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Child's perception on 'Melting of Glacier' as ice-cream

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EDITORIAL

In the current issue of *School Science*, we have included the articles from various disciplines of Science and Mathematics education. The article 'New Identity and Formulas for Solving Mathematical Problems' discusses the mathematical identity that helps in solving mathematical problems.

In the article 'Climate Change— National and International Senario', the author has thrown light on a serious ongoing issue, and dealt with the impact of global warming, rising of sea-levels, high level of pollution and erratic rainfall patterns. Significant steps taken by the United Nations Framework Connection on Climate Change in 1992, the Kyoto Protocol of 1997 and the Bali Action Plan of 2007 have been incorporated along with the aim of Paris agreement on climate change 2015. The author has made successful efforts to demonstrate India's role in— climate change.

In the article, 'Promoting Metacognitive Strategies in Teaching and Learning of Science', the author discusses about how metacognitive strategies may be useful in the classroom process of teaching and learning with the help of some concepts from life sciences. Similarly, in the article 'Use of Analogy in Science Teaching— A Constructivist Approach', the author highlights importance of analogy in the learning of science. In the inclusive set-up, this may be an appropriate approach of learning science.

Further, like the other issues, this one also has Science News and Web Watch for our readers. 'Science News the section' provides new inventions and investigations related to science. In the Web Watch section, we have included two free websites where you will get to read novels— classic and contemporary— and a website related to science.

We sincerely hope that our readers would find the articles, features and news items interesting and educative. Your valuable suggestions, observations and comments are always welcome which guide us to bring further improvement in the quality of the journal. We wish you fruitful and joyful reading.

I am uncompromising in the matter of woman's rights. In my opinion, she should labour under no legal disability not suffered by man. I should treat the daughters and sons on a footing of perfect equality.

NEW IDENTITY AND FORMULAS FOR SOLVING MATHEMATICAL PROBLEMS

D.P. SAINI

Ambika Mata English Medium School

Kanwat (Sikar), Rajasthan

Introduction

From time to time, discoveries are made whenever problems arise.

This mentioned identity is discovered by me to solve the mathematical problem, Beal conjecture. Beal conjecture is Fermat's last Theorem (Fit).

Beal's conjecture is, if $A^x + B^y = C^z$ where A, B, C, x, y and z are positive integers and x, y and z are greater than 2, then A, B and C must have a common prime factor.

Identity

(i) $2^1 + 2^1 = 2^2$, $2^2 + 2^2 = 2^3$, $2^2 + 2^3 = 2^4$

.....

(ii) $3^1 + 3^1 + 3^1 = 3^2$, $3^2 + 3^2 + 3^2 = 3^3$, $3^3 + 3^3 + 3^3 = 3^4$

.....

(iii) $4^1+4^1+4^1+4^1 = 4^2$, $4^2+4^2+4^2+4^2=4^3$, $4^3+4^3+4^3+4^3=4^4$

.....

Like this, it can be continued further.

Solution to the Beal Conjecture is driven from the identity mentioned at serial number 1.

Beal conjecture: $A^x+B^y=C^z$

Formula to solve above conjecture is :

$A^{P2} + (B=A^P) = [A^2]^{\frac{P^2+1}{2}}$

Take P=3 (P is an odd number greater than 2)

A=2, $B=2^3=8$, $C=A^2=2^2=4$, $x=P^2=3^2=9$, $y=P=3$, $z=2^9+8^3=4^5$, The common factor of A, B and C is 2.

Take P=5

A=2, $B=A^P=2^5=32$, $C=A^2=2^2=4$, $x=P^2=5^2=25$, $y=P=5$,

$z= \frac{P^2+1}{2} = \frac{25+1}{2} = 13$

$2^{25}+3^{25} = 4^{13}$, the common factor of A, B and C is 2.

Take P=7

A=2, $B=A^P=2^7=128$, $C=A^2=2^2=4$, $x=P^2=7^2=49$, $y=P=7$,

$z= \frac{P^2+1}{2} = \frac{49+1}{2} = 25$

$2^{49}+128^7=4^{25}$, The common factor of A, B and C is 2.

Like this, it can be continued further by taking P value as any odd number greater than 2. We can slightly change this formula and we can find the solution to this problem.

P= any odd number greater than 2.

Take P=3

$A=B^P$, B=2, $C=B^2$, x=P, $y=P^2$, $z= \frac{P^2+1}{2}$

$8^3+2^9=4^5$, the common factor of A, B and C is 2

Take P=5

$A=B^P=2^5=32$, B=2, $C=B^2=2^2=4$, x=P=5, $y=P^2=5^2=2^5$,

$z= \frac{P^2+1}{1}$ $32^5+2^{25}=4^{13}$, the common factor of A, B and C is 2.

Like this, it can be continued further by taking P value as any odd number greater than 2.

The following formulas prove that mentioned identity is true for solving math's problems

1. $A^{2X}+B^{X}=C^{2X+1}$, here A=2,B=A^2, C=A, X is a whole number
2. $A^{4X}+B^{2X}+C^{X}=D^{4X+1}$, here A=3, B=$A^2$, C=$A^4$, D=A , X is a whole number
3. $A^{8X}+B^{4X}+C^{2X}+D^{X}= E^{8X+1}$, here A=4, B=$A^2$, C=$A^4$, D=$A^8$, E=A, X is a whole number. Like this, it can be continued further.

About the Beal and Conjecture

Andrew Beal is a number theory enthusiast who resides in Dallas, Texas. He has a particular interest in some of Fermat's work and has spent many, many hours thinking about Fermat's Last theorem. He is the founder/chairman/owner of Beal Bank, Dallas's largest locally owned bank. He is also the recent founder/CEO/ owner of Beal Aerospace, which is designing and building the next generation rocket for launching satellites into earth's orbit.

Andy Beal wrote many letters to mathematics periodicals and number theorists. Among the replies, two were considered responses from number theorists. Dr Harold Edward from the department of mathematics at New York University and author of 'Fermat's Last Theorem: A Genetic Introduction to Algebraic Number Theory' confirmed that the discovery was unknown and called it 'quite remarkable'. Dr Earl Taft from the department of mathematics at Rutgers University relayed Andy Beal's discovery to Jarell Tunnel who was 'an expert on Fermat's Last Theorem according to Taft's response, and he also confirmed that the discovery and conjecture were unknown. There is no known evidence of prior knowledge of Beal's conjecture and all reference to it begin after Andy Beal's 1993 discovery and subsequent dissemination of it (Mourya, 2014). The related ABC conjecture hypothesises that only a finite number of solutions could exist.

Conclusion

The mentioned identity and formulas would help the teacher and students to understand the difficult mathematical problems and to find the solutions of the mathematical problems.

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PROBLEM-BASED LEARNING IN BASIC PHYSICS – VIII

A.K. Mody
V.E.S. College of Arts, Science and Commerce
Sindhi Society Chembur, Mumbai

H.C. Pradhan
HBCSE, TIFR
Mumbai

In this article, eighth in the series of articles, we present problems for a problem-based learning course based on dimensional analysis. We present the technique of dimensional analysis in the area of basic physics and what each problem tries to achieve with its solution.

Introduction

The dimensions of physical quantity are the powers (or exponents) to which the base quantities are raised to represent that quantity (NCERT, 2006).

The applications of dimensional analysis are:

1. Checking the dimensional consistency of equations.
2. Deducing relations among physical quantities. The limitation of this is, we cannot relate number of quantities that may result in number of equations less than number of unknowns. Thus, number of quantities involved cannot be greater than the number of fundamental quantities whose dimensions are involved.
3. To find dimensions of a new quantity.

Argument of a Function

Most of the functions can be expanded into power series as shown below.

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \ldots$$

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \ldots$$

$$e^x 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + - \ldots\ldots\ldots$$

In such cases, x has to be a dimensionless quantity otherwise we have right hand side of an equation in which each term has different dimension.

Now, consider famous equations like

1. $N = N_o e^{-\lambda t}$ from radioactive decay
2. $q = Q\left(1 - e^{(-t/RC)}\right)$ for charging a capacitor in an RC circuit
3. $\mathfrak{q} = \frac{E}{R}\left(1 - e^{(-Rt/L)}\right)$ for growth of current in an LR circuit

   In all of the cases, quantities in the exponent have to be dimensionless and thus $\frac{1}{\gg}, \frac{1}{RC}, RC, and \frac{L}{R}$ and $\frac{L}{R}$ have dimensions of time and are called time constants. These quantities in some sense represent time scale at which changes occur in respective systems.
4. $y = A\sin(kx - \omega t)$ for one-dimensional simple

harmonic progressive wave has wavelength $\lambda=\frac{2\pi}{k}$ which has dimensions of length and time period of oscillation $T=\frac{2\dot{A}}{\acute{E}}$ which has dimensions of time.

1. Using dimensional analysis check the consistency of equation $T = 2\pi\sqrt{\frac{1}{g}}$ of time period of a simple pendulum on mass *m* of its bob, length *l* of its length and acceleration due to gravity *g*.
2. Excess (above atmospheric value) pressure inside a liquid is expected to depend on depth *h* below its surface, density *p* and gravity *g*. Using dimensional analysis, deduce relation between pressure P and *h*, *p*, *g*.
3. Using dimensional analysis establish — (i) dependence of potential energy of a particle of mass *m*, placed in the earth's gravitational field having acceleration due to gravity *g* at a height *h* above the earth's surface; (ii) dependence of kinetic energy of a particle of mass *m*, moving with velocity *v*; (iii) In this, it is not possible to determine constant of proportionality from dimensional analysis. However, using 2 and 3 above with the law of conservation of energy, and kinematical equations, determine the ratio of proportionality constants in 2 and 3.
4. Viscous force between two layers of liquid in motion is defined by Newton's formula as $F=\eta A\frac{dv}{dz}$ where *A* is the area of contact between the two layers, and $\frac{dv}{dz}$ is the velocity gradient in the liquid, i.e., velocity of the flow changes by *dv* in distance *dz* perpendicular to flow direction. Which are the dimensions of η, known as coefficient of viscosity? When a spherical object of radius R flows through a viscous medium with speed *v*, it experiences viscous drag (resistive force). Find an expression of this viscous force using dimensional analysis, assuming it to depend on η, R and *v*. In this case, it is not possible to determine constant of proportionality which turns out to be $6\neq$ and the formula thus obtained is known as Stokes' law.
5. A great physicist of previous century (P.A.M. Dirac) loved playing with numerical values of fundamental constants of nature. By playing dimensionally with mass of electron m_e charge on electron *e*, Planck's constant *h*, and gravitational constant G we may be able to obtain expressions for what is known as Planck length *lP*, Planck time *tP* and Planck mass *mP*. Obtain these expressions dimensionally and estimate value of these quantities. Particle Physicists and Cosmologists use these values in trying to understand evolution of our universe.
6. From Coulomb's formula $\vec{E}=\frac{1}{4\pi\in_0}\frac{q}{r^2}\hat{r}$ and Bio-Savart's Law $\vec{B}=\int\frac{\mu_0}{4\pi\in_0}\frac{idl}{r^2}\hat{r}$ find dimensions of ε_0 0 and μ0. Show that $\frac{1}{\sqrt{\varepsilon_0\mu_0}}$ has dimensions of velocity. From the values of $\varepsilon_0 = 8.85\times10^{-12}$ SI units and $\mu_0 = 4\pi\times10^{-7}$ SI units, estimate value of this velocity.
7. A dense collection of equal number of electrons and positive ions is called neutral plasma. Certain solids containing fixed positive ions surrounded by free electrons can be treated as neutral plasma. Let 'N' be the number density of free electrons, each of mass 'm'. When electrons are subjected to electric field, they are displaced relatively away from the heavy positive ions. If the electric field becomes zero, the electrons begin to oscillate about the positive ions

with a natural angular frequency *'Ep'* , which is called plasma frequency. To sustain the oscillations, a time varying electric field needs to be applied that has an angular frequency ω , where a part of energy is absorbed and a part of it is reflected. As ω approaches $\sqrt{\frac{Ne}{m\varepsilon_0}}$ all the free electrons are set to resonate together and all the energy is reflected. This is explanation of highly reflective metals.

(i) Taking the electronic charge as *'e'* and the permittivity as 'εo', use dimensional analysis to determine the correct expression for ω p.

(ii) $\sqrt{\frac{Ne}{m\varepsilon_0}}$ (b) $\sqrt{\frac{m\varepsilon_0}{Ne}}$ (c) $\sqrt{\frac{Ne^2}{m\varepsilon_0}}$ (d) $\sqrt{\frac{m\varepsilon_0}{Ne^2}}$

(iii) Estimate the wavelength at which plasma reflection will occur for a metal having the density of electrons N = 4×10^{27} m^{-3}. Take $\in_0 \approx 10^{-11}$ and m ≈ 10^{-30}, where these quantities are in proper SI units.
(a) 800nm (b) 600nm (c) 300nm (d) 200nm
[JEE, 2011]*

Hints, Solutions, Answers:

1. $[l] = [L]^1$ $[g] = [L]^1[T]^{-2}$. Thus
$$\left[\sqrt{\frac{l}{g}}\right] = \left[\frac{[L]^1}{[L]^1[T]^{-2}}\right]^{1/2} = [T]$$
The given equation is dimensionally correct.

2. Let $\alpha h^x p^y g^z$ here
[p] = [F/A]=$[M^1L^1T^{-2}]/[M]^1$ $[L]^{-1}$ $[T]^{-2}$
$[h] = [L]^1, [A] = [M]^1[L]^{-3}$ and $[g] = [L]^1[T]^{-2}$
Taking $[p] = [h]^x [A]^y [g]^z$, and equating dimensions of m, L and T, we get
(power of [M]) : *y=1,*
(power of [L]) : x–3y + z = –1
(power of [T]) : –2z = –2
This gives us z = 1 and x = 1 and we have
$p \alpha hpg$

3. We get $PE\alpha$ mgh and 2 $KE\alpha mv^2$ using conservation of energy and kinematical equation. If we choose system of units such that $PE = mg$ then $KE = \frac{1}{2}mv^2$

4. $F\alpha\eta^x R^y v^z$ and $[F] = [\eta]^x [R]^y [v]^z$
$\therefore [M^1L^1T^{-2}] = [M^1L^{-1}T^{-1}]^x [L]^y [L^1T^{-1}]^z$
Matching the powers on two sides, this gives us *x* = 1, *y* = 1 and *z* = 1.
Thus , F $\alpha\eta$ R v , the constant of proportionality 6 ≠ is determined from some other method.

5. We get $t_p - \left(\frac{Gh}{c^5}\right)^{1/2} = 1.35 \times 10^{-43}$ sec
$l_r \alpha \left(\frac{Gh}{c^5}\right)^{1/2} = 4.05 \times 10^{-35}$ and
$m_p \alpha \left(\frac{ch}{G}\right)^{1/2} = 5.46 \times 10^{-8}$ kg

6. Taking
$[q] = [I^1T^1], [E] = [F]/[q]$ and $[B]$
$= [F]/[q][v]$ and $[B] = [F]/[q][v]$, we get
$[E] = [M^1L^1T^{-3}I^{-1}]$ and $[B] = [M^1T^{-2}I^{-1}]$
This gives us $[\varepsilon_0] = [M^{-1}L^{-3}T^4I^2]$
and $[\mu_0] = [M^1L^1T^{-2}I^{-2}]$
Thus, $\left[\frac{1}{\sqrt{\varepsilon_0\mu_0}}\right] = [L^1T^{-1}]$ and from the given values $\frac{1}{\sqrt{\varepsilon_0\mu_0}} = 3 \times 10^8$

7. [Ans: (i) - (c) , (ii) - (b)]

*JEE–Joint Entrance Examination for admission to IIT.

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JEE - Joint Entrance Examination for admission to IIT 2011.

PROMOTING METACOGNITIVE STRATEGIES IN TEACHING AND LEARNING OF SCIENCE

Bharti Dogra

Associate Professor, School of Education (SOE)

IGNOU, New Delhi

Metacognition is 'thinking about thinking'. All those science teaching strategies which provide space to students to discuss, analyse, synthesise, paraphrase, summarise, apply, ask questions and think aloud, help in developing metacognition. Science students must be encouraged to record thinking process involved in reading science chapters, conducting laboratory activities, investigative projects as well as other science-based co-curricular activities. When science students revisit the recorded events or situations, this facilitates in understanding their own learning styles, needs, strengths and weaknesses which forms the basis of their understanding. Science teachers can also plan their strategies keeping in mind the needs of their students. This paper discusses various metacognitive strategies, such as concept-mapping, illustrations, brainstorming, planning strategies, and generating questions, evaluating actions, teaching capability, communication skills and journal keeping in science teaching-learning process.

Introduction

A Class X student, Ram attends few biology classes on 'Heredity and Evolution'.The Biology teacher explains concepts, such as variations during reproduction and heredity. The teacher also explains the rules for the inheritance of traits in human beings, role of DNA and chromosomes. An assignment based on the concepts covered in the class is prepared by the biology teacher. Ram, now after reading the assignment, finds it difficult to understand it. He discusses it with his friends and says that he has not understood any of these concepts in the last few classes. Ram was not paying much attention in the classroom. He should have pointed it out to the subject teacher that he has not understood anything. He should have stopped the teacher then and there only. The other options were to reread the chapter and look for other clues like pictures, glossary, graphs, etc., to make some sense out of it, or to reflect on why he did not understand this chapter or some topics of this chapter. Ram was unable to attempt the questions of the assignment. He could not understand the concepts taught in the class.

Teachers find many students like Ram in their classes who sit and listen quietly and hardly ask any questions. These students must be made to realise their strengths and weaknesses as a student. Teachers must help students develop strategies to learn on their own. These strategies can help students learn about learning and help them in academic pursuits even beyond the walls of the classrooms. These are called metacognitive strategies, and they help in meaningful learning of science concepts. This paper highlights the importance of promoting metacognitive strategies in science teaching-learning process.

Understanding Metacognition

Metacognition can be simply defined as thinking about one's own thinking, knowledge of one's own cognitive strategies and how one learns, and the ability to control or regulate this (Fetherston, 2001), the development of which improves students' learning and accomplishments (Kramarski, 1999). Indeed Scardamalia, Bereiter and Lamon (1994) found improved student reflection and progressive thought to be increased when attention was placed on metacognition, with students taking multiple perspectives and demonstrating independent thinking. Flavell (1985) provided a more complex definition when he wrote that metacognition is:

One's knowledge concerning one's own cognitive processes....Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objective on which they bear, usually in the service of some concrete goal or objective (Flavell, 1985, p. 232).

The basic metacognitive strategies are (Dirkes, 1985):

1. Connecting new information to former knowledge.
2. Selecting thinking strategies deliberately.
3. Planning, monitoring and evaluating thinking processes.

Grabe (2001) suggests that metacognition is the individual's ability to evaluate, plan for and regulate and adjust his or her own learning and its characteristics. It promotes self-directed and student-centred learning, in which, in part, students decide on requirements, set their own goals and decide the best strategies to reach them. Through metacognition, passive learning can be converted into active learning and then into most efficient learning. There are multiple perspectives on what metacognition means.

Metacognitive Skills

Research studies show different models of metacognition. For example, some studies use the two factor model of Schraw and Dennison (see Bransford et al., 1999; de Carvalho and Yuzawa, 2001; Flavell, 1979; Paris and Winograd, 1990; Pintrich et al., 2000). There are also other models that assess metacognition with more specific factors (e.g., Allen and Armour-Thomas, 1993; Cheng, 1993; Desoete, roeyers and Buysse 2001; Fang and Cox, 1999). These studies have shown that not all of the extracted factors of metacognition consistently have the same effects on outcome measures. The inconsistency indicates that different factors of metacognition have different effects depending on the outcome measured. In this paper, two models of metacognition are being discussed:

1. Two factor model of metacognition:
   A two factor model is the common conceptualisation of metacognition (Flavell, 1987; Schoenfeld, 1983, 1985, 1987; Winn and Snyder, 1996). These two components are knowledge of cognition and regulation of cognition. Knowledge of cognition is the reflective aspect of metacognition. It is the individuals' awareness of their own knowledge, learning preferences, styles, strengths and limitations, as well as their awareness of how to use this knowledge that can determine how well they can perform different tasks. Regulation of cognition on the other hand is the control aspect of learning.

2. Eight factor model of metacognition: The original model of Schraw and Dennison (1994) proposed that metacognition is composed of eight major components that are consistent with the factors proposed by Artzt and Armour-Thomas (1992), as well as, that by Baker (1989). These sub- processes are: (1) declarative knowledge, (2) procedural knowledge, (3) conditional knowledge, (4) planning, (5) information management strategies, (6) monitoring, (7) debugging strategy and (8) evaluation of learning. Metacognition with multiple and specific factors are viewed to be more functional as explained in the framework of metacognition in problem solving by Artzt and Armour-Thomas (1992).

Why is Metacognition Important in Science Class?

Science teachers use various strategies for teaching science concepts. The abstract concepts are simplified through concrete examples. Let us discuss use of metacognition in the science classrooms:

1. Based on Vygotsky's (1978) concept of the zone of proximal development, teachers provide scaffolding to students which are a temporary support from an expert. This support is gradually reduced and later withdrawn as students become independent in their learning and thinking and can perform the task without any support. Scaffolding has been found to be an excellent method of developing students' higher level thinking skills (Rosenshine and Meister, 1992). Metacognition helps science teachers in using scaffolding effectively as they consider issues, such as what type of support can be given, how to sequence them and when to reduce or withdraw support from learners.
2. Teachers use various instructional methods keeping in mind the learning styles of students and the content selected. There are some unanimously accepted approaches for teaching some selected content. But teachers cannot stick to a commonly accepted approach. Teachers should use their metacognition to carefully reflect on the implications of what research has shown about the advantages and disadvantages of different instructional methods for different learning styles and content.
3. According to Cook and Mayer (1988), students often complain about reading their science texts. Even otherwise competent readers are not aware of the top-level structures underlying scientific texts. Top-down structures are important because they trigger higher-order ideas that activate schemata which allow details to be inferred and attention to be allocated effectively (Pressley and McCormick, 1995). Thus developing students' metacognition about how to read scientific texts can improve their comprehension by helping them focus on relevant information and use it to create internal connections and representations.
4. There are many misconceptions and alternative conceptions in textbooks. Abimbola and Baba (1996) recommend that teachers should consider the number of misconceptions and alternative conceptions while selecting among science textbooks and select the one with the fewest. Metacognition can help science teachers in selection of textbooks with minimum or no misconceptions.

5. Metacognition can help science teachers to consider at what level to pitch their teaching in relation to (Tomlinson's equalizer framework, 1997):
    - Information, ideas, materials and applications (simple–complex). For example, while teaching respiration in man, the content coverage includes meaning of respiration, difference between breathing and respiration, aerobic and anaerobic respiration or details, such as glycolysis, Kreb's cycle, fermentation, etc.
    - Representation (concrete–abstract). Concrete representations are used during introduction of a new lesson and provide useful and engaging perceptual scaffolding for abstract concepts.
    - Disciplinary connections (unifaceted–multifaceted). Whether science teacher makes single discipline connections or connects many aspects in science.
    - Developing insights (small leaps–large leaps). Whether science teacher moves slowly from one teaching point to another while helping students develop deep understanding or jumps from one teaching point to another, depends on their metacognitive abilities.
    - Decision making (open–more structured). The level of objectivity/ subjectivity in a science lesson plan.
    - Process (clearly defined to fuzzy problems)
    - Planning (degrees of independence: less—more)
    - Pace of study (slower–quicker)

The Metacognitive Approach in Problem solving

Metacognition is an important component of problem solving. Metacognitive skills are of great importance to children not only to develop their problem solving skills but also to develop thinking skills more generally. Due to lack of metacognition, children use ineffective problem solving strategies. Schoenfeld (1987) suggests a number of techniques to teach children metacognitive strategies:

1. Develop awareness of thinking processes among learners. Schoenfeld has suggested activities, such as showing a video of other learners engaged in cooperative problem solving, so that learners can see others using ineffective problem solving strategies. This can impress upon them the importance of awareness of what one is doing.
2. Work problems through on the blackboard by solving the whole problem rather than cutting it short to the final solution. This strategy is useful because it brings certain behaviours to centrestage and highlights the importance of metacognitive skills.
3. Let the entire class collectively work on a problem, with the teacher moderating the classroom discussion. The learners will choose to do certain things which may or may not be right. If their strategy does not turn out well, new solutions should be tried until they find the right solution. This is then followed by a debriefing session conducted by the teacher. This activity helps in self-regulation.

For example, learners are given a task to design water filtration system using sand, gravel, cotton and charcoal. Learners brainstorm and

come out with possible designs. They discuss advantages and disadvantages of each design. Learners select materials keeping in mind their water purification properties. The make models and draw figures of their designs. Taking a model at a time they communicate the results. If not satisfied with the results, they test another design.

Metacognitive skills can be developed through specific activities. Cooperative group work can be used for developing metacognitive skills because it makes scaffolding possible.
Cooperative support provides an opportunity for discussion on science concepts whereby they listen to each others' views and then reflect. Such reflection helps in metacognition and self-regulation. Learners working in small groups can be given cards containing a number of basic questions that should help them to think about their own thinking. These include — 'What am I doing now?', 'Is it getting me anywhere?', and 'What else could I be doing instead?'(Salomon and Perkins, 1989) Later, 'scaffold' (the cards) can be removed once learners have internalised metacognitive thinking.

Metacognition for Developing Critical Thinking Skills

Critical thinking skills enable teachers and learners to adopt an objective, questioning perspective. Critical thinking skills enable us to take a step back from any immediate situation (Barnett, 1994) and 'read' it from an objective position, whether this is in relation to teaching, learning or the introduction of, for example new syllabus. Halpern (1998) proposed a model for teaching thinking skills for transfer across domains of knowledge. This model consists of four parts — (a) a dispositional or attitudinal component, (b) instruction in and practice with critical thinking skills, (c) structure-training activities designed to facilitate transfer across contexts and (d) a metacognitive component used to direct and assess thinking.

Metacognitive Component in Halpern's Fourfold Model of Critical Thinking

In critical thinking, learners must monitor their thinking process to see whether they are progressing appropriately towards their goal. This monitoring of thinking and reflection helps in making timely decisions about the use of time and efforts. These metacognitive monitoring skills need to be shared with others so that they can be examined and feedback can be given /received about how well they are functioning. Guiding questions can help in this case. For example, students can be given a problem or an argument to analyse and then asked the following questions before they begin the task (Halpern, 1998):

- How much time and effort is this problem worth?
- What do you already know about this problem or argument?
- What is the goal or reason for engaging in extended and careful thought about this problem or argument?
- How difficult do you think it will be to solve this problem or reach a conclusion?
- How will you know when you have reached the goal?
- What critical-thinking skills are likely to be useful in solving this problem or analysing this argument? As students work on the

problem or argument, they should be asked to assess their progress towards the goal.

- Are you moving towards a solution? Finally, when the task is completed, the students should be asked to judge how well the problem was solved or how well the argument was analysed.
  Well-structured questions will help students reflect on their learning and may provide insights that will be useful in the future.

Metacognition in Inquiry Science Learning

In an inquiry classroom, teachers and learners are linked as part of a disciplinary community of knowledge generation (Pottenger, 2007; Seraphin and Baumgartner, 2010). Just like scientists, learners ask questions, collect, analyse and interpret data and share findings with the scientific community. Students in inquiry learning move from 'question' phase to 'implementation' phase. The steps between 'question' phase and 'implementation' phase of inquiry such as identification of manipulated and responding variables often occur without student realisation that they are important features of the process. The teacher must facilitate students' becoming aware of their thinking process even though it may seem like an unconscious or natural process.

Summing Up...

Metacognition is considered very important in learning in general and science learning in particular. It provides an opportunity to science teachers to think about their thinking as far as planning of teaching-learning process, selection of learning materials, methods, selection of textbooks, providing scaffolding support, withdrawing it and making different decisions in the classrooms. On the other hand, students can also be helped to monitor and reflect on their learning so as to develop better metacognitive strategies and self-regulation.

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USE OF ANALOGY IN SCIENCE TEACHING – A CONSTRUCTIVIST APPROACH

Tanu Tandon
Amity Institute of Education,
Amity University, Lucknow

This paper examines the role of analogy in teaching of science. Analogy is finding similarities between different concepts and utilises learner's previous knowledge to construct new knowledge. Such construction of knowledge using analogy thus supports and follows premises of constructivism. Constructivism asserts that knowledge is actively constructed by learner based on his previous experiences. Science and scientific concepts are abstract in nature and difficult to understand. Analogy can be used effectively to elucidate and facilitate understanding of scientific concepts. In this paper, examples are discussed where DNA translation is taught using analogy.

Introduction

Analogy is the process of identifying similarities between different concepts. Finding similarities between concepts is a cognitive process, as it involves figuring out the familiar in unfamiliar. Thus, analogy is also about building new knowledge on previous knowledge. As it is a well-established fact that learning based on previous knowledge is more effective, such learning which takes place through analogy is multi-directional and multi-dimensional. It involves creating knowledge by borrowing and making comparison from knowledge in different, varied directions. Analogy thus utilises learner's previous knowledge to understand new concepts. Since analogy borrows familiar aspects from different directions, there can be multiple understandings hence multiple interpretations and construction of knowledge gets easier and richer.

Analogy in Line with Constructivism

Such construction of knowledge using analogy thus supports and follows premises of constructivism. Constructivism asserts that knowledge is actively constructed by learner based on his previous experiences. Constructivism is an epistemology, a learning or meaning making theory. It states that individuals construct their own understanding and knowledge through the interaction of their previous knowledge and the new ideas or events result in multiple realities. Each and every student is taken as a unique case with his own set of realities, experiences, values and culture. Thus, this approach focusses on students and how they should be taught. Constructivism emphasises that students should be taught in natural settings and classrooms should provide multiple representations of reality and vast and varied experiences. The local understanding should be encouraged since every child is unique with his bank of knowledge, experiences, values, culture and background peculiar to him alone, which should be honoured and taken care of while providing new information. The opportunities to explore, observe and discuss should be provided to students. Activities should be student centred and ideas should be presented holistically, students should be encouraged to ask questions,

carry out analogies and reach conclusions and draw inferences. Students should be encouraged to work in groups, discuss their ideas with each other, and communicate their views. Negotiation of outcomes is equally important so that students can compare their reality with that of other students and correlate their knowledge with the outside world, resulting into productive useful knowledge which would provide them with basics to continuously learn and adjust in society. Every individual has a life space and science should fit in that and have utility value in their life. This would enable them to become "life long learner".

Constructivist Learning

In constructivist learning, there is spiral growth with emphasis on all three, past, present and future. The students are actively involved in construction of knowledge, reflect upon old and new knowledge and in ever evolving new learning things. They also learn from mistakes as well. Thus, a student learns, relearns and even unlearns during the learning process and involves knowledge with others throughout making it a collaborative process.

In a constructivist classroom following are encouraged–

- *Enquiry:* Students are encouraged to ask questions.
- *Multiple Intelligence:* Students are encouraged to give their interpretations and express their views and ideas leading to multiple realities.
- *Collaborative Learning:* Students work in groups and learn from each other, discuss their outcomes with their peers and teacher as well and all learn as a result.

Constructivism in Science: Constructivism in science has emerged as an approach against positivism. It rectifies the fault of positivism which views science as an absolute truth. Positivism focuses on justification of inquiry and only believes in one single reality, which can be studied in parts, constructivism on the other hand emphasises on the importance of experiences. It treats every case as unique and believes in multiple realities which explains the formulations of new theories and discoveries. It views knowledge as whole, where in inquiry leads to another inquiry. Scientific knowledge as per constructivism is therefore, an inductive inquiry which can be constructed in totality, by describing multiple realities and mutually shaping interactions leading to emergence of theory. According to this approach, knower and known cannot be separated hence emphasises on mutual causal relationship.

Analogy in Science Teaching

Science and scientific concepts are abstract in nature and difficult to understand. Analogy can be used effectively to elucidate and facilitate understanding of scientific concepts, as it allows the learner to find similarities, cause and effect relationships, promotes inductive thinking and reasoning thereby leading to analysis and prediction. Since it encourages inductive thinking, it also motivates learners to think creatively 'out of box' and also in multiple directions, observe their world, find similarities, explore, hypothesise and come up with solutions and novel ideas. Thus, analogy helps in inculcating and developing scientific skills in children. Use of analogy also makes learning interesting and easier and since students start with what they already know they are more

confident and ready to explore. It is also true that not everything that has to be learnt will be with student; some changes have to be made to make learning easier. Secondary school teachers often resort to using analogies to facilitate understanding (Glynn, 1997; Venville and Treagust, 1997). There use is less in primary school (Glynn and Takahashi, 1998) as it is argued that young children are assumed to have limited knowledge base hence cannot draw analogies.

Story and poems are two very effective mediums which can be used for analogy learning.

The use of non-literal language to explain scientific concepts has been the subject of pedagogic research since early 1960s (Kuhn, 1962). Cameron (1996) suggests that the more prosaic use to which analogies are put in the sciences lies on a cognitive continuum that has their poetic use in the arts at the other end. Lakoff and Johnson (1980) also assert that we come to understand the world around us through the analogies we use. Churchland (1989) argues that both the extremes of the continuum can co-exist even when the poetic is seemingly at odds with the prosaic. The comparison between moon and lover is understood by astronomer also.

Storytelling is an effective medium through which analogy can be drawn between story, its theme and characters and various scientific concepts. This medium was used effectively during practice teaching session of B.Ed. students wherein pupil teacher taught difficult and abstract concept of DNA Translation and Transcription with the help of a story based on production of candies.

DNA Translation, Transcription and Candy Factory: The teacher narrated the story of production of candies and drew similarities between the process of candy manufacturing and DNA Translation and Transcription.

"David is the owner of candy factory where he makes yummy candies. He also has a library of all the recipes of candies. Like David has recipes of candies, similarly DNA is the boss of cell and has recipe for proteins. Now, as candies are produced in a factory, similarly proteins are also produced in protein factories called Ribosome. David sends a messenger, his peon with the recipe to the factory, in the same way mRNA is the messenger which carries information about protein manufacturing to Ribosome. The cooks prepare the candies in factory, similarly tRNA help in making of proteins, it gathers the amino acid which is the ingredient in proteins manufacturing. Thus, Translation is a process by which proteins are made through flow of information from DNA-mRNA-tRNA –Protein."

Poem is also an effective medium to learn scientific facts easily and in a playful manner. These mediums serve dual purpose, not only they help in understanding the concept in an interesting manner, but also enhance the aesthetic sense of learners, thereby nurturing the affective domain, which is said to be neglected in science teaching. Poems help in developing a sense of rhythm and music, appreciating of nature, increasing vocabulary and helps instilling values in student.

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CLIMATE CHANGE—NATIONAL AND INTERNATIONAL SCENARIO

Pushp Lata Verma
Assistant Professor, DESM
NCERT, Delhi

Climate change has emerged as one of the most serious challenges. Large dimensions of the problem and the seriousness of its impact have shaken the entire humanity. Global warming, rising of sea levels, high level of pollution, erratic rainfall patterns are just a few manifestations of climate change. Attempts have been made both at the national and international levels to restrict the ill-effects of climate change. The United Nations Framework Connection on Climate Change in 1992, the Kyoto Protocol of 1997 and the Bali Action Plan of 2007 are significant steps in this direction.

India's per capita GHG emission (2.33t CO_{2e}) is 1/3 of the world average (6.76) and is very low compared to developed countries, as well as, many of the devoloping countries.

Around 55 per cent of India's population still does not have access to commercial energy. In the energy sector, some of the specific initiatives taken by India include introduction of Compressed Natural Gas (CNG) for public and private transport in metropolitan areas. A great emphasis has also been laid on the development of alternate fuel, namely hydrogen and biofuel. Recently, a decision has been taken to promote desert as a hub for renewable energy by establishing a Solar City in the Thar desert area. Besides, steel, aluminium, fertilisers, paper, cement are some of the major energy-intensive sectors where India's energy efficiency has attained the global standards.

India formulated the National Action Plan on Climate Change in 2008. India introduced specific policies that target at conservation of rivers, improvement of urban air quality, enhanced afforestation and a significant increase in the installed capacity of renewable energy technologies. India has enacted the Energy Conservation Act and notified the Energy Efficiency Code for new commercial buildings. India has also launched the 'Green India' project that will be the world's largest afforestation project covering six million hectares of degraded forestland. Latest Green Index taken out by the 'National Geographic' puts India as the No. 1 country in the world on a Green Index.

Climate change a global environmental problem, is primarily caused by the building up of green house gases (GHG), eg., carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2) and others in the atmosphere. Climate change is one of the all-encompassing global environmental changes having deleterious effects on natural and human systems, economies and infrastructure. The risks associated with it call for a broad spectrum of policy responses and strategies at all levels — local, regional, national and global.

Climate change is a serious global environmental phenomenon, which has been viewed with concern in international academic and scientific circles for many decades, particularly because of the adverse impacts that anthropogenic climate change may have on various sectors of society, ecosystem and economy. Of late, it has received high degree of attention at political levels because of its

implications for energy security and ecologically sustainable development.

Climate change is primarily caused by the building up of greenhouse gases in the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), the global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750, and have now far exceeded the pre-industrial values. The global increase in carbon dioxide concentration is primarily due to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.

According to the Intergovernmental Panel on Climate Change (IPCC), the enhanced greenhouse effect will result in additional warming of the Earth's surface. The Fourth Assessment Report of 2007 of the Working Group III of the IPCC states that Global Greenhouse Gas (GHG) emissions have grown since pre-industrial times, with an increase of 70 per cent between 1970 and 2004. The largest growth in global GHG emissions during this period has come from the energy supply sector (an increase of 145 per cent). The growth in direct emissions from transport had been 120 per cent, industry 65 per cent and Land Use, Land Use Change, and Forestry (LULUCF) 40 per cent.

Impact of Global Warming

The Fourth Assessment Report of the IPCC submitted in 2007 has stated that global warming may have a devastating impact on the climate of the earth. It is very likely that climate change can slow down the pace of progress towards sustainable development either directly through increased exposure to adverse impact or indirectly through erosion of the capacity to adapt. The Report predicts that there would be enlargement and increased number of glacial lakes and increasing ground instability in permafrost regions, and rock avalanches in mountain regions. Effects of temperature increase have also been documented in some aspects of human health, such as heat-related mortality in Europe, infectious disease vectors in some areas, and allergenic pollen in Northern Hemisphere high and mid-latitudes. Settlements in the mountain regions are at enhanced risk to glacier lake outburst floods caused by the melting glaciers. Sea-level rise and human development are together contributing to losses of coastal wetlands and mangroves and increasing damage from coastal flooding in many areas. Increases in the frequency of droughts and floods are projected to affect local production negatively, especially in subsistence sectors at low latitudes. Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise and the effect will be exacerbated by increasing human-induced pressures on coastal areas. The Report projected that climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through: increases in malnutrition and consequent disorders, with implications for child

Figure 1. Increase in temperature causes global warming: Child's perception

growth and development; and increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts.

Regarding the Asian region, the Report points out that glacier melt in the Himalayas is projected to increase flooding, rock avalanches from destabilised slopes, and to affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. The Report further predicts an adverse impact of climate change on human health as endemic morbidity and mortality due to diarrhoeal diseases primarily associated with floods and droughts, are expected to rise in East, South and Southeast Asia due to projected changes in hydrological cycle associated with global warming. Increases in coastal water temperature would exacerbate the abundance and/or toxicity of cholera in South Asia.

In April 2009, the IPCC decided that much greater consideration was required to improve the treatment of regional matters in Fifth Assessment Report (AR5). The fifth Assessment Report of IPCC comprises three Working Groups and a Synthesis Report. It stated that reducing emissions is critical if global warming is to be limited to 2°C — a target recognised in 2009 as the threshold of dangerous climate change. The report suggested that the renewables will have to grow from their current 30 per cent share to 80 per cent of the power sector by the year 2050. It also stated that fossil fuel power generation without carbon capture and storage (CCS) technology would require to be phased out almost entirely by the year 2100.

Impact on India

India is also not immune from the impact of global warming and climate change. Any sharp rise in sea level could have a considerable impact on India. The United Nations Environment Programme included India among the 27 countries that are most vulnerable to a sea level rise.

Figure 2. Melting of glacier as ice-cream: Child's perception

Glaciers in the Himalayas feed important rivers, such as the Ganga, the Indus and the Brahmaputra that provide water for millions of people as well as for irrigation and industry. The accelerated melting which these glaciers are experiencing as a result of the Earth's warming, will have an adverse effect on future water availability. The Gangotri glacier, one of the largest in the Himalayas, has been retreating since long and more rapidly in the recent decades. As the glaciers retreat, they become more fragmented and the smaller glaciers are more sensitive to global warming.

International Scenario

The international community set up the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, which seeks to address the challenge of climate change on the basis of the principle of 'common but differentiated responsibilities and respective capabilities' of the member parties. The objective of UNFCCC is to stabilise the concentration of greenhouse gases in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system.

The UNFCCC recognises the legitimate need of developing countries for sustained economic growth and poverty alleviation. Article 3.1 of the UNFCCC mentions that Parties to the Convention should protect the climate system for the benefit of present and future generations of human kind on the basis of equity and in accordance with their 'common but differentiated responsibilities and respective capabilities'. It is also noted in the Preamble of the UNFCCC, that the largest share of historical and current global emissions of greenhouse gases has originated in the developed countries, that per capita emissions in developing countries are still relatively low, and that the share of global emissions originating in developing countries will grow to meet their social and development needs. The implementation of the Convention is promoted and reviewed through the decisions taken at the annual meetings of the Conference of Parties (CoP).

In the year 1997, Parties adopted the Kyoto Protocol, which set legally binding targets for GHG reductions by industrialised countries during the 'first commitment period', i.e., 2008–12. The developed country parties were expected to reduce, by 2012, their GHG emissions by an order of 5.2 per cent below their aggregate 1990 emissions. The Kyoto Protocol is the most significant agreement till date to combat climate change. The Protocol provides for quantified emission limitation and reduction commitments for the developed countries while presenting/ suggesting mechanisms to facilitate review of, and compliance with these targets. India is a party to the United Nations Framework Convention on Climate Change and its Kyoto Protocol.

The 21st Conference of Parties (CoP-21) under UNFCCC was held in Paris from 30 November to 12 December 2015. India's Honourable Minister of Environment, Forests and Climate Change lead an inter-ministerial delegation and advocated ambitious actions based on the principles of equity and common but differentiated responsibilities (CBDR).

Paris Agreement on Climate Change, 2015

A historic agreement to combat climate change and unleash actions and investment towards a low carbon, resilient and sustainable future was agreed by 195 nations in Paris on 12 December 2015. The Paris Agreement for the first time brought all nations into a common cause based on their historic, current and future responsibilities. The universal agreement's main aim is to keep a global temperature rise for this century well below 2°C and to drive efforts to limit the temperature increase even further to 1.5 °C above pre-industrial levels. The 1.5 °C limit is a significantly safer defense line against the worst impacts of a changing climate. Additionally, the agreement aims to strengthen the ability to deal with the impacts of climate change. To reach these ambitious and important goals, appropriate financial flows will be put in place, thus making stronger action by developing countries and the most vulnerable possible, in line with their own national objectives. Future generations will mark the 12 December 2015 as a date when cooperation, vision, responsibility, a shared humanity and a care for world took centrestage to protect the planet.

Salient features of the Paris Agreement are as follows:

- The purpose of the Agreement is not only achieving the objective of UNFCCC but also enhancing the implementation of UNFCCC.

- The ideas of Climate Justice, Sustainable Lifestyles and Right to Development, which were specifically raised by India were explicitly recognised in the preamble of the Agreement.
- Equity and the principle of 'Common but Differentiated Responsibilities and Respective Capabilities' were mentioned in the Agreement, capturing the notion of historical responsibility of the developed countries.
- Differentiated obligations based on Annexes as mentioned in UNFCCC were not reflected in the Agreement. However, differentiation across all elements was maintained for developed and developing country parties.
- Developed Country Parties will undertake absolute emission reduction targets while Developing Country Parties will continue to enhance their mitigation efforts.
- The Agreement not only includes NDCs (Nationally Determined Contributions) on mitigation but also has elements of adaptation, finance, technology transfer and capacity building. NDCs will be furnished every five years. Harmonisation of the timeframes of NDCs (currently 5 or 10 years) will be considered at the first meeting of the Parties to the Paris Agreement. At any time, a Party may adjust its existing NDCs with a view to enhance its level of ambition.
- Developed Country Parties shall provide financial resources to assist Developing Country Parties with respect to both mitigation and adaptation in continuation of their existing obligations under UNFCCC. Developed Country Parties would continue to take the lead in mobilising climate finance and also provide information on financial, technology transfer and capacity building support to Developing Country Parties.
- An enhanced transparency framework for action and support, building on the arrangements under UNFCCC, has been established. India's proposal to link transparency with capacity building initiative was agreed to.
- Article 2(1) (c) of the Agreement refers to making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development. This was included despite opposition from India and other developing countries, and could possibly be interpreted as a 'green conditionality' on international finance flows.

India's Response

India has probably the most comprehensive framework of legal and institutional mechanisms in the region to respond to the tremendous challenges to the environment it is facing, owing to population explosion, poverty and illiteracy augmented by urbanisation and industrial development. India is probably the first developing country which has incorporated into its Constitution the specific provisions for environmental protection. Article 48A of the Constitution of India provides that 'the State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country'. Similarly, Article 51A(g) makes it obligatory for every citizen of India, 'to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures'.

As a developing nation, India, in its endeavour to bring millions of people out of poverty cannot accept binding commitments for cutting emission of greenhouse gases. The total emission of greenhouse gases is bound to

increase in India in the course of meeting the demands for raising the standards of living and providing access to commercial energy to all. Around 55 per cent of India's population still does not have access to commercial energy.

India and the International Organisations

India is a Party to the United Nations Framework Convention on Climate Change. India has established the National Clean Development Mechanism Authority (NCDMA) on 2 December 2003.

India's CDM potential represents a significant component of the global CDM market. As of April 2009, 420 out of total 1,593 projects registered by the CDM Executive Board are from India, which so far is the second highest by any country in the world. Also, as on 31 March 2009, the National CDM Authority has accorded Host Country Approval to 1,230 projects facilitating an investment of more than ₹1,51,650 crore. These projects are in the sectors of energy efficiency, fuel switching, industrial processes, municipal solid waste and renewable energy. If all these projects get registered by the CDM Executive Board, they have the potential to generate 574 million Certified Emission Reductions (CERs) by the year 2012.

It has been India's stand not to agree to any commitments related to reducing greenhouse gas emissions. In order to meet the demands of rising standards of living and providing access to commercial energy to those lacking it, the total emission of greenhouse gases is bound to increase in India and also in other developing countries. Developed countries, being responsible for the problem, owing to their historical as well as current emissions, are required to stabilise and reduce their emissions of GHGs. Hence, developed countries should come forward and take further deeper commitments beyond the year 2012.

Climate-friendly Measures taken by India

India is conscious of the challenge of climate change, and the urgency of actions needed to counter its possible adverse impacts. The past few years have witnessed the introduction of environmental measures in India that have targeted conservation of rivers, improvement of urban air quality, enhanced afforestation and a significant increase in the installed capacity of renewable energy technologies. These deliberate actions, by consciously factoring in India's commitment to the UNFCCC, have realigned the economic development to a more climate-friendly and sustainable path.

India believes that adaptation is critical for the developing countries that are most vulnerable to the climate change. India has implemented,in pursuit of this objective, several major programmes addressing the climate variability concerns. These include cyclone warning and protection, coastal protection, floods and drought control and relief, major and minor irrigation projects, control of malaria, food security measures, research on drought resistant crops, etc.

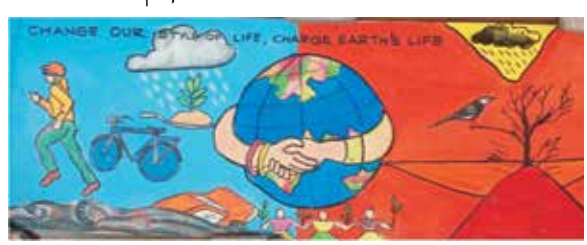

Figure 3. Change of Life style Changes Earth: Child's Perception

The goal of India's climate change related actions is to ensure sustainable development, which is inclusive in nature. The policy does not compromise on the developmental imperatives including energy security and poverty alleviation. India's National Environment Policy, 2006 underlines that 'while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependant on particular resources obtain better livelihoods from the fact of conservation, than from degradation of the resource'.

Figure 4. Save Water for Future Generation: Child's Perception

As India endeavours to increase energy consumption to empower its people, the national policies are designed to ensure that the means are also sustainable. This includes use of market mechanisms and the relevant technology along with the promotion of energy efficiency, conservation and renewable energy. As a part of such policy, measures have been taken to promote the use of CNG for public transport, introduce Metro rail in two cities, enact the Energy Conservation Act, 2001, and notify an Energy Efficiency Code for the new commercial buildings.

India's per capita consumption of energy is 530 kgoe (Kilogram of Oil Equivalent) of primary energy compared to the world average of 1770 kgoe. India's per capita emission of CO_2 is among the lowest in the world: it is approximately 1 tonne per annum as against a world average of 4.2 tonnes per annum, while the average for industrialised countries ranges between 10–20 tonnes per capita. The fossil fuel CO_2 intensity in India is the same as in Japan, and better than in Germany. This is owing to the fact that, at the national level, an effective regime of policies, regulations and programmes has been set up to address energy efficiency and energy security concerns. This has had a positive effect on India's development process.

The Government of India has set up an elaborate institutional mechanism to consider and address issues relating to climate change. A Council chaired by the Prime Minister, called Prime Minister's Council on Climate Change, was constituted in June 2007, to coordinate national action for assessment, adaptation and mitigation of climate change. The Council provides the overall guidance to climate change related actions taken by various ministries in the Government and other agencies. An expert committee set up in 2007, under the chairmanship of the Principal Scientific Adviser to Government of India, is also looking into the impacts of climate change. The committee is studying the impact of anthropogenic climate change on India and is engaged in identifying the measures that may have to be taken to address the adverse impacts.

Further, a Policy Guidance Group for International Negotiations headed by the Prime Minister and consisting of ministers concerned and a Core Negotiating Team of officials and technical experts for assisting the international negotiations, has also been set up.

National Action Plan on Climate Change

As a part of national voluntary actions to address climate change related concerns, India released its National Action Plan on Climate Change

(NAPCC) on 30 June 2008. The National Action Plan advocates a strategy that promotes, firstly, the adaptation to climate change and secondly, further enhancement of the ecological sustainability of India's development path. It recognises that climate change is a global challenge and that it should be successfully overcome through a globally collaborative and cooperative effort based on the basis of the principle of equity. The Action Plan suggests that the long-term convergence of per capita GHG emissions is the only equitable basis for a global agreement to tackle climate change. The Action Plan assures the international community that India's per capita GHG emissions would not exceed the per capita GHG emissions of developed countries, despite India's developmental imperatives.

India's National Action Plan stresses that maintaining a high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability to the impacts of climate change. Accordingly, the Action Plan identifies measures that promote the objectives of sustainable development of India while also yielding co-benefits for addressing climate change. It also outlines a national strategy that aims at enabling the country to adapt to climate change and enhances the ecological sustainability of India's development path.

Eight National Missions (National Solar Mission*, National Mission on Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green India, National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change), which form the core of the National Action Plan represent multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change. Besides the national missions, several other initiatives that are critical to achieve the objective of the NAPCC are to be implemented as a part of agreed national strategy for development and which will have significant co-benefits for climate. The national missions are to be institutionalised by the respective ministries and will be organised through inter-sectoral groups. Comprehensive Mission documents detailing objectives, strategies, plan of action, timelines and monitoring and evaluation criteria are being evolved.

International Negotiations

Efforts to counter climate change at the international level are currently focused on the negotiations that are taking place amongst the member countries of the UNFCCC, in pursuance of Bali Action Plan (BAP) adopted at the thirteenth Conference of Parties (CoP-13), held at Bali, Indonesia in December 2007. The Bali Action Plan calls for full, effective and sustained implementation of the UNFCCC through long-term cooperative action, now, up to and beyond 2012. It is a comprehensive dialogue to address the four major building blocks of climate change, i.e., GHG mitigation, adaptation to climate change impacts, technology development

* In a step forward, Gujarat has decided to promote the deserts as a hub for renewable energy by establishing solar power plants in the Rann of Kutch. The state government has decided to allocate 1,500 hectares of land to build Solar City in the desert. The incentives offered in the new Solar Power Policy include exemption from electricity duty and demand cut of 50 per cent of the installed capacity. The expected cost of the project is ₹61,019 crore.

and cooperation, and finance. This is a particularly significant development as it sets out differentiated approaches for the developed and developing countries in the key area of GHG mitigation on the basis of UN Framework Convention on Climate Change and underscores the importance of its principles and provisions, especially the 'common but differentiated responsibilities and respective capabilities'.

Several meetings of the Parties to UNFCCC were held since the adoption of Bali Action Plan in December 2007, viz. the UN Climate Change Talks were held at Bangkok from 31 March– 4 April 2008, at Bonn, Germany from 2–13 June 2008, at Accra, Ghana during 21–27 August 2008 and the 14th Conference of Parties was held at Poznan, Poland during 1–12 December 2008. Poznan Conference was intended to enable the Parties to take a stock of the progress made since the adoption of Bali Action Plan. The CoP-14 agreed on a timetable for the negotiations to commence and also the modalities for the preparation of a negotiating text that would form the basis of the negotiations. In June 2009, a meeting was held in Bonn to provide a basis for the group to intensify negotiations on further emission reduction commitments.

Accordingly, pre-sessional meetings of the Ad-hoc Working Groups of the Convention and the Kyoto Protocol (AWG-LCA 5 and AWG-KP 6) were held in Bonn from 29 March – 8 April 2009. The pre-sessional meetings discussed areas of convergence and divergence in the ideas submitted by the Parties for inclusion in the text for negotiations. A meeting was held in Bonn from 26 May – 12 June 2009 in which a negotiation text was prepared by the Chair of the Ad-hoc Working Group on Long-term Cooperative Action (AWG-LCA) to facilitate the negotiations among Parties on the fulfillment of Bali Action Plan. India has been able to project its views adequately and effectively in various meetings.

The UNFCCC talks are crucial for developing countries which are increasingly being subjected to pressures from the developed countries to agree to an emissions pathway in future and a set of internationally monitored, nationally appropriate actions for mitigation (NAMAs). While Bali Action Plan does call for NAMAs for Annex I* and non-Annex I** countries, the actions of developing countries is dependent on the support in terms of finance and technology received by such countries from the developed countries. Moreover, the burden of achieving the global goal of stabilisation of climate is to be shared equitably on the basis of the principle of the Convention which clearly differentiates between the countries on the basis of their responsibility and respective capability. While EU and most of the other Annex. I countries including US (which is not a signatory to Kyoto

* **Annex. I**: Parties include the industrialised countries that were members of the OECD (Organisation for Economic co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

** **Non-Annex. I**: Parties are mostly developing countries. Certain groups of developing countries are recognised by the Convention as being especially vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. Others (such as countries that rely heavily on income from fossil fuel production and commerce) feel more vulnerable to the potential economic impacts of climate change response measures. The Convention emphasises activities that promise to answer the special needs and concerns of these vulnerable countries, such as investment, insurance and technology transfer.

Protocol) have increased their emissions in recent years and failed to achieve the Kyoto targets, they are insisting that countries like India and China should come on board for a new deal to be forged in Copenhagen. While their own declaration of targets for their second commitment period under Kyoto Protocol are totally inadequate (EU — 20 per cent reduction in emissions over 1990 levels by 2020, US — 14 per cent reduction over 2005 levels by 2020, Australia — 5–25 per cent over 1990 by 2020, Japan — 6–25 per cent over 1990 by 2020 against 40–45 per cent over 1990 by 2020 as recommended by IPCC), they have asked the developing countries also to deviate by 15–30 per cent from their Business As Usual (BAU), in order to support the actions of the Annex I countries. India is opposed to such approaches and has argued that an agreement in Copenhagen has to be premised on the principles of the Convention.

As the subject of climate change has gained increasing significance and prominence, it is being discussed in various international groupings, such as Major Economies Meeting (MEM), G-8, etc. An initiative comprising the major economies, viz. Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Korea, South Africa, United Kingdom and the EU was launched in May 2007, to develop and contribute to discussions on energy security and climate change. The MEM seeks to complement the existing national, bilateral, regional and international programmes to address the long-term challenges of global climate change and to achieve agreement on the actions necessary to counter climate change. In the G-8 and Outreach Countries Summit held in July 2008, where India and other major economies were invited, the developing countries stressed their position regarding GHG mitigation as per the differentiated responsibilities and respective capabilities as envisaged in the UNFCCC and called for support in terms of technology and finance.

In the Major Economies Meeting on Climate Change held on the sidelines of G-8 Summit in Japan, the Prime Minister, emphasised the importance of enhanced implementation of the UNFCCC decisions through long-term cooperative action in accordance with the provisions and principles of the Convention, especially 'common but differentiated responsibilities and respective capabilities' are respected in these negotiations and their outcomes in letter and spirit.

India has been consistently raising the voice in all world fora that global warming is taking place everywhere and its adverse consequences will impact most heavily on developing countries like India. The reference at the above meeting to a two degree centigrade increase as a threshold reflects a prevalent scientific opinion internationally and only reinforces what India has been saying about the dangers from global warming. This is for the first time that India has accepted a reference to two degree centigrade in a document, as a possible threshold guiding global action, but this is entirely in line with our stated position on global warming.

India is a partner in the Asia Pacific Partnership on Clean Development and Climate (APP). The partnership consists of key developed and developing countries in Asia and North America across the Pacific — Australia, China, Japan, South Korea, Canada and the USA, besides India. It focusses on development, diffusion and transfer of clean and more efficient technologies and is consistent with the principles of the UNFCCC and complements the efforts under the UNFCCC. Under APP, eight (8) Task Forces in

the area of aluminum, buildings and appliances, cement, use of fossil energy, coal mining, power generation and transmission, renewable energy and distributed generation, and steel have been set up to facilitate collaboration in technology development and diffusion.

India engages bilaterally with several countries in the field of climate change. An MoU for cooperation in the field of Clean Development Mechanism under the Kyoto Protocol was signed in New Delhi between India and Denmark on 27 October 2008. The Third Meeting of the Indo-UK Structured Dialogue on Climate Change was held in September 2008, at New Delhi wherein important issues such as Bali Action Plan, Technology Transfer, Forestry, National Action Plan, etc., were discussed.

Policy Measures taken by India to Mitigate Climate Change

The past few years have witnessed the introduction of landmark environmental policy measures in India that have targeted conservation of rivers, improvement of urban air, enhanced forestation and a significant increase in the installed capacity of renewable energy technologies. These and similar measures, affirmed by the democratic and legislative processes, have been implemented by committing additional resource, as well as by re-aligning new investments. Besides, several other climate-friendly measures have been taken in recent years that have a direct bearing on mitigating climate change.

India is the fourth largest GHG emitter in absolute terms after China, US and EU-28 but its share of global emissions is only around 6 per cent of the world's total GHG emissions. The percentage emissions of the world's total and absolute emissions in Gigatons of CO_2 equivalent of the top 4 emitters are: China (22.5 per cent, 10.7 Gt CO_2e); US (12.2 per cent, 5.8 Gt CO_2e); EU-28 (8.6 per cent, 4.1 Gt CO_2e); India (6 per cent, 2.9 Gt CO_2e). They are followed by Russia; Indonesia, Brazil (7th largest emitter, 1.8 Gt CO_2e), Japan, Canada, Germany and Mexico. South Africa, another BASIC country is the 18th largest emitter with emissions of 0.4 Gt CO_2e. India's per capita GHG emission (2.33 Gt CO_2e) is 1/3 of the world average (6.76) and is very low compared to developed countries as well as many of the developing countries. The per capita GHG emissions measured in terms of tonnes of CO_2 equivalent per capita of some of the countries are China (7.91); US (18.55); EU-28 (8.22); Russia (15.75); Japan (9.46); Brazil (9.18); South Africa (8.86); Saudi Arabia (18.63). Among the top 10 absolute emitters only two (India, Mexico) have per capita emissions that are below the world average.

India's environment policy has been driven by the imperatives of sustainable development, and has, as a co-benefit, led to a decline in the intensity of energy use and carbon dioxide emissions as well. The high ratio of recycling in India, compared to that of other major economies has also limited the growth in energy use, and GHG emissions, because of the lower demand for virgin material such as steel, aluminum and copper.

The Electricity Act, 2003, requires States Electricity Regulatory Commissions to specify a percentage of electricity that the electricity distribution companies must procure from renewable sources. Several commissions have already operationalised this mandate, and also notified preferential prices for electricity from renewable sources. This has contributed to an acceleration in renewable-electricity capacity addition, and over the past three years, about

2,000 MW of renewable electricity capacity has been added in India every year, bringing the total installed renewable capacity to over 11,000 MW. Of this, a little over 7,000 MW is based on wind power. India now has the fourth largest installed wind capacity in the world. The National Hydro Energy Policy has resulted in the accelerated addition of hydropower in India, which is now over 35,000 MW.

Currently, the primary energy sector growth rate is around 3 per cent per year, against GDP growth exceeding 8 per cent. Steel, aluminium, fertiliser, paper, cement are some of the major energy-intensive sectors where India's energy efficiency has attained the global standards. Especially, in the cement sector, the energy efficiency of Indian plants is among the world's highest.

An Energy Conservation Building Code (ECBC) was launched in May, 2007, which addresses the design of new, large commercial buildings to optimise the building's energy demand. Commercial buildings are one of the fastest growing sectors of the Indian economy, reflecting the increasing share of the services sector in the economy. Nearly 100 buildings are already following the Code, and compliance with it has also been incorporated into the Environmental Impact Assessment requirements for large buildings.

In the area of off-grid and rural applications, biogas and solar-lighting have reached four million and one million households, respectively, while in the area of solar water heating systems, around 2 million sq. m collector area has been deployed. Besides, Village Electrification Programme is also being implemented to electrify 10,000 villages through renewable energy resources by 2012.

The Government of India has also launched the 'Green India' project that will be the world's largest afforestation project covering six million hectares of degraded forestland.

Lastly, the latest Green Index taken out by National Geographic puts India as the No.1 country in the world on a Green Index. The Greendex is a comprehensive measure of consumer behaviour in 65 areas relating to housing, transportation, food and consumer goods. Greendex 2009 ranks average consumers in 17 countries—up from 14 in 2008, for which changes are tracked—according to the environmental impact of their discretionary and non-discretionary consumption patterns within these four major categories. Environmental concern and engagement among the public has increased, and many programmes and initiatives by governments and companies were put in place as a result. Overall, environmental concerns have remained strong, and awareness of the issues at hand has increased.

Conclusion

Risks emanating from climate change, caused by anthropogenic greenhouse gas emissions are now widely perceived to be real. Unless addressed expeditiously, these can have adverse consequences upon those least able to cope, that is, the poor and disadvantaged across the globe, but particularly those residing in the developing countries. The issue of climate change needs to be addressed within the framework of sustainable development, without halting the process of development. The importance accorded to the subject of climate change in various international forums addressed, many times at the State of Head level itself, shows the recognition of the problem.

This, in turn, results in paving the way for taking appropriate policy measures at national and international level. There are several means to check the threat which includes exchange of information by all nations, international cooperation in developing environment friendly innovative technologies, technology transfer from developed to developing countries and access to environmentally sound services. India's participation in different global environmental negotiations and several domestic initiatives to counter global warming and climate change underlines its commitment and seriousness towards the problem.

SCIENCE NEWS

Spintronics Just Got Faster

In a tremendous boost for spintronic technologies, EPFL scientists have shown that electrons can jump through spins much faster than previously thought.

Electrons spin around atoms, but also spin around themselves, and can cross over from one spin state to another, a property which can be exploited for the next-generation hard drives. However, 'spin crossover' has been considered too slow to be efficient. Using ultrafast measurements, EPFL scientists have now shown for the first time that electrons can cross spins at least 1,00,000 times faster than previously thought. Apart from its enormous implications for fundamental physics, the finding can also propel the field of spintronics forward. The study is published in *Nature Chemistry*.

The rules of spin

Although difficult to describe in everyday terms, electron spin can be loosely compared to the rotation of a planet or a top spinning around its axis. Electrons can spin in different manners referred to as 'spin states' and designated by the numbers 0, 1/2, 1, 3/2, 2, etc. During chemical reactions, electrons can cross from one spin state to another, e.g., from 0 to 1 or 1/2 to 3/2.

Spin crossover is already used in many technologies, e.g., optical light-emitting devices (OLED), energy conversion systems and cancer phototherapy. Most prominently, spin crossover is the basis of the fledgling field of spintronics. The problem is that spin crossover has been thought to be too slow to be efficient enough in circuits.

Spin crossover is extremely fast

The lab of Majed Chergui at EPFL has now demonstrated that spin crossover is considerably faster than previously thought. Using the highest time-resolution technology in the world, the lab was able to 'see' electrons crossing through four spin states within 50 quadrillionths of a second or 50 femtoseconds.

"Time resolution has always been a limitation," says Chergui. "Over the years, labs have used techniques that could only measure spin changes to a billionth to a millionth of a second.

So they thought that spin crossover happened in this timeframe."

Chergui's lab focussed on materials that show much promise in spintronics applications. In these materials, electrons jump through four spin-states: from 0 to 1 to 2. In 2009, Chergui's lab pushed the boundaries of time resolution to show that this 0–2 'jump' can happen within 150 femtoseconds — suggesting that it was a direct event. Despite this, the community still maintained that such spin crossovers go through intermediate steps.

But Chergui had his doubts. Working with his postdoc Gerald Auböck, they used the lab's world-recognised expertise in ultrafast spectroscopy to 'crank up' the time resolution. Briefly, a laser shines on the material sample under investigation, causing its electrons to move. Another laser measures their spin changes over time in the ultraviolet light range.

The finding essentially demolishes the notion of intermediate steps between spin jumps, as it does not allow enough time for them: only 50 quadrillionths of a second to go from the '0' to the '2' spin state. This is the first study to ever push time resolution to this limit in the ultraviolet domain. "This probably means that it's even faster," says Chergui. "But, more importantly, that it is a direct process."

From observation to explanation

With profound implications for both technology and fundamental physics and chemistry, the study is an observation without an explanation. Chergui believes that the key is electrons shuttling back-and-forth between the iron atom at the center of the material's molecules and its surrounding elements. "When the laser light shines on the atom, it changes the electron's spin angle, affecting the entire spin dynamics in the molecule."

It is now up to theoreticians to develop a new model for ultrafast spin changes. On the experimental side of things, Chergui's lab is now focussing on actually observing electrons shuttling inside the molecules. This will require even more sophisticated approaches, such as core-level spectroscopy. Nonetheless, the study challenges ideas about spin crossover, and might offer long-awaited solutions to the limitations of spintronics.

Peppermint Oil and Cinnamon could Help Treat and Heal Chronic Wounds

Infectious colonies of bacteria called biofilms that develop on chronic wounds and medical devices can cause serious health problems and are tough to treat. But now scientists have found a way to package antimicrobial compounds from peppermint and cinnamon in tiny capsules that can both kill biofilms and actively promote healing. The researchers say that the new material, reported in the journal *ACS Nano*, could be used as a topical antibacterial treatment and disinfectant.

Many bacteria clump together in sticky plaques in a way that makes it difficult to eliminate them with traditional antibiotics. Doctors sometimes recommend cutting out infected tissues. This approach is costly, however, and because it's invasive, many patients opt out of the treatment altogether. Essential oils and other natural compounds have emerged recently as alternative substances that can get rid of pathogenic bacteria, but researchers have had a hard time translating their antibacterial activity into treatments. Vincent M. Rotello and colleagues wanted to address this challenge. The researchers packaged peppermint oil and cinnamaldehyde, the compound in cinnamon responsible for its flavour and aroma, into silica

nanoparticles. The microcapsule treatment was effective against four different types of bacteria, including one antibiotic-resistant strain. It also promoted the growth of fibroblasts, a cell type that is important in wound healing.

Mammoths Killed by Abrupt Climate Change

New research has revealed that abrupt warming, that closely resembles the rapid human-made warming occurring today, has repeatedly played a key role in mass extinction events of large animals, the megafauna, in earth's past.

Using advances in analysing ancient DNA, radiocarbon dating and other geologic records, an international team led by researchers from the University of Adelaide and the University of New South Wales (Australia) have revealed that short, rapid warming events, known as interstadials, recorded during the last ice age or Pleistocene (60,000–12,000 years ago) coincided with major extinction events even before the appearance of man.

Published earlier in *Science*, the researchers report extreme cold periods, such as the last glacial maximum, do not appear to correspond with these extinctions.

"This abrupt warming had a profound impact on climate that caused marked shifts in global rainfall and vegetation patterns," said University of Adelaide lead author and Director of the Australian Centre for Ancient DNA, Professor Alan Cooper.

"Even without the presence of humans we saw mass extinctions. When you add the modern addition of human pressures and fragmenting of the environment to the rapid changes brought by global warming, it raises serious concerns about the future of our environment."

The researchers came to their conclusions after detecting a pattern, 10 years ago, in ancient DNA studies suggesting the rapid disappearance of large species. At first the researchers thought these were related to intense cold snaps.

However, as more fossil-DNA became available from museum specimen collections and through improvements in carbon dating and temperature records that showed better resolution through time, they were surprised to find the opposite. It became increasingly clear that rapid warming, not sudden cold snaps, was the cause of the extinctions during the last glacial maximum.

The research helps explain further the sudden disappearance of mammoths and giant sloths that became extinct around 11,000 years ago at the end of the last ice age.

"It is important to recognise that man still plays an important role in the disappearance of the major mega fauna species," said fellow author Professor Chris Turney from the University of New South Wales.

The abrupt warming of the climate caused massive changes to the environment that set the extinction events in motion, but the rise of humans applied the coup de grace to a population that was already under stress.

In addition to the finding, the new statistical methods used to interrogate the datasets (led by Adelaide co-author, Professor Corey Bradshaw) and the new data itself has created an extraordinarily precise record of climate change and species movement over the Pleistocene.

This new dataset will allow future researchers a better understanding of this important period than has ever been possible before.

High-pressure Oxygen can Effectively Treat Fibromyalgia

Fibromyalgia is almost impossible to diagnose. The chronic pain syndrome strikes an estimated 1 in 70 Americans, most of them women. The disorder is often triggered by head trauma, a neurological infection, or severe emotional stress, and is characterised by symptoms such as musculoskeletal pain, fatigue, memory loss and mood swings. Fibromyalgia is often mistaken for other culprits and most patients suffer months, even years, of unrelenting pain before being properly diagnosed. And once diagnosed, patients enjoy little respite because few therapies have been found to be effective in assuaging its symptoms.

A new study published in *PLOS One* by Tel Aviv University researchers may turn the tide. The research found that women with fibromyalgia were able to drastically reduce, or even eliminate, their use of pain medication following hyperbaric oxygen treatment. The study was led by the late Prof. Eshel Ben-Jacob of TAU's School of Physics and Astronomy and Rice University's Center for Theoretical Biological Physics, Dr. Shai Efrati of TAU's Sagol School of Neuroscience and Assaf Harofeh Medical Center and Prof. Dan Buskila from Soroka Medical Center, and was conducted by a team of scientists from TAU, Rice University, Assaf Harofeh Medical Center, Ben-Gurion University, and Tel Aviv Sourasky Medical Center.

The TAU researchers believe that they have also identified the primary factor causing fibromyalgia: the disruption of the brain mechanism for processing pain. "As a physician, the most important finding for me is that 70 per cent of the patients could recover from their fibromyalgia symptoms," said Dr. Efrati.

"The most exciting finding for the world of research, however, is that we were able to map the malfunctioning brain regions responsible for the syndrome."

A high-pressure solution

Hyperbaric oxygen chambers expose patients to pure oxygen at higher-than-atmospheric pressures and are commonly used to treat patients with embolisms, burns, carbon monoxide poisoning and decompression sickness.

The clinical trial, which exposed participants to two months of hyberbaric oxygen therapy, found significant changes in the brain activity and symptoms of 70 per cent of participants. The trial involved 60 women who had been diagnosed with fibromyalgia at least two years earlier. Half of the 48 patients who completed the therapy received 40 hyperbaric oxygen treatments—90-minute treatments exposing patients to pure oxygen at twice the atmospheric pressure, five days a week over the course of two months.

The successful treatment enabled patients to drastically reduce or even eliminate their use of pain medications. "The intake of the drugs eased the pain but did not reverse the condition. But hyperbaric oxygen treatments did reverse the condition," said Dr. Efrati, who added that the findings warrant further study.

Getting to the root of the problem

"The results are of significant importance," Dr. Efrati said. "Hyperbaric oxygen treatments are designed to address the actual cause of fibromyalgia — the brain pathology responsible for the syndrome. It means that brain repair, including neuronal regeneration, is possible even for chronic, long-lasting pain syndromes, and we can and should aim for that in any future treatment development."

The researchers did find some discrepancies among patients with different fibromyalgia catalysts. When fibromyalgia was triggered by a traumatic brain injury, for example, they witnessed a complete resolution without any need for further treatment. But when the trigger was attributed to other causes, such as fever-related diseases, patients required periodic maintenance therapy.

The researchers are continuing to conduct comprehensive studies on the renewal of brain tissue under hyperbaric conditions.

Eyeing Up Earth-like Planets

Almost 2,000 exoplanets have been discovered to date, ranging from rocky Earth-like planets to hot-Jupiters, and orbiting every type of star. But how many of these distant worlds are habitable? Today's technology means that we currently have very little information about what exoplanets are like beyond their presence, size and distance from star. With the launch of the James Webb Space Telescope (JWST), we may have our first glimpses into atmospheres of Earth-like exoplanets, according to the results of a study by Dr Joanna Barstow presented at the National Astronomy Meeting in Llandudno.

"A planet's atmosphere provides a good guide to likely conditions on the surface," said Barstow, of the University of Oxford. "The Earth's atmosphere contains significant amounts of nitrogen, oxygen, ozone and water. By contrast, its inhospitable 'evil twin', Venus, has an atmosphere made mostly of carbon dioxide, which drives its surface temperature to a blistering 450°C."

A successor to the Hubble Space Telescope, JWST is due for launch in 2018 and will study the Universe in infrared wavelengths. Barstow's study shows that JWST may be able to differentiate between a planet with a clement, Earth-like atmosphere, and one with more hostile conditions, such as those that are found on our neighbouring planet Venus. JWST will have the capability to detect key markers that could indicate the presence of a climate like our own when looking at Earth-sized planets around stars that are smaller and redder than Sun.

Different gases have already been identified successfully in the atmospheres of several large, hot, Jupiter-sized planets by studying tiny variations in the starlight that passes through their atmospheres when they cross in front of their parent stars. However, these variations are miniscule: the light filtered through the exoplanet's atmosphere is one ten-thousandth of the total starlight detected. Studying planets the size of the Earth is an even greater challenge. Although JWST would struggle with analysing a Solar System exactly like our own, it would be capable of studying Earth-like planets around cooler stars — if such a system were to be found.

"If we took the Earth and Venus, and placed them in orbit around a cool, red star that's not too far away, our study shows that JWST could tell them apart. Earth's ozone layer, 10 kilometres above the surface, is produced when light from the Sun interacts with molecules of oxygen in the atmosphere, and it produces an unmistakable signal that could be detected by JWST. Venus, without a substantial ozone layer, would look very different," said Barstow. "That's assuming that planets starting out like Earth and Venus would evolve in the same way around a cool star!"

However, JWST will be used for a wide range of astronomical applications, not just detecting exoplanets, and securing time on the telescope will be highly competitive. To make these detections, astronomers would need to observe the exoplanets at least 30 times, taking valuable telescope time.

"Future telescopes that are dedicated to observing the atmospheres of many rocky planets around different stars will be required to fully resolve the question of habitability on exoplanets. In the meantime, JWST will observe many other weird and wonderful planets in unprecedented detail," said Barstow.

Rhythm of Cells: Daily Changes in Human Cells

Life is subject to natural rhythms, such as the light and dark cycle or seasonal variation in temperature. A recent study by researchers at the Vetmeduni Vienna, shows that the composition of human cell membranes varies depending on the time of day. These cyclical changes in cell membranes could have a significant impact on health and disease. The results were published in the *Journal of Biological Rhythms*.Fatty acids are important components of cell membranes. They have signalling functions within the cells and play a role in controlling metabolic processes in the entire body. Thomas Ruf and Walter Arnold of the Research Institute of Wildlife Ecology at the University of Veterinary Medicine, Vienna, investigated these cyclic fluctuations in human cells.

"Nearly all physiological processes in humans and animals, such as body temperature or heart rate, undergo daily rhythms, and many even exhibit annual fluctuations. We wanted to find out if these rhythms are related to changes in cell membranes," explains first author Thomas Ruf.

The researchers investigated buccal mucosa cells in 20 subjects over a period of one year. Study participants collected their cells on a predetermined day every month at three-hour intervals by intensively rinsing their mouths with water and then freezing the samples in special flasks.

The composition of fatty acid changes during the course of the day

The analysis of the cell membranes revealed significant daily rhythms in 11 fatty acids. Several fatty acids were present in higher concentrations at night, others during the daytime. "The cellular changes have one thing in common: they always occurred at about the same time in all participants. This shows that a clear rhythm is present," Ruf explains.

"From animal physiology, we know that the fatty acid composition in cell membranes can be remodelled in response to environmental conditions. Fatty acid composition is especially subject to seasonal fluctuations. However, while the participants of our study all showed daily fluctuations, seasonal changes occurred only in individual cases."

In contrast to wildlife, no clear annual rhythm could be seen in the fatty acid patterns of the study participants. Around one half of the subjects showed yearly rhythms, but these were not synchronous. Some participants exhibited a peak in spring or in summer, while in others the same fatty acid had higher concentrations in autumn or in the winter. "In western countries, seasons are having an increasingly smaller impact on the body. This is due to the prevalence of artificial light, which makes for longer days, and the long heating season, which minimises temperature fluctuations. Annual rhythms still exist, but these are no longer synchronised with the seasons," says Ruf.

Certain diseases occur in seasonal rhythms

This remodelling of human cell membranes could be of medical importance. It is known that certain fatty acids, such as omega-3 fatty acids offer protection against certain diseases, while

others, if taken up in excess, can have negative effects. The composition of the fatty acids in cell membranes may therefore have a variety of different health consequences.

"This may also explain why certain diseases and even death occur at specific times of day. Statistically speaking, heart attacks occur more often in the morning than in the evening. Blood pressure usually rises before noon. We currently do not know exactly what causes the changes in the composition of the cell membranes. The type of food eaten and the time of food intake may also play a role. These questions must still be researched," Ruf points out.

In addition to consuming sufficient quantities of important healthy fatty acids, such as omega-3 fatty acids in fish oil or oleic acids in olive oil, it may also be important to choose the right time for intake.

Climate Change

Global Sea Levels

Global sea levels have risen six metres or more with just slight global warming.

A new review analysing three decades of research on the historic effects of melting polar ice sheets found that global sea levels have risen at least six metres, or about 20 feet, above present levels on multiple occasions over the past three million years.

What is most concerning, scientists say, is that the amount of melting was caused by an increase of only 1–2 degrees (Celsius) in global mean temperatures.

Results of the study have been published earlier in the journal *Science*.

"Studies have shown that both the Greenland and Antarctic ice sheets contributed significantly to this sea level rise above modern levels," said Anders Carlson, an Oregon State University glacial geologist and paleoclimatologist, and co-author of the study. "Modern atmospheric carbon dioxide (CO_2) levels are today equivalent to those about three million years ago, when sea level was at least six metres higher because the ice sheets were greatly reduced."

"It takes time for the warming to whittle down the ice sheets," added Carlson, who is in OSU's College of Earth, Ocean and Atmospheric Sciences, "but it doesn't take forever. There is evidence that we are likely seeing that transformation begin to take place now."

Co-author Peter Clark, an OSU paleo-climatologist, said that because current CO_2, levels are as high as they were three million years ago, "we are already committed to a certain amount of sea level rise."

"The ominous aspect to this is that CO_2 levels are continuing to rise, so we are entering uncharted territory," Clark said. "What is not as certain is the time frame, which is less well-constrained. We could be talking many centuries to a few millennia to see the full impact of melting ice sheets."

The review, which was led by Andrea Dutton of the University of Florida, summarised more than 30 years of research on past changes in ice sheets and sea level. It shows that changes in Earth's climate and sea level are closely linked, with only small amounts of warming needed to have a significant effect on seal levels. Those impacts can be significant.

Six metres (or about 20 feet) of sea level rise does not sound like a lot. However, coastal cities worldwide have experienced enormous growth in population and infrastructure over the past couple of centuries — and a global mean sea

level rise of 10 to 20 feet could be catastrophic to the hundreds of millions of people living in these coastal zones.

Much of the state of Florida, for example, has an elevation of 50 feet or less, and the city of Miami has an average elevation of six feet. Parts of New Orleans and other areas of Louisiana were overcome by Hurricane Katrina — by a surging Gulf of Mexico that could be 10 to 20 feet higher in the future. Dhaka in Bangladesh is one of the world's 10 most populous cities with 14.4 million inhabitants, all living in low-lying areas. Tokyo and Singapore also have been singled out as extremely vulnerable to sea level rise.

"The influence of rising oceans is even greater than the overall amount of sea level rise because of storm surge, erosion and inundation," said Carlson, who studies the interaction of ice sheets, oceans and the climate system on centennial time scales. "The impact could be enormous."

The Science review is part of the larger Past Global Changes, or PAGES, international science team. A working group known as PALSEA2 (Paleo constraints on sea level rise) used past records of local change in sea level and converted them to a global mean sea level by predicting how the surface of the Earth deforms due to changes in ice-ocean loading of the crust, along with changes in gravitational attraction on the ocean surface.

Independently, Greenland and Antarctic ice sheet volumes were estimated by observations from adjacent ocean sediment records and by ice sheet models.

"The two approaches are independent of one another, giving us high confidence in the estimates of past changes in sea level," Carlson said. The past climates that forced these changes in ice volume and sea level were reconstructed mainly from temperature-sensitive measurements in ocean cores from around the globe, and from ice cores.

The National Science Foundation supported the research.

Promising Progress for New Treatment of Type 1 Diabetes

New research from Uppsala University shows promising progress in the use of anti-inflammatory cytokine for treatment of Type 1 diabetes (T1D). The study, published in the open access journal *Scientific Reports* (Nature Publishing Group), reveals that administration of interleukin-35 (a protein made by immune cells) to mice with Type 1 diabetes, reverses or cures the disease by maintaining a normal blood glucose level and the immune tolerance.

T1D is a chronic disease, which for the patients leads to a life-long dependence of daily injections of insulin. In Sweden, approximately two new cases of the disease are diagnosed everyday. Insulin is a hormone, which is produced by the beta cells in the pancreas. Insulin is required to prevent a harmful rise in the blood glucose level.

The exact cause of T1D is not yet known, however, it is considered as an auto-immune disease. A condition that occurs when our own immune system by mistake attacks and destroys healthy cells. In T1D, an infection and/or unknown factors probably trigger(s) the immune cell attack, which ultimately leads to an insufficient insulin production.

In the new study, Dr. Kailash Singh, a Ph.D. student in Professor Stellan Sandler's research group at the Department of Medical Cell Biology at Uppsala University, studied the so-called immune regulatory T cells' actions in T1D mouse models. The study shows that the immune regulatory T cells alter their function by producing pro-inflammatory

destructive proteins instead of protective anti-inflammatory proteins, such as interleukin-35 (IL-35) under T1D conditions.

"This suggests that the good guys have gone bad in early development of Type 1 diabetes and therefore our immune cells destroy the beta cell," says Dr. Kailash Singh.

Furthermore, the concentration of IL-35 was lower in T1D patients compared to healthy individuals. These findings may suggest that IL-35 could play a crucial role in human T1D. In addition, the researchers have found a novel mechanism that explains how the immune regulatory T cells are changing their destiny under a T1D condition.

Professor Sandler's research team tested whether or not IL-35 could also suppress development of T1D and reverse established T1D. To induce T1D in mice they injected a chemical compound called streptozotocin. These mice developed signs of TID and increasing blood glucose levels similar as in human T1D. IL-35 injections given after disease induction prevented from development of T1D. Strikingly, IL-35 injections to mice, which were diabetic for two consecutive days, normalised blood glucose concentrations.

The research team also successfully investigated IL-35 in another model of T1D called non-obese diabetic mouse (NOD). The interruption of IL-35 treatment did not result in return of diabetes in any of the mouse models.

The findings encourage further research on the use of IL-35 for treatment of T1D and offer new clues as to why immune regulatory T cells fail in counteracting T1D.

"To the best of our knowledge, we are the first to show that IL-35 can reverse established Type 1 diabetes in two different mouse models and that the concentration of the particular cytokine is lower in Type 1 diabetes patients than in healthy individuals. Also, we are providing an insight into a novel mechanism: how immune regulatory T cells change their fate under autoimmune conditions," says Dr. Kailash Singh.

Managing Mining of the Deep Seabed

Thousands of feet below the ocean's surface lies a hidden world of undiscovered species and unique seabed habitats—as well as a vast untapped store of natural resources including valuable metals and rare-earth minerals. Technology and infrastructure development worldwide is dramatically increasing demand for these resources, which are key components in everything from cars and modern buildings to computers and smartphones. This demand has catalysed interest in mining huge areas of the deep-sea floor.

In a paper published in *Science*, researchers from the Center for Ocean Solutions and co-authors from leading institutions around the world proposed a strategy for balancing commercial extraction of deep-sea resources with protection of diverse seabed habitats. The paper is intended to inform upcoming discussions by the International Seabed Authority (ISA) that will set the groundwork for future deep-sea environmental protection and mining regulations.

"Our purpose is to point out that the ISA has an important opportunity to create networks of no-mining Marine Protected Areas (MPAs) as part of the regulatory framework they are considering in their July meeting," says lead author Lisa Wedding, an early career science fellow at the Center for Ocean Solutions. "The establishment of regional MPA networks in the deep sea could potentially benefit both mining and biodiversity

interests by providing more economic certainty and ecosystem protection."

The ISA is charged with managing the seabed and its resources outside of national jurisdictions for the benefit of humankind. According to the United Nations Convention on the Law of the Sea (UNCLOS), the deep seabed is legally a part of the 'common heritage of humankind,' meaning that it belongs to each and every human on the planet.

"The ISA is the only body with the legal standing and responsibility to manage mining beyond national jurisdiction," said Kristina Gjerde, an international high-seas lawyer and co-author of the *Science* paper.

Since 2001, the ISA has granted 26 mining exploration contracts covering more than one million square kilometers of seabed, with 18 of these contracts granted in the last four years. Researchers recommend that the ISA, as part of its strategic plans to protect deep-seabed habitats and manage mining impacts, take a precautionary approach and set up networks of MPAs before additional large claim areas are granted for deep seabed mining.

"Given our paltry understanding of deep-sea environments, regional networks of MPAs that designate significant portions of the deep seabed as off-limits to mining would provide key insurance against unanticipated environmental impacts," said co-author Steven Gaines, Dean of the Bren School of Environmental Science & Management at the University of California at Santa Barbara.

Mining impacts could affect important environmental benefits that the deep sea provides to human beings. For example, the deep sea is a key player in our planet's carbon cycle, capturing a substantial amount of human-emitted carbon which impacts both weather and climate. Mining activities could disturb these deep-sea carbon sinks, releasing excess carbon back into the atmosphere. The deep sea also sustains economically important fisheries, and harbors micro organisms which have proven valuable in a number of pharmaceutical, medical and industrial applications.

"Deep-sea areas targeted by mining claims frequently harbor high biodiversity and fragile habitats, and may have very slow rates of recovery from physical disturbance," said Craig Smith, a co-author and professor of oceanography at the University of Hawaii at Manoa. Smith and a team of scientists, helped the ISA pioneer the deep sea's first regional environmental management plan in 2012. Located in an area of the Pacific Ocean known as the Clarion-Clipperton Zone (CCZ), the plan honoured existing mining exploration claims while protecting delicate habitats by creating a network of MPAs. The CCZ serves as a model for how future deep-sea ecosystem management could unfold.

"This kind of precautionary approach achieves a balance of economic interests and conservation benefits," said Sarah Reiter, a co-author and former early career law and policy fellow at the Center for Ocean Solutions, and ocean policy analyst at the Monterey Bay Aquarium.

The upcoming ISA session on July 15th represents a critical juncture for defining the future of deep-sea mining and protection.

"The time is now to protect this important part of the planet for current and future generations," said Larry Crowder, a co-author and science director at the Center for Ocean Solutions and senior fellow at the Stanford Woods Institute for the Environment. "Decisions that affect us all will be made by the ISA this summer."

Don't look now, but the pronoun 'I' is becoming obsolete.

Recent microbiological research has shown that thinking of plants and animals, including humans, as autonomous individuals is a serious over-simplification.

A series of groundbreaking studies have revealed that what we have always thought of as individuals are actually 'biomolecular networks' that consist of visible hosts plus millions of invisible microbes that have a significant effect on how the host develops, the diseases it catches, how it behaves and possibly even its social interactions.

"It's a case of the whole being greater than the sum of its parts," said Seth Bordenstein, associate professor of biological sciences at Vanderbilt University, who has contributed to the body of scientific knowledge that is pointing to the conclusion that symbiotic microbes play a fundamental role in virtually all aspects of plant and animal biology, including the origin of new species.

In this case, the parts are the host and its genome plus the thousands of different species of bacteria living in or on the host, along with all their genomes, collectively known as the microbiome. (The host is something like the tip of the iceberg while the bacteria are like the part of the iceberg that is underwater: Nine out of every 10 cells in plant and animal bodies are bacterial. But bacterial cells are so much smaller than host cells that they are generally unnoticed.)

Microbiologists have coined new terms for these collective entities — holobiont — and for their genomes — hologenome. "These terms are needed to define the assemblage of organisms that make up the so-called individual," said Bordenstein.

In the article 'Host Biology in Light of the Microbiome: Ten Principles of Holobionts and Hologenomes' published online on 18 August in the open access journal *PLOS Biology*, Bordenstein and his colleague Kevin Theis from the University of Michigan take the general concepts involved in this new paradigm and break them down into underlying principles that apply to the entire field of biology.

They make specific and refutable predictions based on these principles and call for other biologists to test them theoretically and experimentally.

"One of the basic expectations from this conceptual framework is that animal and plant experiments that do not account for what is happening at the microbiological level will be incomplete and, in some cases, will be misleading as well," said Bordenstein.

The first principle they advance is that holobionts and hologenomes are fundamental units of biological organisation.

Another is that evolutionary forces, such as natural selection and drift may act on the hologenome, not just on the genome. So mutations in the microbiome that affect the fitness of a holobiont are just as important as mutations in the host's genome. However, they argue that this does not change the basic rules of evolution but simply upgrades the types of biological units that the rules may act upon.

Although it does not change the basic rules of evolution, holobionts do have a way to respond to environmental challenges that is not available to individual organisms: They can alter the

composition of their bacterial communities. For example, if a holobiont is attacked by a pathogen that the host cannot defend against, another symbiont may fulfill the job by manufacturing a toxin that can kill the invader. In this light, the microbes are as much part of the holobiont immune system as the host immune genes themselves.

According to Bordenstein, these ideas are gaining acceptance in the microbiology community. At the American Society of Microbiology General Meeting, he convened the inaugural session on 'Holobionts and their Hologenomes' and ASM's flagship journal *mBio* plans to publish a special issue on the topic.

However, adoption of these ideas has been slower in other fields.

"Currently, the field of biology has reached an inflection point. The silos of microbiology, zoology and botany are breaking down and we hope that this framework will help further unify these fields," said Bordenstein.

Not only will this powerful holistic approach affect the basic biological sciences but it also is likely to impact the practice of personalised medicine as well, Bordenstein said.

Take the missing heritability problem, for example. Although genome-wide studies have provided valuable insights into the genetic basis of a number of simple diseases, they have only found a small portion of the genetic causes of a number of more complex conditions, such as auto-immune and metabolic diseases.

These may in part be 'missing' because the genetic factors that cause them are in the microbiome, he pointed out.

"Instead of being so 'germophobic,' we need to accept the fact that we live in and benefit from a microbial world. We are as much an environment for microbes as microbes are for us," said Bordenstein.

Obesity Breakthrough: Metabolic Master Switch Prompts Fat Cells to Store or Burn Fat

Obesity is one of the biggest public health challenges of the 21st century. Affecting more than 500 million people worldwide, obesity costs at least $200 billion each year in the United States alone, and contributes to potentially fatal disorders, such as cardiovascular disease, Type 2 diabetes and cancer.

But there may now be a new approach to prevent and even cure obesity, thanks to a study led by researchers at MIT and Harvard Medical School and published in the *New England Journal of Medicine.* By analysing the cellular circuitry underlying the strongest genetic association with obesity, the researchers have unveiled a new pathway that controls human metabolism by prompting our adipocytes, or fat cells, to store fat or burn it away.

"Obesity has traditionally been seen as the result of an imbalance between the amount of food we eat and how much we exercise, but this view ignores the contribution of genetics to each individual's metabolism," says senior author Manolis Kellis, a professor of computer science and a member of MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and of the Broad Institute.

New mechanism found

The strongest association with obesity resides in a gene region known as 'FTO,' which has been the focus of intense scrutiny since its discovery in 2007. However, previous studies have failed

to find a mechanism to explain how genetic differences in the region lead to obesity.

"Many studies attempted to link the FTO region with brain circuits that control appetite or propensity to exercise," says first author Melina Claussnitzer, a visiting professor at CSAIL and instructor in medicine at Beth Israel Deaconess Medical Center and Harvard Medical School. "Our results indicate that the obesity-associated region acts primarily in adipocyte progenitor cells in a brain-independent way."

To recognise the cell types where the obesity-associated region may act, the researchers used annotations of genomic control switches across more than 100 tissues and cell types. They found evidence of a major control switchboard in human adipocyte progenitor cells, suggesting that genetic differences may affect the functioning of human fat stores.

To study the effects of genetic differences in adipocytes, the researchers gathered adipose samples from healthy Europeans carrying either the risk or the non-risk version of the region. They found that the risk version activated a major control region in adipocyte progenitor cells, which turned on two distant genes, IRX3 and IRX5.

Control of thermogenesis

Follow-up experiments showed that IRX3 and IRX5 act as master controllers of a process known as thermogenesis, whereby adipocytes dissipate energy as heat, instead of storing it as fat. Thermogenesis can be triggered by exercise, diet, or exposure to cold, and occurs both in mitochondria-rich brown adipocytes that are developmentally related to muscle, and in beige adipocytes that are instead related to energy-storing white adipocytes.

"Early studies of thermogenesis focussed primarily on brown fat, which plays a major role in mice, but is virtually nonexistent in human adults," Claussnitzer says. "This new pathway controls thermogenesis in the more abundant white fat stores instead, and its genetic association with obesity indicates that it affects global energy balance in humans."

The researchers predicted that a genetic difference of only one nucleotide is responsible for the obesity association. In risk individuals, a thymine (T) is replaced by a cytosine (C) nucleobase, which disrupts repression of the control region and turns on IRX3 and IRX5. This then turns off thermogenesis, leading to lipid accumulation and ultimately obesity.

By editing a single nucleotide position using the CRISPR/Cas9 system — a technology that allows researchers to make precise changes to a DNA sequence — the researchers could switch between lean and obese signatures in human pre-adipocytes. Switching the C to a T in risk individuals turned off IRX3 and IRX5, restored thermogenesis to non-risk levels, and switched off lipid storage genes.

"Knowing the causal variant underlying the obesity association may allow somatic genome editing as a therapeutic avenue for individuals carrying the risk allele,"says Kellis. "But more importantly, the uncovered cellular circuits may allow us to dial a metabolic master switch for both risk and non-risk individuals, as a means to counter environmental, lifestyle, or genetic contributors to obesity."

Success in human and mouse cells

The researchers showed that they could indeed manipulate this new pathway to reverse the signatures of obesity in both human cells and mice.

In primary adipose cells from either risk or non-

risk individuals, altering the expression of either IRX3 or IRX5 switched between energy-storing white adipocyte functions and energy-burning beige adipocyte functions.

Similarly, repression of IRX3 in mouse adipocytes led to dramatic changes in whole-body energy balance, resulting in a reduction of body weight and all major fat stores, and complete resistance to a high-fat diet.

"By manipulating this new pathway, we could switch between energy storage and energy dissipation programs at both the cellular and the organismal level, providing new hope for a cure against obesity,"says Kellis.

The researchers are currently establishing collaborations in academia and industry to translate their findings into obesity therapeutics. They are also using their approach as a model to understand the circuitry of other disease-associated regions in the human genome.

Glitter from Silver Lights Up Alzheimer's Dark Secrets

Scientists have caught a glimpse of the elusive toxic form of the Alzheimer's molecule, during its attempt to bore into the outer covering of a cell decoy, using a new method involving laser light and fat-coated silver nano-particles.

While the origin of Alzheimer's Disease, one that robs the old of their memory, is still hotly debated, it is likely that a specific form of the Amyloid beta molecule, which is able to attack cell membranes, is a major player. Defeating this molecule would be easier if its shape and form were known better, but that has proven to be a difficult task until now.

"Everybody wants to make the key to solve Alzheimer's Disease, but we don't know what the lock looks like. We now have a glimpse of something which could be the lock. May be it's still not the real thing, but as of now, this is our best bet," says Sudipta Maiti, who co-directed the efforts with P. K. Madhu (both from TIFR). If they are right, then designing the key, i.e., making a drug molecule which can attack the lock, may be more achievable now.

The lock looks like a bunch of amyloid beta molecules in the shape of a hairpin, but with a twist. Debanjan Bhowmik, the lead contributor of the study says, "This has been suspected earlier, but what we found was an unexpected twist in the structure, now becoming a beta-hairpin — very different from the typical hairpin structure people imagined. This may allow these bunch of amyloid beta molecules to form toxic pores in the cell membranes."

The findings published in the journal *ACS Nano* by a joint team of researchers from the Tata Institute of Fundamental Research, Indian Institute of Science and the University of Toronto, have cracked the problem that has eluded scientists for years, by using a modified version of Raman Spectroscopy.

They studied a tiny laser-induced signal from the amyloid beta which reported their shape. A critical modification in the original Raman Spectroscopy technique allowed the measurement of tiny signals that would otherwise have gone unnoticed. They encased silver nanoparticles in a fat layer ('membrane') that mimicked the outer membranes of living cells. According to co-author Gilbert Walker, "While the amyloid beta got fooled by it and stuck to the membrane, the silver inside enhanced the signal to a measurable level and acted as a light beacon to reveal the peptide signature." The technique offers promise for deciphering the shape of many such membrane molecules, some of which may be related to other types of diseases.

Each research team brought something different to the table. As Jaydeep Basu, who led the IISc team, says, "It's a great example of how contemporary science breaks all barriers to bring people together for the pure love of science and the quest for the unknown!" One hopes that the search for the key to solve Alzheimer's has taken a step forward with this finding.

Human Body has gone through Four Stages of Evolution

Research into 4,30,000-year-old fossils collected in northern Spain found that the evolution of the human body's size and shape has gone through four main stages.

A large international research team including Binghamton University anthropologist Rolf Quam studied the body size and shape in the human fossil collection from the site of the Sima de los Huesos in the Sierra de Atapuerca in northern Spain. Dated to around 4,30,000 years ago, this site preserves the largest collection of human fossils found to date anywhere in the world. The researchers found that the Atapuerca individuals were relatively tall, with wide, muscular bodies and less brain mass relative to body mass compared to Neanderthals. The Atapuerca humans shared many anatomical features with the later Neanderthals not present in modern humans, and analysis of their postcranial skeletons (the bones of the body other than the skull) indicated that they are closely related evolutionarily to Neanderthals.

"This is really interesting since it suggests that the evolutionary process in our genus is largely characterised by stasis (i.e. little to no evolutionary change) in body form for most of our evolutionary history," wrote Quam.

Comparison of the Atapuerca fossils with the rest of the human fossil record suggests that the evolution of the human body has gone through four main stages, depending on the degree of arboreality (living in the trees) and bipedalism (walking on two legs). The Atapuerca fossils represent the third stage, with tall, wide and robust bodies and an exclusively terrestrial bipedalism, with no evidence of arboreal behaviours. This same body form was likely shared with earlier members of our genus, such as *Homo erectus*, as well as some later members, including the Neanderthals. Thus, this body form seems to have been present in the genus Homo for over a million years.

It was not until the appearance of our own species, *Homo sapiens*, when a new taller, lighter and narrower body form emerged. Thus, the authors suggest that the Atapuerca humans offer the best look at the general human body shape and size during the last million years before the advent of modern humans.

Seeing Quantum Motion; Even One Day Ripples in the Fabric of Space-time?

Consider the pendulum of a grandfather clock. If you forget to wind it, you will eventually find the pendulum at rest, unmoving. However, this simple observation is only valid at the level of classical physics—the laws and principles that appear to explain the physics of relatively large objects at human scale. However, quantum mechanics, the underlying physical rules that govern the fundamental behaviour of matter and light at the atomic scale, state that nothing can quite be completely at rest.

For the first time, a team of Caltech researchers and collaborators has found a way to observe—and control—this quantum motion of an object that is large enough to see. Their results are published in the 27 August online issue of the journal *Science*.

Researchers have known for years that in classical physics, physical objects indeed can be motionless. Drop a ball into a bowl, and it will roll back and forth a few times. Eventually, however, this motion will be overcome by other forces (such as gravity and friction), and the ball will come to a stop at the bottom of the bowl.

"In the past couple of years, my group and a couple of other groups around the world have learned how to cool the motion of a small micrometer-scale object to produce this state at the bottom, or the quantum ground state," says Keith Schwab, a Caltech professor of physics and applied physics, who led the study. "But we know that even at the quantum ground state, at zero-temperature, very small amplitude fluctuations—or noise—remain."

Because this quantum motion, or noise, is theoretically an intrinsic part of the motion of all objects, Schwab and his colleagues designed a device that would allow them to observe this noise and then manipulate it.

The micrometer-scale device consists of a flexible aluminum plate that sits atop a silicon substrate. The plate is coupled to a superconducting electrical circuit as the plate vibrates at a rate of 3.5 million times per second. According to the laws of classical mechanics, the vibrating structures eventually will come to a complete rest if cooled to the ground state.

But that is not what Schwab and his colleagues observed when they actually cooled the spring to the ground state in their experiments. Instead, the residual energy — quantum noise — remained.

"This energy is part of the quantum description of nature — you just can't get it out," says Schwab. "We all know quantum mechanics explains precisely why electrons behave weirdly. Here, we're applying quantum physics to something that is relatively big, a device that you can see under an optical microscope, and we're seeing the quantum effects in a trillion atoms instead of just one."

Because this noisy quantum motion is always present and cannot be removed, it places a fundamental limit on how precisely one can measure the position of an object.

But that limit, Schwab and his colleagues discovered, is not insurmountable. The researchers and collaborators developed a technique to manipulate the inherent quantum noise and found that it is possible to reduce it periodically. Co-authors Aashish Clerk from McGill University and Florian Marquardt from the Max Planck Institute for the Science of Light proposed a novel method to control the quantum noise, which was expected to reduce it periodically. This technique was then implemented on a micron-scale mechanical device in Schwab's low-temperature laboratory at Caltech.

"There are two main variables that describe the noise or movement," Schwab explains. "We showed that we can actually make the fluctuations of one of the variables smaller—at the expense of making the quantum fluctuations of the other variable larger. That is what's called a quantum squeezed state; we squeezed the noise down in one place, but because of the squeezing, the noise has to squirt out in other places. But as long as those more noisy places aren't where you're obtaining a measurement, it doesn't matter."

The ability to control quantum noise could one day be used to improve the precision of very sensitive measurements, such as those obtained

by LIGO, the Laser Interferometry Gravitational-wave Observatory, a Caltech-and-MIT-led project searching for signs of gravitational waves, ripples in the fabric of space-time.

"We've been thinking a lot about using these methods to detect gravitational waves from pulsars—incredibly dense stars that are the mass of our sun compressed into a 10 km radius and spin at 10 to 100 times a second," Schwab says. "In the 1970s, Kip Thorne [Caltech's Richard P. Feynman Professor of Theoretical Physics, Emeritus] and others wrote papers saying that these pulsars should be emitting gravity waves that are nearly perfectly periodic, so we're thinking hard about how to use these techniques on a gram-scale object to reduce quantum noise in detectors, thus increasing the sensitivity to pick up on those gravity waves," Schwab says.

In order to do that, the current device would have to be scaled up. "Our work aims to detect quantum mechanics at bigger and bigger scales, and one day, our hope is that this will eventually start touching on something as big as gravitational waves," he says.

Urine Test for Early Stage Pancreatic Cancer Possible after Biomarker Discovery

A combination of three proteins found at high levels in urine can accurately detect early-stage pancreatic cancer, UK researchers have found. The discovery could lead to a non-invasive, inexpensive test to screen people at high risk of developing the disease.

A team at Barts Cancer Institute, Queen Mary University of London, has shown that the three-protein 'signature' can both identify the most common form of pancreatic cancer when still in its early stages — and distinguish between this cancer and the inflammatory condition chronic pancreatitis, which can be hard to tell apart.

The study, published in the journal *Clinical Cancer Research*, was funded by the UK charity, the Pancreatic Cancer Research Fund. It looked at 488 urine samples: 192 from patients known to have pancreatic cancer, 92 from patients with chronic pancreatitis and 87 from healthy volunteers. A further 117 samples from patients with other benign and malignant liver and gall bladder conditions were used for further validation.

Around 1,500 proteins were found in the urine samples, with approximately half being common to both male and female volunteers. Of these, three proteins — LYVE1, REG1A and TFF1 — were selected for closer examination, based on biological information and performance in statistical analysis.

Patients with pancreatic cancer were found to have increased levels of each of the three proteins when compared to urine samples from healthy patients, while patients suffering from chronic pancreatitis had significantly lower levels than cancer patients. When combined, the three proteins formed a robust panel that can detect patients with stages I–II pancreatic cancer with over 90 per cent accuracy.

With few specific symptoms even at a later stage of the disease, more than 80 per cent of people with pancreatic cancer are diagnosed when the cancer has already spread. This means they are not eligible for surgery to remove the tumour — currently the only potentially curative treatment.

The five-year survival rate for pancreatic cancer in the UK is the lowest of any common cancer, standing at 3 per cent. This figure has barely improved in 40 years. There is no early diagnostic test available.

Lead researcher, Dr Tatjana Crnogorac-Jurcevic, said: "We've always been keen to develop a diagnostic test in urine as it has several advantages over using blood. It's an inert and far less complex fluid than blood and can be repeatedly and non-invasively tested. It took a while to secure proof of principle funding in 2008 to look at biomarkers in urine, but it's been worth the wait for these results. This is a biomarker panel with good specificity and sensitivity and we're hopeful that a simple, inexpensive test can be developed and be in clinical use within the next few years."

Although there is no universal cause of pancreatic cancer, people at higher risk of developing the disease include those with a family history of pancreatic cancer, heavy smokers, the obese and people over 50 years with new-onset diabetes.

The team is hoping to conduct further tests on urine samples from people in high risk groups, to further validate the study findings. Dr Crnogorac-Jurcevic is also keen to access samples of urine collected from volunteers over a period of 5–10 years. By examining samples from donors who went on to develop pancreatic cancer, this 'longitudinal' information will allow the researchers to see if the 3-biomarker signature is present during the latency period— the time between the genetic changes that will cause the cancer to develop and the clinical presentation.

"For a cancer with no early stage symptoms, it's a huge challenge to diagnose pancreatic cancer sooner, but if we can, then we can make a big difference to survival rates," says co-author and Director of Barts Cancer Institute, Professor Nick Lemoine. "With pancreatic cancer, patients are usually diagnosed when the cancer is already at a terminal stage, but if diagnosed at stage 2, the survival rate is 20 per cent, and at stage 1, the survival rate for patients with very small tumours can increase up to 60 per cent."

Pancreatic Cancer Research Fund CEO, Maggie Blanks, said: "This is an exciting finding and we hope to see this research taken forward into a much needed early diagnostic test. Early diagnosis is an important part of our overall efforts against this aggressive cancer, alongside developing new treatments to tackle the disease once diagnosis is made. It underlines the importance of increased research efforts to help improve survival rates."

"Many of the urine samples from healthy individuals tested by Tanja's team were donated from the charity's own supporter community, and I know they will be extremely proud that they have directly contributed to research progress in ways that go beyond traditional financial support."

Source: ***Science Daily Online***

Compiled and edited by

Sunita Farkya, *Professor*
DESM, NCERT, New Delhi
Neelam Chauhan
Junior Project Fellow, DESM, NCERT, New Delhi

WEB WATCH

In this section, we present websites and a brief introduction about them. Inclusion of a site does not imply that *School Science* endorses the content of the site. Sites have been suggested on the basis of their possible utility to school systems.

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Compiled and edited by

Sunita Farkya
DESM, NCERT, New Delhi

Neelam Chauhan
Junior Project Fellow, DESM, NCERT, New Delhi

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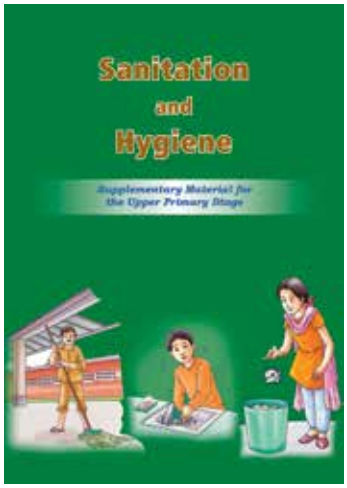

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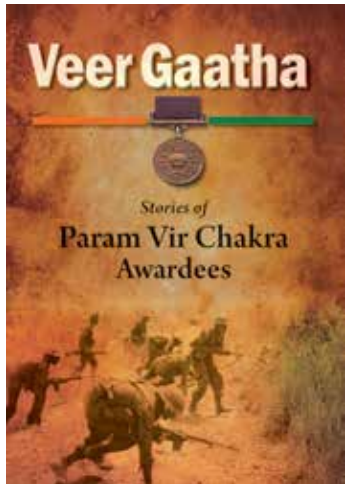

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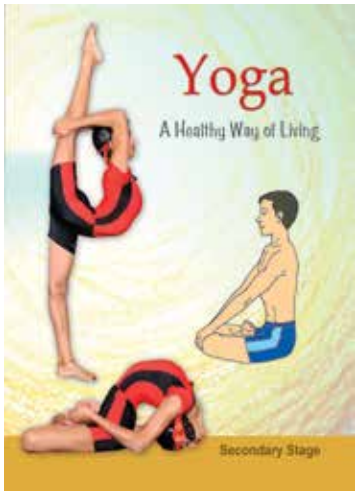

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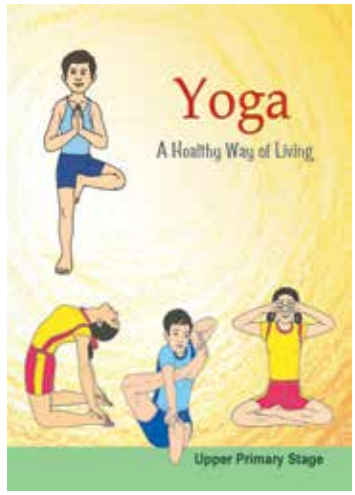

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