40) or (63+3+30+34) is '130'.

Notwithstanding the fact that there are so many symmetries, the sum of the numbers along any diagonal is not '260'. So, as per the strict definition of a magic square, the Franklin Magic Square does not qualify to be one. It is not known what method Franklin used to obtain his magic square. But it is said that he could generate magic squares as fast as he could write. May be these came to him naturally, like his very practical statement – *"Early to bed and early to rise, makes a man healthy, wealthy and wise."*

Pythagorean Magic Square

This article will be concluded by making reference to a set of three magic squares, which constitute a very interesting representation called the Pythagorean magic square[4] (Fig. 14). It is a combination of a (3×3), a (4×4) and a (5×5) magic squares, arranged respectively on the two mutually perpendicular sides and the hypotenuse of a right-angled triangle (Fig. 15). We know that (3, 4, 5) form a Pythagorean trio, $3^2+4^2=5^2$.

It can be seen that the Magic Square Constant of each magic square is '174'. The sums of the numbers of the magic squares are as under:

(3×3) Square – 174×3 = 522

Fig.14. Pythagoras

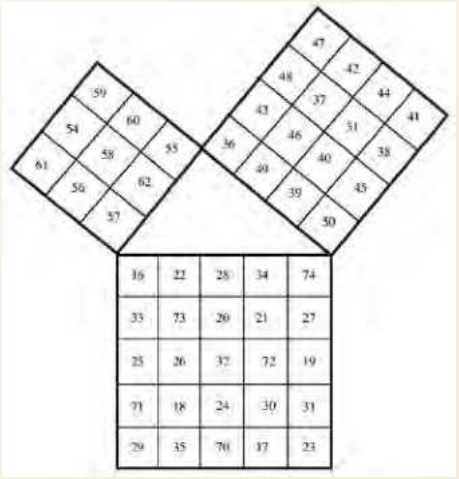

Fig.15. Pythagorean magic square

(4×4) Square – 174×4 = 696

(5×5) Square – 174×5 = 870

And as, $3^2+4^2=5^2$, we have,

$522^2+696^2=870^2$, which is an identity establishing that the sums of the numbers constituting the three magic squares form a non-primitive Pythagorean Trio.

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Zika virus : A serious threat to mankind

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Zika virus is a member of the virus family Flaviviridae that causes mild illness called zika fever with symptoms similar to dengue or chikenguniya. It is known to

Aedes mosquitoes transmit many viral diseases

spread within equatorial belt from Africa to Asia. The infection is caused by the bite of infected Aedes mosquito. It is related to dengue, yellow fever, Japanese encephalitis and west nile virus disease, but produces a comparatively mild symptoms in humans. Symptoms of the zika virus disease include mild headaches, maculopapular rash (a type of rash characterised by a flat, red area on the skin that is covered with small merging bumps), fever, malaise, pink eye and joint pains. One out of five infected people develops symptoms of the disease. The disease is usually mild and can last 2 to 7 days after being bitten by an infected mosquito and there is no report that it can cause death. Despite symptoms similar to dengue it cannot be treated by associated drugs or vaccines. However, the infection is suspected o cause microcephaly (an abnormally small head and underdeveloped brain) in new-born babies through infected mothers.

Virus genome and replication

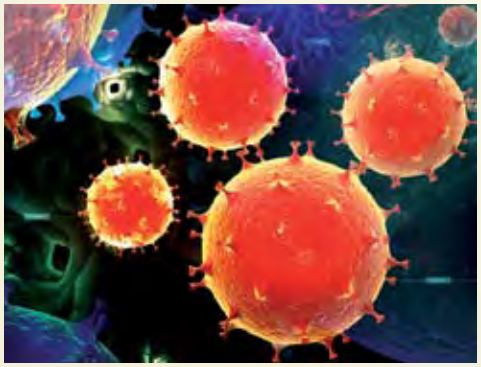
Zika virus was first isolated in 1947 from rhesus monkeys in Zika forest of Uganda and in 1968 was isolated for the first time from a human in Nigeria. Further infection was reported from other African countries and parts of Asia. The infection of the zika virus starts with the mosquito bite with the virus ultimately entering blood stream. While flaviviruses usually replicate in the cytoplasm, zika virus have been found in infected cell nuclei.

Transmission

Aedes aegypti is a vector for the zika virus. Mosquitoes become infected when they feed on a person already infected with the virus. It is also transmitted by *Aedes hensilli*, *Ae. polynesiensis* and *Ae. albopictus*. There has been one report of possible spread of the virus through blood transfusion and one report of possible spread of the virus through sexual contact.

Diagnosis

Many methods can be employed to diagnose the disease. During the first week of illness reverse transcriptase-polymerase chain



Diagrammatic representation of ziks virus

reaction (RT-PCR) can be performed to detect the viral nucleic acid in the serum of the patient. It can also be used to detect in urine or saliva of the patient. Plaque reduction neutralisation test can be performed to detect virus specific for this disease. Serological tests like immunofluorescence assays and enzyme-linked immunosorbent assays may be helpful to show the presence of anti-zika virus IgM and IgG antibodies. However, caution is needed with serological results as IgM cross-reactivity with other flaviviruses has been reported in both primary infected patients and those with a probable history of prior flavivirus infection.

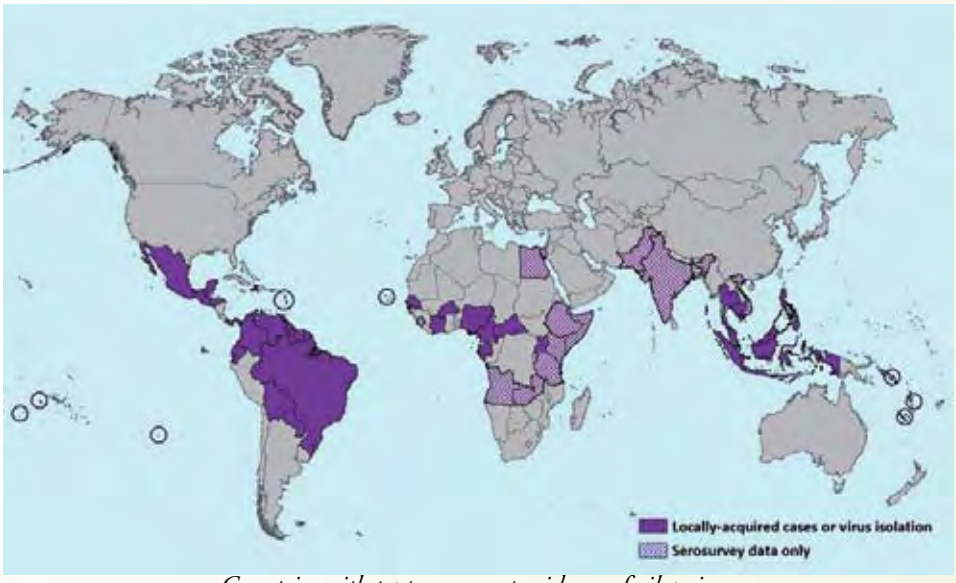
Treatment

There is no commercial vaccine or antiviral drug treatment specific for zika virus infection available. Treatment is primarily based on symptoms and anti-pyretic and analgesic medicines are prescribed. No hospitalisation is required for this disease and death is rare. Plenty of rest and consumption of fluids is usually advised to prevent dehydration. Medicines such as acetaminophen or paracetamol is usually prescribed to relieve fever and pain. However, aspirin and other non-steroidal anti-inflammatory drugs (NSAIDs) like ibuprofen and naproxen need to be avoided until dengue can be ruled out to reduce the risk of hemorrhage (bleeding). Medication should be always taken in consultation with of healthcare professionals.

Outbreak

There are two lineages of zika virus, African lineage and Asian lineage. *Ae. aegypti* is confined to tropical and sub-tropical regions, while *Ae. albopictus* can be found in tropical, sub-tropical and temperate regions. First outbreak of zika virus outside of Africa and Asia occurred in 2007 without any death claimed. In 2007, *Ae. hensilli* was implicated in the spread of zika virus on Yap Island in the western Pacific Ocean, where nearly 75% of the population was infected. *Ae. polynesiensis* was suspected to spread

Symptoms of zika virus infection



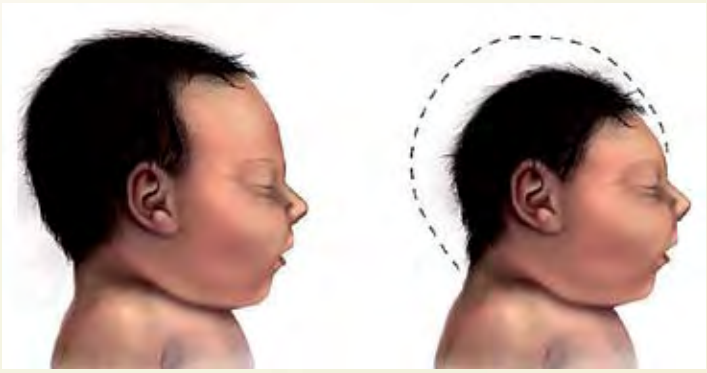
Countries with past or current evidence of zika virus transmission as of December 2015 (Credit: CDC)

zika virus in French Polynesia in 2013. Since April 2015 a large outbreak occurred in Brazil and spreaded to south and central America and the Caribbeans. From October 2015 to January 2016 more than 3,500 cases of microcephaly have been reported and some deaths have been claimed due to severe microcephaly. Women travelling to affected countries have been advised to delay pregnancy. There are concerns that pregnant women who become infected with zika virus can transmit the disease to their unborn babies, with potentially serious consequences.

Zika virus is considered an emerging infectious disease with the potential to spread to new areas where the Aedes mosquito vector is present. As of now, there is no report from India of zika virus infection, but climatic conditions are favourable for the Aedes species of mosquitoes and likely chance to spread the disease in future.

Matter of concern

Microcephaly is a condition in which the affected baby's brain development is not proper and smaller than expected (in comparision to other normal children of the same age and sex). It is a kind of birth defect in which brain develops abnormally in womb or does not grow after birth. It can range from mild to severe. In mild condition it does not affect much, but if the condition is severe, routine check-up is required to monitor the growth and development.



A baby with microcephaly (right) compared to a baby with a typical head size (left)

It can cause seizure, delay in intellectual development like learning ability and daily life functions, difficulty in movement and maintaining balance, feeding problem, and vision and hearing loss.

Another concern of zika virus infection is a possible increased incidence of Guillain-Barre syndrome (GBS) in the affected areas. GBS is an auto-immune neuronal disorder in which the immune system attacks healthy nerve cells of own body in peripheral nervous system. The cause of GBS is unknown but it occurs following an infectious illness like lung infection or stomach flu. It causes muscle weakness and paralysis. There is no cure for GBS, but treatment helps in lessening the severity of the symptoms and reduce the duration of the illness while body's own neuronal system recovers. It can last from a few weeks to months and years. In most cases patient recovers from illness, but in some cases death also occur.

Prevention and control

Prevention and control rely mainly on the control of mosquito breeding and mosquito bite. Emptying standing water from containers such as flowerpots or buckets regularly can go a long way in preventing infection. Use of mosquito repellents containing DEET or picaridin on areas of exposed skin along with protective clothing can help. No vaccine is currently available to prevent zika virus disease, so it is better to prevent zika by avoiding mosquito bites.

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Renewable Energy for Rural India


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A large section of the population in India lives in villages without access to electricity or other sources of energy. In most villages, biomass and fuel wood is used as the primary sources of energy for cooking, which not only leads to depletion of forests but also causes air pollution which affects health. Against this background, renewable sources of energy such as solar and wind energy and biogas offer promising options, which not only have direct bearing on meeting essential energy requirements in villages, but also have the potential in saving the environment and protecting the health of the people. Common renewable sources include solar thermal and solar photovoltaic, biomass and biogas.

Solar thermal devices

A solar thermal device converts solar radiation into heat energy that can be used for cooking, heating or drying. This is achieved by using a black metallic surface (absorber) enclosed in an air-tight box and covered by a transparent glass cover on one side and insulating materials on the other sides.

Solar cookers

Box type solar cookers can be used for cooking different types of food and for steaming, roasting, boiling, etc. It consists of an airtight box with a double-glass cover. A reflector is placed over it for boosting the solar radiation and thus increasing the temperature inside. Because of its simplicity and ease of handling, the box-type solar cooker has found wide acceptance, especially in rural areas.

Solar Box Cooker

Dish solar cooker is a concentration type parabolic dish cooker with diameter of 1.4 m and focal length 0.28 m. The reflecting material used for fabrication of this cooker is anodised aluminium sheet which has a reflectivity of over 75 per cent. The cooker is tracked manually; that is, adjusted every 15 to 20 minutes during cooking time in order to keep the dish always pointed towards the Sun. Such a cooker produces about 0.6 kW of heat which can boil 2 to 3 litres of water in half an hour.

Solar water heating system

It is a flat-plate collector with built-in channels or riser tubes attached to the absorber sheet. The absorber plate is usually coated with black paint to increase the efficiency of heat absorption. Water can be heated up to a temperature of 90°C in such a system, while by using selective coatings or evacuated tubular collectors the temperature of water can be raised up to 100°C. At present solar water heating systems are routinely used for domestic, commercial and industrial applications.

FPC type

Solar dryers

Solar drying systems have many applications in industry and agriculture. Various designs of direct as well indirect type solar dryers for drying vegetables, fruits, grains, fish, timber, chemicals and other industrial products are available. Such dryers not only save energy but also occupy less area, improve quality of the product, and save time. Solar dryers circumvent some of the major disadvantages of classical drying. Solar drying can be used for the entire drying process or for supplementing artificial drying systems, thus reducing the total amount of fuel required.

Solar domestic dryers

Solar dryers are useful for:

- Seasoning of wood and timber.
- Textile industries for drying of textile materials.
- Agricultural crop drying
- Food processing industries for dehydration of fruits, potatoes, onions and other vegetables.

Solar still

A solar still can be used to produce about 4 to 6 litres of distilled water per square metre of basin area in a day of 8-9 hours of sunshine. The yield of a solar still depends on solar insolation (amount and intensity of sunlight), ambient temperature, quality of the glazing, etc.

At present, fibreglass body basin type solar still is available commercially in the market for industrial and other applications. The land requirement for installation of a 100 litres/day capacity solar distillation system would be about 30 to 49 m^2. The solar distilled water is suitable for industrial and laboratory use, in batteries, and can also be used as drinking water in areas where the available water is brackish.

Solar photovoltaic technology

Solar photovoltaic technology enables the conversion of sunlight directly into electricity in an environmentally clean manner. Photovoltaic systems have emerged as useful power sources not only for applications such as lighting, water pumping and telecommunication, but also as power plants for meeting the electrical energy needs of villages, hospitals, lodges etc., besides production of electricity for the grid.

Solar lantern

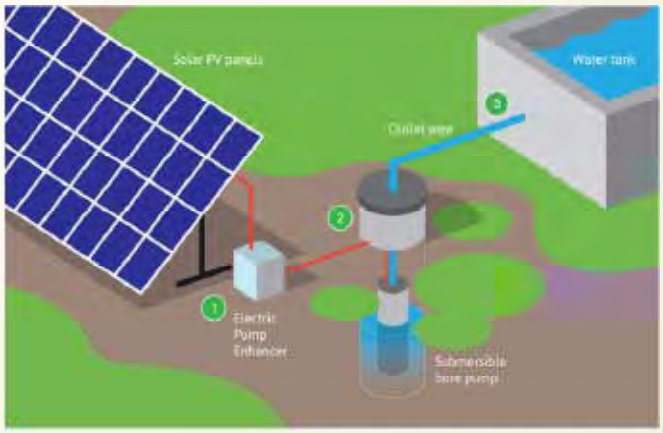
A typical solar lantern consists of a small photovoltaic module, a light source, a high-frequency inverter/ballast, battery, and charge controller. During the day hours, the module is placed in the Sun and it converts the solar radiation into electricity and charges the battery which is connected to the lantern through a cable. In the evening, the lantern with the charged battery is disconnected from the module and is available for indoor or outdoor use. Usually an energy-efficient CFL or LED lamp is used as light source

Street lighting system

A solar PV based street lighting system has a pole, a battery enclosure, a battery, an LED or CFL-based light and photovoltaic module. During the day hours, the module charges the battery. In the evening, when generation through the solar PV module falls, the controller automatically switches on the light for lighting the streets or roads. In the morning, when module starts producing power, the controller automatically switches off the light. At present, such solar PV-based street lights are being used in many remote areas of Rajasthan, islands of the Sunderbans and many remote villages not connected to the grid.

Solar water pumping

Solar water pumps are used to draw water for irrigation as well as for drinking using solar PV technology. A typical solar PV water pumping system comprises a DC or AC, surface mounted or submersible or floating pump that runs on power from a solar PV array. The array is mounted on a suitable structure and place in a shadow-free open space with its module facing south and inclined at local latitude.



Solar water pumping system for irrigation
(Source: http://www.tatapowersolar.com/Solar-Water-Pump

Components of a solar pumping system include:

1. Solar PV array – a set of photovoltaic modules connected in series and parallel combination. The output of solar array is passes through pump controller for conditioning.
2. Pump controller – an electronic device that boosts the linear current. It is equipped with a maximum power point tracking (MPPT) controller and an inverter. The MPPT controls the pump as a function of solar radiation and inverter converts DC power to AC power with suitable frequency. Farmers can benefit from the maximum amount of pump output during the day.
3. Pump block – generally comprising of the motor, which drives the operation and the actual pump which draws the water under pressure, combined in a single block.

A solar photovoltaic array directly generates electricity from sunlight with no moving or wearing parts. Here solar radiation is converted into direct current (DC electricity) which is subsequently converted into AC power and used to run the pump. Solar pumping systems can be used in community water supply systems, fish farming and agriculture, forestry, and wastewater treatment plants. Solar pumping has several benefits over diesel including better return on investment, low maintenance, and no environmental pollution.

Biomass gasification

Biomass gasification is basically conversion of solid biomass (e.g., wood/wood waste, agricultural residue, etc.) into a combustible gas mixture. The process is typically used for "cellulosic" biomass and involves partial combustion of such biomass.

One of the main advantages of biomass gasification is that the gas can be used to run diesel engines in dual-fuel mode. Also it can be used in standard configuration for stand-alone operation, operation through a changeover switch or in grid paralleled mode

Improved cook stoves

In rural households, food is generally cooked on clay stoves called '*chulhas*', which use fuel wood or biomass as fuel. A family of 5 to 6 persons requires about 8 kg of fuel every day. Surveys show that, on an average, the domestic fuel consists mainly of agricultural residues and dried cattle dung, supplemented by fuel wood to the extent of about 40%. Even families, which can afford conventional fuels, prefer to use biomass because it is available free of cost. In forested regions, where the inhabitants are mainly tribals, the fuel consists almost exclusively of wood.

However, these traditional *chulhas* are very wasteful – they use only 10% of the total heating potential of the fuel burnt in them. A more serious disadvantage of the traditional *chulhas* is that they produce a lot of smoke, soot and unburnt volatile organic matter, which not only blacken the pots and the walls of the kitchen, but

also lead to indoor air pollution, which is one of the leading, and yet often neglected, causes of deaths in the developing world. It adversely affects the health of the rural householders by slow health degradation and setting the onset of killer respiratory diseases. In fact, several constituents of the flue gas are even known to cause cancer. Housewives and infants are affected the most by these pollutants, because they are maximally exposed to these gases.

The new, improved cook stoves with metal body and based on the principle of gasification that run on woody/dry biomass are clean and efficient in operation and offer a steady blue flame. This makes them popular in rural as well as semi-urban areas. Once charged with fuel, it can operate continuously for 1.5 to 2 hours. Gasification leads to blue flame and negligible level of emissions.

Wind energy

Wind energy can be successfully used for pumping water, grinding of grains and for electricity generation.

Wind pump

The sized of wind pumps currently available range from 1 to 8-m rotor diameter. The pumping height and average wind speed influences the average power output that can range from a few watts to about 1 kW. For higher power demands, wind electric pumping systems (WEPS) can be used, incorporating a wind generator (available in larger diameter) driving an electric motor-pump combination. At higher power output levels (10 kW or more), the pumping system could be integrated with a small electric grid, supplying electricity for other purposes besides water pumping. For average rural Indian applications, the daily output ranges from 0.1 to 30 kWh per day.

Power generation from wind

Wind energy can be successfully tapped for generation of electricity. Currently, wind generated power accounts for about 20GW of installed capacity countrywide. Wind farms, which constitute clusters of grid-connected wind electric generators of 250-500 kW capacity, have proved to be a feasible method of power generation on a large scale. It is well suited in locations where the annual average wind speed is at least 18 km/h. As wind farms need large open spaces (8-10 hectares/MW), the availability of land in windy regions is extremely important. But within a wind farm, only 5-10 per cent of the land area is actually required for installation of the wind electric generators and roads, etc.; the remaining land can be put to productive use such as crop growing, cattle grazing, etc.

Wind pump

Wind mill

Biogas technology

Biogas comprises of 60-65 percent methane (CH_4), 35- 40 percent carbon dioxide (CO_2), 0.5-1.0 per cent hydrogen sulphide (H_2S), and traces of water vapour. It is almost 20 percent lighter than air. Biogas cannot be converted into a liquid like liquefied petroleum gas (LPG) under normal temperature and pressure. The slurry coming from digester is rich in nitrogen and can be used as a valuable nutrient for plant growth.

Biogas is an easy and healthy cooking fuel since methane emissions from untreated cattle dung and biomass wastes can also be avoided. Since there is no pollution from biogas plants, these are one of the most potent tools for mitigating climatic change.

There are two designs of biogas plant popular in India: (a) In floating drum type design, the digester is an underground tank constructed in brick masonry, stone masonry, RCC or ferrocement. It has an inverted metallic drum which acts as gas holder. The gas produced in digester is collected in gas holder at a constant pressure depends on the weight of gas holder. (b) The fixed dome type biogas plant is a dome shaped underground construction. The masonry gas holder is an integral part of the digester called dome. The gas produced in the digester is collected in dome at variable pressure by displacement of slurry to inlet and outlet.

KVIC biogas plant (left) Deenbandhu biogas plant (centre) Balloon biogas plant (right)

Summary

In contrast to conventional energy sources such as coal and oil, the potential supply from renewable sources is essentially inexhaustible and largely free of external costs. Some renewable energy technologies are already competitive with conventional energy sources, for example biomass or biogas applications. Renewable energy provides greater flexibility. Various daily household applications can be run using more than one source of renewable technology. To conclude, introducing modern technologies for renewable energy production and use can mitigate drudgery of the women folk, especially in the rural areas, reduce environmental damage, support meeting of basic energy needs and foster productive activities.

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Obesity — An Undisputable Killer

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Today, obesity has become one of the major causes of death in the world. Be it the western developed world or a developing country like India, the number of obese people is growing in numbers. Gone are the days when our forefathers used to engage in a lot of physical work and kept themselves fit. In contrast, the present generation spends most time doing sedentary jobs, without much physical activity.

Obesity is a medical condition in which excess body fat accumulates to the extent that it has a negative effect on health, leading to reduced life expectancy and/or increased health problems. The basis on which obesity is calculated is the Body Mass Index (BMI), which is expressed as a person's weight in kilograms divided by the square of height in metres. The following table shows how people are categorised according to their BMI:

BMI (kg/m2)	Classification
< 18.50	Underweight
18.50–24.99	Normal weight
25.00–29.99	Overweight
30.00–34.99	Class I obesity
35.00–39.99	Class II obesity
≥ 40.00	Class III obesity

Causes

Sedentary lifestyle

In the modern age, cars, computers, washing machines, electronic gadgets, etc., have made the life of a common man easy to such an extent that he/she has almost about his/her health! There is hardly any physical activity that an average person engages in.

Diet

Due to modernisation and westernisation, the typical Indian foods are now being

replaced by burgers and other fast foods, which are full of cholesterols and low-density lipids. As a result there is detrimental effect on the health, leading to obesity. Also, lack of balanced diet in itself is one of the major causes of obesity.

Social determinants

Many explanations have been put forth for the associations between BMI and social class. It is thought that in developed countries, where the wealthy are able to afford more nutritious food, they are under greater social pressure to remain slim, and have more opportunities along with greater expectations for physical fitness. In many underdeveloped countries, on the other hand, cultural values favouring a large body size is believed to contribute to the observed patterns. Attitudes toward body weight held by individuals may also play a role in obesity. A correlation in BMI changes over time has been found among friends, siblings, and spouses. Stress and perceived low social status with a slim body appear to increase risk of obesity.

Genetics

Genetics plays a major role in the causation of obesity. Obesity runs in families and highest rate of occurrence is in the first degree relatives and so is with the diseases it causes.

Infectious agents

Intestinal flora has been shown to differ between lean and obese humans. There is an indication that gut flora in obese and lean individuals can affect the metabolic potential. This apparent alteration of the metabolic potential is believed to confer a greater capacity to harvest energy contributing to obesity.

Effects on health

Obesity, as mentioned earlier, has detrimental effects on health. Excessive body weight is associated with various diseases, particularly cardiovascular diseases, diabetes mellitus type 2, obstructive sleep apnoea, certain types of cancer, osteoarthritis, and asthma.

Cardiovascular diseases mainly manifest in the form of palpitations, i.e., feeling of one's own heartbeat, breathlessness, ischemic heart disease, high blood pressure, and congestive heart failure.

Continued on page 21

Stress incontinence – The embarrassing unintentional loss of urine

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Urinary incontinence – the loss of bladder control – is a common and often embarrassing problem. The severity of this condition may range from occasionally leaking urine when a person coughs or sneezes to having an urge to urinate that's so sudden and strong that you don't get to a toilet in time.

This malady can be of many types. Of them, the commonest is stress incontinence. Stress incontinence happens when physical movement or activity – such as coughing, sneezing, running or heavy lifting – puts pressure on the urinary bladder. Even though named so, stress incontinence is in no way related to psychological stress.

Stress incontinence differs from urge incontinence, which is the unintentional loss of urine caused by the bladder muscle contracting, usually associated with a sense of urgency. Stress incontinence is much more common in women than men.

If you have stress incontinence, you may feel embarrassed, become a nervous wreck, isolate yourself, or limit your work and social life, especially exercise and leisure activities. With treatment, you'll likely be able to manage stress incontinence and improve your overall well-being.

What causes stress incontinence?

Stress incontinence occurs when the pelvic floor muscles – the muscles and other tissues that support the bladder; and the urinary sphincter, or the muscles that regulate the release of urine – weaken.

The bladder expands as it fills with urine. Normally, valve-like muscles in the urethra – the short tube that carries urine out of your body – stay closed as the bladder expands, preventing urine leakage until you reach a bathroom. But when those muscles weaken, anything that exerts force on the abdominal and pelvic muscles, for example, sneezing, bending over, lifting, or laughing hard, can put pressure on your bladder and cause urine leakage.

A number of things can work against the normal strength of your pelvic floor muscles and urinary sphincter. They may weaken because of:

Multiple childbirths

In women, poor function of pelvic floor muscles or the sphincter may occur because of tissue or nerve damage during delivery of a child. Stress incontinence from this damage may begin soon after delivery or occur years later.

Women who undergo repeated childbirths at short intervals are particularly vulnerable. This is particularly true in women who return to manual toil soon after childbirth.

Prostate surgery

In men, the most common factor leading to stress incontinence is the surgical removal of the prostate gland, or prostatectomy, to treat a prostate condition. Since the sphincter lies directly below the prostate gland and encircles the urethra, a prostatectomy may result in a weakened sphincter.

Culpable factors

A number of factors can precipitate or worsen stress incontinence. These include:

Age

Although stress incontinence isn't a normal part of aging, physical changes associated with ageing, such as hormonal changes and the weakening of muscles, may make a woman more susceptible to stress incontinence. However, occasional stress incontinence can occur in women of any age.

Multiple deliveries

Multiple vaginal deliveries are often associated with higher rates of the later development of stress incontinence.

Many of these women may also have forceps delivery to more rapidly deliver a healthy baby. Such a forceps delivery may also be associated with a greater risk of stress incontinence.

Obesity

People who are overweight or obese have a much higher risk of stress incontinence. Excess weight increases pressure on the abdominal and pelvic organs. As a result, the pressure on the bladder may be increased even without the additional pressure from a cough or other force. Weight loss can improve stress urinary incontinence.

Previous pelvic surgery

Hysterectomy (surgical removal of the womb) in women and surgery for prostate in men can alter the function and support of the bladder and urethra, making it much more likely for a person to develop stress incontinence. This effect can be either immediate or delayed.

Illnesses

Illnesses that cause chronic coughing or sneezing makes a person vulnerable to develop stress incontinence. Smoking, which can cause frequent coughing, acts in a like manner.

Recognising the Symptoms

If you have stress incontinence, you may experience urine leakage when you:

- Cough
- Sneeze
- Laugh
- Stand up
- Lift something heavy
- Step out of a vehicle
- Exercise
- Have sex

You may not experience incontinence every time you do one of these things, but any pressure-increasing activity can make you more vulnerable to unintentional urine loss, particularly when your bladder is full.

Complications

The biggest complication of stress incontinence is the personal distress you suffer. The condition interferes with your daily activities, and you may feel deeply embarrassed and frustrated by the condition. It can disrupt your work, social activities, interpersonal relationships and even your sex life. Some people are mortified that they need to wear pads or incontinence garments.

You may also experience skin rash or irritation. This happens because skin if constantly in contact with urine tends to become sore and can break down. You are particularly liable to suffer this with severe incontinence if you don't take precautions, such as using moisture barriers or incontinence pads.

When to See a Doctor

If urinary incontinence affects your day-to-day activities, don't hesitate to see your doctor. You may require referral to an urologist, a specialist doctor who treats urinary disorders both in women and men; or a specialist in urinary disorders in women (urogynaecologist).

Write down your symptoms before you visit the doctor. Make a list of the symptoms you're experiencing, including the times when urine leakage occurs. Be prepared to tell the doctor: How often do you leak urine? When you leak urine, is it a few drops or are your clothes soaked? Are there times when you know that you will leak? Do you leak urine when you exercise? Do you wake up during the night to urinate? How often? What's your typical daily fluid intake? Does anything seem to make your incontinence better? How about worse? What bothers you most about your urinary incontinence? Do you also have bowel leakage? How often? Does this cause you to restrict your activities? Does it seem as if there's something "falling out" of your pelvis or vagina?

These questions can give your doctor a good idea of your illness.

What Your Doctor Would Do

During your visit, the doctor would look for clues that may also indicate contributing factors. Your appointment will likely include a:

- Medical history
- Physical exam with particular focus on your abdomen and genitals
- Urine sample to test for infection, traces of blood or other abnormalities
- Brief neurological exam to identify any pelvic nerve problems
- Urinary stress test, in which the doctor observes urine loss when you cough or bear down

Your doctor might also ask you to undergo a few specialised tests although, in most cases, the problem can simply be identified with the help of a detailed history and careful physical examination.

(*Next month*: Stress incontinence: Tests and Treatments)

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Recent Developments in Science and Technology

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New theory of Moon's origin

There have been many theories of the origin of Earth's Moon. The currently most accepted is the one known as the 'Giant Impact' hypothesis, according to which the Moon was formed in a catastrophic collision between the Earth and another body called Theia, roughly the size of Mars, about 4.5 billion years ago when the Earth was still not fully formed. It visualised collision with Theia at an angle of 45 degrees or more – a powerful side-swipe – that led to release of debris that later formed the Moon. New evidence, however, suggests that it was a violent head-on collision. The evidence comes from the analysis of seven rocks brought to the Earth from the Moon by the Apollo 12, 15, and 17 missions, as well as six volcanic rocks from the Earth's mantle – five from Hawaii and one from Arizona (*Science*, 29 January 2016 | DOI: 10.1126/science.aad0525).

The study was done by researchers of the University of California-Los Angeles (UCLA) who analysed the oxygen isotope composition of the moon rocks. More than 99.9 percent of Earth's oxygen is O-16, so called because each atom contains eight protons and eight neutrons in the nucleus. But there are also other heavier isotopes of oxygen, namely O-17, the atoms of which have one extra neutron, and O-18, which have two extra neutrons. Earth, Mars and other planetary bodies in our solar system each has a unique ratio of O-17 to O-16, each one a distinctive "fingerprint". In the recent study, using state-of-the-art technology and techniques to make extraordinarily precise and careful measurements, the researchers found absolute similarity between the Earth and the Moon rocks' oxygen isotope ratios.

According to Edward Young of UCLA, the fact that oxygen in rocks on the Earth and our Moon share the same chemical signature was very telling. Had Earth and Theia collided in a glancing side blow, the vast majority of the Moon would have been made mainly of Theia, and the Earth and Moon should have different oxygen isotope ratios. A head-on collision, however, likely would have resulted in similar chemical compositions of both Earth and the Moon.

This image shows from left Paul Warren, Edward Young and Issaku Kohl. Young is holding a sample of a rock from the Moon. (Credit: Christelle Snow/UCLA)

The extremely similar chemical composition of rocks on the Earth and Moon helped scientists determine that a head-on collision, not a glancing blow, took place between Earth and Theia.

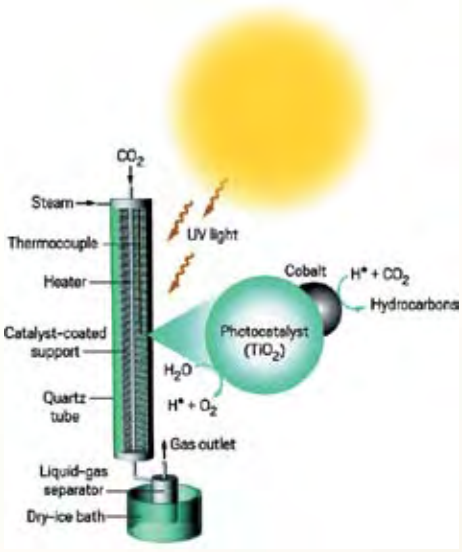
"Theia was thoroughly mixed into both the Earth and the Moon as a result of the giant impact, and evenly dispersed between them," Young said. "This explains why we don't see a different signature of Theia in the Moon versus the Earth."

According to the scientists, Theia, which did not survive the collision (except that it now makes up large parts of Earth and the Moon) was growing and probably would have become a planet if the crash had not occurred. But, if that happened then Earth would not get its only Moon!

One-step process turns CO_2 and water into fuel

The current concern with the use of fossil fuels arises mainly due to the unlocking of carbon stored in the fossil fuels for millions of years and its release into the atmosphere as carbon dioxide. As result the level of carbon dioxide in Earth's atmosphere has been steadily rising leading to global warming and climate change that is already visible as disruption in global weather patterns and increasing frequency of severe weather phenomena around the world. The simplest way to tackle the problem would be of course reducing or stopping the use of fossil fuels altogether. But that's easier said than done.

Although alternative non-polluting renewable sources of energy like solar and wind energy are being developed in right earnest around the world, none offer the reliability and convenience of use as liquid fossil fuels like petrol and diesel. Diesel, jet, and gasoline hydrocarbon fuels are unrivalled in terms of energy density and ease of use and storage. Now a team of chemists and engineers at the University of Texas at Arlington in USA has come up with a better alternative.



Hydrocarbons generated within the SPARC reactor are condensed and separated to complete the process. (Credit: Proc. Natl. Acad. Sci. USA)

They have found a way to convert carbon dioxide and water directly into usable liquid hydrocarbon fuels using heat and high pressure (*Proceedings of National Academy of Sciences*, 22 February 2016, DOI: 10.1073/pnas.1516945113). The process known as "solar photothermochemical alkane reverse combustion" (SPARC) process, operating at 180 to 200 degrees Celsius, and pressures up to six atmospheres, could be achieved in one step. According to the researchers, "This simple and inexpensive sustainable technology could potentially help limit global warming by removing carbon dioxide from the atmosphere to make fuel". An additional advantage of the process is the production of oxygen as a by-product that can be released into the atmosphere.

The tube-shaped reactor is designed in such a way that when sunlight strikes a bed of photocatalysts, made from cobalt-coated titanium dioxide beads, charge carriers are liberated, which travel to a bead's surface and oxidise water into oxygen and electrons. The cobalt takes up the electrons, which then react with protons and CO_2 to form hydrocarbons in a process similar to Fischer-Tropsch synthesis.

There have been previous successes in producing hydrocarbons using the same starting ingredients, but it was rare to produce anything with more than one carbon, such as methane or methanol. But the UT Arlington team has developed a reactor that can create products with up to 13 carbon atoms – liquid hydrocarbons that can be used as fuel.

The significance of the new technology stems from the fact that an efficient solar process for the one-step conversion of carbon dioxide and water to liquid hydrocarbons and oxygen could revolutionise "how solar fuel replacements for gasoline, jet, and diesel solar fuels could be produced and could lead to a carbon-neutral fuel cycle". However, the researchers admit that the efficiency of the current system is not commercially viable, but it does open up a promising new path by which such solar processes may be realised. The researchers have plans to use parabolic mirrors to concentrate sunlight on the catalyst bed, providing both heat and photo-excitation for the reaction.

Gene for grey hair found

Greying of hair is a natural phenomenon seen around the world, especially in countries where people predominantly have dark hair when young. Grey hair is caused by the depletion of melanin – the pigment responsible for the dark colour of hair in black-haired people. Greying is considered a part of the aging process when the production of melanin diminishes or stops altogether, although some people are known to get grey hair even at a young age. Spotting the first grey hair is often a disheartening experience for many and that is why there is a large demand for hair dyeing cosmetics. Recent research at University College London has for the first time brought to light a gene which is said to be responsible for grey hair. Kaustubh Adhikari of University College London who led the international team of researchers in the study said, "We already know several genes involved in balding and hair colour, but this is the first time a gene for greying has been identified in humans."

A gene for grey hair has been discovered.

The study analysed a population of over 6,600 people with varied ancestry across Latin America to identify new genes associated with hair colour, greying, density and shape, e.g., straight or curly. Nearly half the participants were of European background, 40 percent were Native American, and six percent were of recent African origin. According to Adhikari, altogether the study yielded 10 previously unknown correlations between genes and hair-related traits that rose to the level of "statistical significance," including the grey hair gene. The study found that depending on ancestry, people tend to go grey at different stages in their lives – ranging from mid-30s for Caucasians to mid-40s for sub-Saharan Africans (*Nature Communications*, 1 March 2016 | doi:10.1038/ncomms10815).

It has been known that the gene identified for grey hair called IRF4, which is involved in regulating production and storage of melanin, plays a role in hair colour; but this is the first time it has been associated with the greying of hair. Hair greying is caused by an absence of melanin in hair, so the scientists are trying to find out IRF4's role in this process. Further research on precisely how IRF4 works could unlock techniques and treatments that slow or even halt that process, said the scientists.

According to the scientists, the finding could mean that changing hair colour could be possible without using dyes. It would simply be a matter of taking a drug which change the expression of certain genes to alter appearance, turning blondes into brunettes or preventing grey hair.

"Preventing grey hair is a possibility and even reversing grey hair might not be impossible. Once we know more about the pigmentation

process and all the genes involved, it should be easy to find a protein or enzyme to up-regulate or down-regulate the activity," says Adhikari,

In course of the study, the team have also discovered several other genes which play a crucial role in physical appearance. For example, EDAR was found to be linked to the ability to grow a full, bushy beard while eyebrow thickness was found to be determined by FOXL2. Likewise the gene PRSS53 was found to influence hair curliness.

Bedbug genome sequenced

Bedbugs have been known as a human parasite for thousands of years and are found all over the globe, especially in the tropical and temperate regions. The common bedbug, *Cimex lectularius*, was a well-known parasite in human dwellings until the end of the Second World War till the advent of DDT reduced the menace in many industrialised countries. But the pest continued to be a nuisance in the poor underdeveloped countries mainly due to overcrowding and low levels of health consciousness. But since the 1990s, bedbugs have been getting more common in many of the developed countries including the United States, Canada, and United Kingdom. Scientists believe a number of factors have contributed to the bedbug's reappearance, including a rise in global travel and increased resistance to insecticides, with recent research showing the pests' ability to withstand some poisons has increased several thousand times over.

Bedbugs can live in any area of the home including tiny cracks in furniture as well as on textiles and upholstered furniture. They tend to be most common in areas where people sleep and generally concentrate in beds, including mattresses, box springs, and bed frames. Bedbugs hide during the day in cracks and crevices in beds, furniture, floors and walls. They emerge at night to feed. Bed bugs survive only on blood, and this particular species, *C. lectularius*, primarily feeds on human blood.

Bedbugs use their mouthparts to seek out blood vessels. Then they inject anticoagulants into their victims, to prevent themselves from getting choked. Researchers have found that bedbugs possess several classes of genes that code for anticoagulant proteins, including for proteins usually associated with snake venom. But bedbug bite is not dangerous, although bedbug infestation has been associated with iron deficiency, secondary bacterial infection from bite sores, and allergic hypersensitivity. At the worst, bedbugs are a nuisance pest to humans, causing loss of sleep due to annoying bites, which often causes severe itching. The main problem with bedbugs is that they are very difficult to kill as they have evolved resistance to many of the chemicals used against them, and their numbers have been soaring. Temperatures between 20°C and 27°C are most favourable for bedbugs, allowing them to develop into adults most rapidly and produce up to three generations per year. Crowded living quarters also facilitate the spread of bedbugs.

Recently, a huge collaborative effort by scientists from dozens of research institutions across the world has resulted in researchers mapping the genome of the bedbug for the first time. The bedbug genome turns out to consist of almost seven hundred million base pairs – much larger than the fruit-fly genome (a hundred and twenty million base pairs). (*Nature Communications*, 2 February, 2016 | doi: 10.1038/ncomms10164 and 10.1038/ncomms10165). The researchers who put together the bedbug genome identified several genes that may be involved in pesticide resistance; this information could potentially be used to create more effective bug killers. The researchers hope the genome sequence will help scientists to better understand the biological mechanisms of this parasite and could even lead to its eradication.

Biman Basu is a former editor of the popular science monthly Science Reporter, published by CSIR, He is a winner of the 1994 'NCSTC National Award for Science Popularisation'. He is the author of more than 45 popular science books.

Obesity — An Undisputable Killer *(Continued from page 26)*

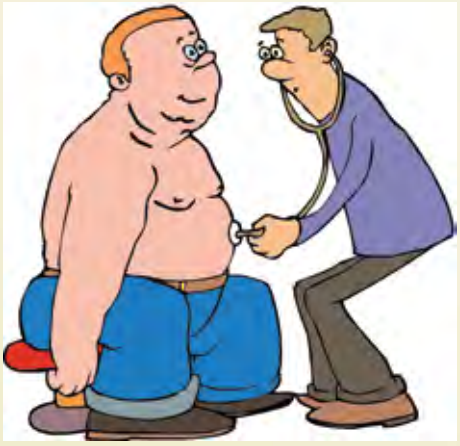
Diabetes mellitus is a silent killer, which slowly and progressively hampers the function of body organs leading to deleterious effects.

Obstructive sleep apnoea manifests in the form of excessive snoring during night time and lack of sleep as a result of which the person is drowsy and sleeps excessively during the day. Needless to say, road traffic accidents are also caused due to this condition.

Asthma presents as difficulty in breathing due to spasm of the bronchial muscles leading to decreased oxygen saturation of the body and its sequel like chronic lung diseases.

Management

As is rightly said, prevention is better than cure. So, the following measures help in decreasing the chances of getting obese and acquiring the diseases further.



The main treatment for obesity consists of dieting and physical exercise. There are also medications which can help in reducing obesity. But many of the medications are found to be associated with gastrointestinal side effects and kidney problems.

In the surgical field, bariatric surgery is found to have beneficial effect in reducing obesity. Surgery for severe obesity is associated with long-term weight loss, improvement in obesity-related conditions, and decreased overall mortality.

To conclude, it's in our own hands to protect ourselves from this deadly combination of obesity and diseases. A change in attitude and lifestyle can bring a great deal of improvement in the health of our future generations.

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Mega Event of Science & Cinema
6th National Science Film Festival and Competition – 2016

The sixth National Science Film Festival & Competition-2016 (NSFF) was organised by Vigyan Prasar in collaboration with National Council of Science Museums, Ministry of Culture, Govt. of India, at Nehru Science Centre, Mumbai from 9 to 13 February 2016. The festival was inaugurated by Dr Mike Pandey, India's iconic wildlife conservationist, environmentalist and filmmaker and Shri Shyam Benegal, eminent film maker, in the august presence of the National Jury and other guests on 9 February. Prasar Bharati (Doordarshan and All India Radio) and Rajya Sabha Television were associated with the 6th NSFF-2016 as media partner. Objective of the NSFF is to promote scientific temper through science films and motivate film makers and science communicators to make science films.

Dr. Mike Pandey expressed the view that science and nature documentaries are closer to life and the heart of the people. He emphasised that films are the most powerful 'tools of change'. He said films are the best medium to communicate information to the remote areas. Shri Shyam Benegal, who was the Chairman of the Jury, said that principles of communication hold good even for the film medium. He opined that the films at the Science Film Festival are really commendable. He strongly recommended starting a 24-hour Indian science television channel. Mrs. Shama Zaidi, a famous writer and art designer, said in the key-note address that more engineers, doctors and people from the other profession should be taught the art of film making and film-making should be assigned as projects to school and college students.

Release of Festival Book of NSFF 2016

All the shortlisted films were screened before the distinguished National Jury of 6th NSFF-2016 chaired by Shri Shyam Benegal. The other members of the National Jury included Mrs. Shama Zaidi, Senior Writer & Art Director; Prof. Iftekhar Ahmad, Director, AJK MCRC, JMI, New Delhi; Mrs Aparna Vaish, ADG, Prasar Bharati; Mr Aseem Sinha, Film Editor; Mr Amrit Gangar, Writer, Film Theorist and Historian; Ms Aruna Raje Patil, Film Maker; Dr Sabyasachi Bhattacharya, Professor, TIFR, and Dr Anil P. Joshi, Environmentalist.

Inauguration of NSFF 2016 by Shyam Benegal

More than 250 professional and student film makers, film enthusiasts and

Award Winning Science Films of 6th NSFF 2016

Category A: Films made by government and non-government institutions / organisations

Award	Title of the Film	Details
Golden Beaver	Nagaland is Changing	Produced by: The Energy and Resources Institute, New Delhi Directed by: Gurmeet Sapal
Silver Beaver	DGWT - A Cause for Concern	Produced by: Educational Multi Media Research Centre (EMRC), University of Mysore Directed by: Syed Kaleem
Bronze Beaver	Soojhboojh se Sanshodhan	Produced by: Dirgha Media, Ahmedabad Directed by: Sarasvatichandra D Acharya

Category B: Films made by individual/independent film makers

Award	Title of the Film	Details
Golden Beaver	Saving the Saviour	Produced & Directed by: Jalaal Ud Din Baba, Srinagar, J&K
Silver Beaver	Birds of *Narsinh Talav*	Produced & Directed by: Umesh Kathad, Gujarat
Bronze Beaver	Sacred Harvest	Produced by: G. S. Unnikrishnan Nair & Anjana Unnikrishnan, Thiruvananthapuram Directed by: G. S. Unnikrishnan Nair

Category C: Films made by students pursuing degree/diploma level courses

Award	Title of the Film	Details
Jury Recognition	Shifting Tides	Produced by: Sanjay Barnela, Bangalore Directed by: Aakash Doshi

Category D: Films made by students studying in class 6 to 12

Award	Title of the Film	Details
Golden Beaver	Ants: A Tiny Creature	Produced & Directed by: Aditya
Silver Beaver	Korba: A City in Peril	Produced & Directed by: Anhad Mishra
Bronze Beaver	STEAM - Then Versus Now	Produced by: Delhi Public School, Bangalore Directed by: Abhigyan Chatterjee

Technical Excellence Awards

Award	Title of the Film	Details
Cinematography: Binu Thomas	The Great Indian Hornbill's Symphony of Life	Produced by: Mathrubhumi Television, Kochi Directed by: BijuPankaj
Editing: Anu George	Sacred Harvest	Produced by: G. S. Unnikrishnan Nair & Anjana Unnikrishnan. Thiruvananthapuram Directed by: G. S. Unnikrishnan Nair
Graphics-Animation-Special Effects: Chandra Kumar	DGWT - A Cause for Concern	Produced by: Educational Multi Media Research Centre (EMRC), University of Mysore Directed by: Syed Kaleem
Sound Recording & Design: VikasYadav, Asheesh Pandya	Nagaland is Changing	Produced by: The Energy and Resources Institute, New Delhi Directed by: Gurmeet Sapal
Direction: Jalal Ud Din Baba	Saving the Saviour	Produced & Directed by: Jalaal Ud Din Baba, Srinagar, J&KA

Special Jury Awards

Award	Title of the Film	Details
For Direction	Steam - Then Versus Now	Produced by: Delhi Public School, Bangalore Directed by: Abhigyan Chatterjee
Film to Promote Scientific Temper	Kanavu Variyam	Produced by: DCKAP Cinemas, Tamil Nadu Directed by: Arun Chidambaram
Film on Innovation	Vigyan ka Varadan	Produced by: Doordarshan Kendra, Bhubaneswar Directed by: Pradipta Kumar Behera

For participation and more information on National Science Film Festival, please contact Shri Nimish Kapoor, Coordinator, NSFF at: nkapoor@vigyanprasar.gov.in

Award winners of Category A

science communicators from various parts of the country participated in the festival. A workshop on science film making with 12 interactive sessions and three panel discussions on science films were organised during the NSFF-2016.

A total of 141 entries were received, out of which 45 films were shortlisted for screening and competition and seven films were shortlisted only for screening.

A total of 18 science films were awarded Beaver Awards, Jury Awards and Technical Excellence Awards at national level. The awards were given away on 13 February by Shri M.S. Sathyu, a well-known film maker.

Along with the Beaver Awards and certificates of merit, the films were awarded with cash prizes. For categories 'A' &,'B' the prize money for Gold, Silver and Bronze

Award winners of Category B

awards were ₹1.00 lakh, ₹50,000 and ₹30,000 respectively. For categories 'C' & 'D', the prize money for Gold, Silver and Bronze awards were ₹50,000, ₹30,000 and ₹20,000 respectively. In category C, only one Jury Recognition Award of ₹20,000 was declared; no Beaver Award was given under this category. Four recipients of Special Award for Technical Excellence were awarded with cash prizes of ₹20,000 with trophies and certificates.