Navi Mumbai Science Foundation

EdUREKA

Education for Spirit of Science

Volume 3, Issue: No.01 **April-June 2021**

DIAMOND FROM SOIL-RANJITSINH DISALE!

April - June 2021
Volume 3, Issue: No.01
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Published by:
Navi Mumbai Science Foundation

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This is a quarterly e-magazine published by Navi Mumbai Science Foundation, a society engaged in spreading science education and scientific temperament among students of Navi Mumbai region for last one decade. The magazine will cover all the activities of the society as well as articles on educating science to the students and teachers.

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Image courtesy:
https://www.globalteacherprize.org/winners/ranjitsinh-disale-2020

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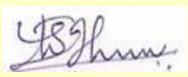
From Editor's Desk!!....

The ongoing debates like whether to go for vaccination or wait, which vaccine is better, whether third wave will be a reality or hype not, in their essence suggests that we are slowly recovering from the shock of second wave of Covid-19. Educational sector has been most badly affected by this pandemic. Aftermath of pandemic on this particular sector is not recognizable right now but will certainly be felt in future. As we were acclimatizing with the new challenges of online education, a low-profile primary teacher from a remote village of Maharashtra was trying to inculcate the seeds of online education at village level. The teachers name was started flashing in the news after his accomplishment in the form of earning the prestigious Global Teacher Award 2020. Mr Ranjitsinh Disale, a real ground level worker was doing his duties which were recognized not on national level but internationally.

Current issue of EduREKA features the lead story which narrates the wonderful and inspiring journey of Disale sir. In fact, we did request Disale sir to write guest editorial for our issue. But he politely declined considering his prior commitments. But at the same has given his best wishes for EduREKA magazine and assured the circulation of the magazine among teachers and students. It indeed was a blissful to interact such an enabling personality during this period.

With the Covid situations becoming normal, spreading false information through social media platform continued as usual during this period. One of the messages about plants giving oxygen during whole day-night became viral. Considering this we have included a clarifying article which systematically disentangles the labyrinth of available information for the readers. This will defiantly help readers to understand and appreciate the scientific basis of oxygen generation in plants. Also, we want to give message of not believing anything coming to social media unless its truth is verified.

Current issue is full of other utility article like impact of outcome-based learning, plant microbe association, students' corner etc. I hope it will be liked by the parents, teachers and students.



RANJITSINH DISALE GURUJI: MILLION DOLLAR DIAMOND FROM THE SOIL OF PARITEWADI

The most important component of our society is undoubtedly the teacher. Teachers find a unique place in the society as they spread knowledge and wisdom. They give the children purpose, set them up for success as citizens of the world and inspire them to do better and succeed in life. One such primary school teacher is in news for last six months whose name is Mr Ranjitsinh Disale. The prominent headlines of news during recent times are like..

- **3rd December 2020**…. Village borne primary teacher own prestigious Global Teacher prize of 1 million dollar…
- **19th April 2021**…Italy government announced Carlo Mazzone-Ranjit Disale Scholarship for the students to complete their school education
- **3rd June 2021**…Ranjit Disale appointed as a World Bank Education Advisor

Photo: School photo and classroom photo of Disale sir..

All these news have shaken the so-called modern education sector of India. The news has come during the phase when our Indian education system is blindly following western world without trying to solve the problem of local village children who are struggling even for the basic education. The disparity between these two classes of children has widened drastically during recent pandemic era. On one side students in cities were using smart phone and 5G connectivity while the underprivileged rural

students were struggling for basic phone having meager connectivity to listen to their teachers.

In this era of struggle and hard time, Ranjit Disale was helping the students to understand the basics of online education, decoding the QR code and connecting with the students of other schools of globe through online mode.

The journey of Ranjit Disale was not easy which started way back in 2005 when Disale sir joined as school teacher at Paritewadi Dist Solapur (MS). In the beginning, he decided to be an IT engineer and had enrolled in an engineering college. But when things didn't fit for him, his father who happens to be a school teacher convinced him to take up the teacher's training programme.

The first school he taught in was located in a dilapidated building, which was sandwiched between cattle shed and a storeroom. First of all, parents were not allowing the children to go school. He was travelling each house to convince the parents for sending their wards to school. Most of the girls were from tribal communities for whom girl's education was never priority at first place, and the practice of teenage marriage was common. Additionally, the curriculum too was not in the student's mother tongue i.e., Kannada, because of which many students were unable to achieve the expected learning outcomes. After putting in a great deal of effort, Ranjitsinh learned Kannada, and redesigned all the textbooks of grades 1-4 for better comprehension, along with

unique QR codes that embedded audio poems, video lectures, stories and assignments in Kannada. Impressed by his innovative endeavours and a successful pilot scheme, the Maharashtra government announced in 2017 that it would introduce QR-embedded textbooks for all grades in the State. Moreover, the Ministry of Human Resource Development (MHRD) had also announced in 2018 that all NCERT textbooks would include QR codes in the future. These QR coded books also benefited many girls when schools were closed for two months due to a terror attack, as they were able to continue with the learning using the books – and BBC News featured a story about them on 5th September 2019 to celebrate Teachers' Day. Students now could reflect on, discuss and showcase what they are learning to a far greater extent – developing thus their communication, creativity and real-world problem-solving skills. He realized early on that the children enjoyed learning from audio and video digital content. Therefore, he created a large, digital resource bank in Marathi, made up of videos, slides and animations. The content itself was wide-ranging, from poetry and music to mathematics and science. The idea became very useful and successful for learning students the difficult lessons and poems.

Photo: QR code displayed on NCERT book.

The biggest beneficiaries of Disale sir's efforts have been the girls in the district, who were earlier married off when they were barely teenagers. In the last ten years says Disale, this has changed dramatically and more girls are finishing school. As a result of his efforts, the attendance of girl children in his school recorded 100%. Not only that, no teenage/underage marriages were reported in the village as well.

As a result of these efforts, Disale sir's school was awarded Best School for the district in 2016, and 98% of students have achieved their expected learning outcomes before completing the school year. In terms of his wider impact, The CEO of Microsoft (Satya Nadella) has recognized Disale sir's work as one of three stories from India in his book "Hit Refresh". The central government felicitated Ranjit Disale as Innovative Researcher of the Year (2016), and he also won the National Innovation Foundation's Innovator of the Year award in 2018. He has communicated his methods by writing more than 500 newspaper articles and blogs as well as participating in television discussions on educational topics.

Disale sir's struggle for better school infrastructure and basic needs of school continued for several years. But the inborn nature of spreading knowledge was not allowing him to take the routine path followed traditionally by the teacher. He started teaching students new techniques about learning. There have been innumerable schemes to take technology and internet access to Government schools in non-urban India. Many have bordered on the ridiculous – like distributing computers to schools with erratic or no power supply. But Disale sir tried to improve the situation by struggling with the system in an innovative manner.

Global Teacher Award:

The **Varkey Foundation**, initially the Varkey GEMS Foundation, is a global charitable foundation focused on improving the standards of education for underprivileged children. It was formed in 2010 by Indian businessman Sunny Varkey, the founder and chairman of GEMS Education, the world's largest operator of kindergarten-to-grade-12 schools. The foundation's main focuses are improving teacher capacity globally by training teachers and principals in developing countries; providing access to education

via a variety of programmes and projects and advocating for change in, and conducting research that can help develop, education policies worldwide.

The Varkey Foundation has partnered with a variety of major global organizations including UNESCO, UNICEF, Clinton Global Initiative etc. In 2013 it launched the Global Education and Skills Forum, an annual education summit dedicated to addressing the world's educational needs. After analyzing the public status of teachers worldwide, in 2014 it launched the annual Global Teacher Prize, a $1 million award to an outstanding pioneering teacher who has had a widespread impact. This prize money is distributed in equal instalments over a 10-year-period, besides financial counselling. The Global Teacher Prize, which has been referred to by journalists as the Nobel Prize for teaching, highlights and celebrates this profession by giving a due recognition to the work of teachers all over the world.

Global Teacher Prize 2020 was announced on 3rd December 2020. Disale sir was among one of the top finalists, selected from over 12,000 nominations from over 140 countries.

Photo: Top 10 finalist of Global Teacher Award 2020.

After getting the award Disale sir commented, "I am a teacher and I will be a teacher for my whole life now. I dedicate my award to all the teachers worldwide. I firmly believe that the government, all stakeholders and teachers should work in tandem to bring change in the education sector. If we all work together, we can get better results,".

"Teachers who are doing good work should be recognised so that they get motivated to do something different. Their voice should be heard, respected and amplified," Disale sir said. There are many challenges in the education sector and these can be addressed if all the stakeholders work together, he said.

Sharing of Prize Money:

After receiving the award, Disale sir decided to share the prize money among all the finalists. This has also resulted in standing him tall. This caught the attention of the Dalai Lama, who said that Disale has set an example of "compassion in action". He further adds that educating young children, especially from poor and needy backgrounds is perhaps the best way to help them as individuals, and actively contributes to creating a better world. "Your work to ensure that disadvantaged girls go to school, as well as your efforts to prepare study materials for them in their own language, the online science lessons you offer pupils in 83 countries and your project building connections between young people in conflict zones are all vivid examples of compassion in action.

This appreciation really narrates the importance of sharing among the other contestants has legacy of humanity.

World Bank Advisor:

Another outstanding achievement followed when Disale sir was appointed as member of Advisory Board of World Bank. In fact, he had been working with the World Bank and had given speeches on the topics such as "Future of the Government" and "Supporting Teachers in the Age of Pandemic". The World Bank has appointed 12 advisors from world over and Disale sir is one of them representing India.

World Bank has recently launched the Global Coach Program, a new initiative focused on accelerate learning by helping countries improve in-service Teacher Professional Development (TPD) programs and systems. This program forms part of the World Bank's broader agenda to tackle the global learning crisis. A Coach typically focuses on supporting countries to improve in-service TPD through a two-pronged approach.

The Coach program focuses on helping countries to transform their TPD programs and policies to ones that adhere to a set of four key principles that have been shown to be linked to improved teaching quality. Mr Disale's through the Advisory Board will provide

a broader impact to the work of the World Bank on core level, which at present is supporting over 18 million teachers around the world. He will be an advisor to the World Bank till December 2024.

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(The article has been prepared from the information available on internet, Varkey foundations webpage, Disale sir's social media platforms. This is for information purpose only).

IMPACT OF OUTCOME BASED LEARNING ON TEACHING, LEARNING AND ASSESSMENT

In most educational institutions today, the focus is mainly on preparing students only with academic capabilities as we want all the students to develop competence in basic knowledge and skills which form the foundation for future learning. Further, in this competitive world, we also want our students to develop more sophisticated skills and higher levels of knowledge to compete as global citizens. But the question is whether we are successful in doing so. Organizations today expect teachers to be able to identify learning objectives on the basis of curriculum and carry out the accurate assessment information about individual students. Contrary to this the futuristic approach would be a radical departure from the past thereby wherein the learning outcomes are identified first and then they are aligned them with learning objectives followed by teaching pedagogies and assessment of the learning. Spady was a leading disciple and defined it as, 'Outcome based education' means organizing for results: on basis of what we want to achieve' (Spady,1988).

Characteristics of Outcome Based Learning: -

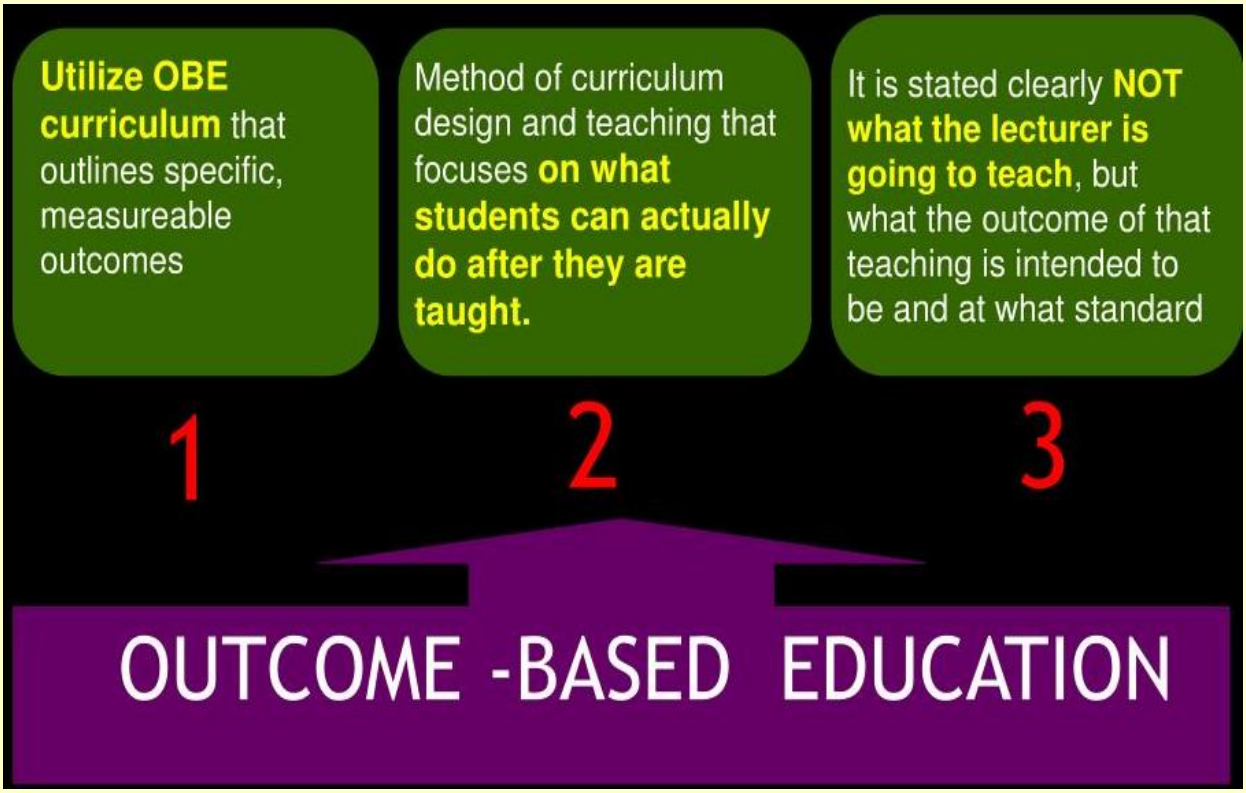
- Clearly defined learning outcomes
- Design of the Curriculum, learning strategies and learning opportunities tailored to ensure the achievement of the learning outcomes
- An assessment process matched to the learning outcomes at individual level
- Provision for appropriate remediation.

As against the conventional methodologies implemented very often in classroom teaching, the Outcome Based Education (OBE) is an educational theory that has its basis revolving around the outcomes of learning.

How is OBE different from the traditional system of education:

In a traditional system, content and performance expectations are based primarily on what was taught in the past to students in a given span of time. Also, students were given grades and rankings compared to each other. The main goal of the education was to disseminate the knowledge and skills which were pre-determined. The process paid little attention to whether or not students learnt any skill or material.

Whereas, in outcome-based education the curriculum planners need to work in reverse direction once the outcomes have been decided. They should decide upon the knowledge and skills to be imparted to reach the outcome and then design the curriculum accordingly.



Definition of Outcome Based Education:

Outcome based education as defined by Spady (1988) as a "way of designing, developing, delivering and documenting instruction in terms of its intended goals, knowledge and outcomes". Exit outcomes are a critical factor, in designing the curriculum. Spady suggests, "You develop the curriculum from the outcomes you want

students to demonstrate, rather than writing objectives for the curriculum you already have." Since the outcomes are well specified there is enough clarity of the delivery mode of the content and its assessment, the results therefore become more tangible and easily measurable which forms the basis of an effective assessment and accreditation process. Hence the learning outcomes play a very important role.

Definition of Learning Outcomes:

Learning outcomes are statements that describe significant and essential learning that learners have achieved at the end of a course or program. In other words, learning outcomes identify what the learner will know and be able to do by the end of a course or program.

Learning Objectives and Learning Outcomes: Generally, there is a confusion between learning objectives and learning outcomes. Learning objectives describe what a faculty member will cover in a course, whereas, learning outcome is what a student must be able to do at the conclusion of a course.

Why should instructional objectives, instructional strategies and assessment to be aligned to the learning Outcomes?

'Constructive alignment' is the process that we usually follow when we build up an OBE syllabus. It is a term coined by Professor John Biggs (1999), which refers to the process to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes. The word 'constructive' refers to what the learner does to construct meaning through relevant learning activities. The 'alignment' aspect refers to what the teacher does. The key to the alignment is that the components in the teaching system, especially the teaching methods used and the assessment tasks are aligned to the learning activities assumed in the intended outcomes.

The Curriculum plays an important role because it works as the medium for the interaction between teacher and student and the fact remains that the final outcome of any transaction should be the attainment of the set goal. More importantly, the content to be taught, the teaching methods to be adopted and the assessments to be conducted need to be aligned with the intended learning outcomes as what actually matters is what is learned rather than what is taught. Hence it becomes necessary to set objectives in terms of its learning outcomes.

How do you write the learning outcomes?

In developing learning outcomes, we need to consider the total learning experiences of the students. Learning Outcomes need to be SMART (specific, measurable, achievable, relevant, time constraint) and more importantly clearly understandable by students.

Hence, it is a challenging task as a number of factors are to be considered. Learning outcomes are written with action words indicating the expected change in behavior of the learner.

While framing the Learning Outcomes the following points need to be considered:

- Identify what students are expected to demonstrate on completion of their program or course
- Keep learning outcomes to one short statement. If more than one statement in a learning outcome, make two.
- Learning outcomes should comprise three components viz., an action verb, a content phrase and a context phrase (Macquarie University FILT, 2015 & Dick; Carey & Carey, 2005)
- Avoid using passive verbs/phrases such as "be familiar with". Instead use more active verbs such as identify, create, recalling, translating, classifying, comparing, etc. for lower-level thinking and analysing, evaluating, constructing, performing, producing for higher level of thinking.

- They should be able to identify cognitive differences between lower and higher-level thinking and also should include outcomes related to application and attitudes/values.

Importance of Learning outcomes:

- Learning Outcomes assist the instructors to precisely communicate to students about what is expected of them.
- They provide a map/pathway to help instructors to design their material effectively.
- Assist the instructors to select relevant teaching and assessment strategies.
- Learning outcomes provide the check points that are measurable to assess the progress of a learner as per the expected holistic learning.

As mentioned in the National Education Policy 2020, amongst some of the major problems currently plaguing the higher education system in India include the poor learning outcomes and development of cognitive skills of students. The teachers need to adopt this futuristic approach of Outcome Based Education as opposed to being the repository of knowledge, must now be a facilitator of learning. As what actually matters is what is learned rather than what is taught.

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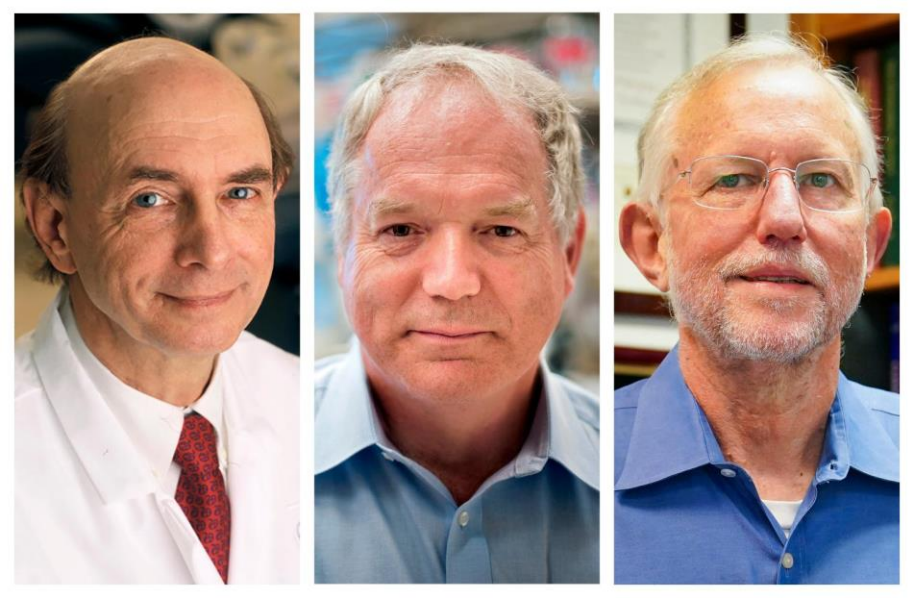
THE NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE 2020

Nobel Prize in Physiology and Medicine for the year 2020 was jointly awarded to Harvey J. Alter, Michael Houghton and Charles M. Rice for the discovery of Hepatitis C virus. These scientists have made a decisive contribution to the fight against blood-borne hepatitis, a major global health problem that causes cirrhosis and liver cancer in people around the world.



These three scientists made seminal discoveries that led to the identification of a novel virus, Hepatitis C virus. Prior to their work, the discovery of the Hepatitis A and B viruses had been critical steps forward, but the majority of blood-borne hepatitis cases remained unexplained. The discovery of Hepatitis C virus revealed the cause of the remaining cases of chronic hepatitis and made possible blood tests and new medicines that have saved millions of lives.

Hepatitis – a global threat to human health

Liver inflammation, or hepatitis, a combination of the Greek words for liver and inflammation, is mainly caused by viral infections, although alcohol abuse, environmental toxins and autoimmune disease are also important causes. In the 1940's,

it became clear that there are two main types of infectious hepatitis. The first, named hepatitis A, is transmitted by polluted water or food and generally has little long-term impact on the patient. The second type is transmitted through blood and bodily fluids and represents a much more serious threat since it can lead to a chronic condition, with the development of cirrhosis and liver cancer. This form of hepatitis is insidious, as otherwise healthy individuals can be silently infected for many years before serious complications arise. Blood-borne hepatitis is associated with significant morbidity and mortality, and causes more than a million deaths per year world-wide, thus making it a global health concern on a scale comparable to HIV-infection and tuberculosis.

An unknown infectious agent

The key to successful intervention against infectious diseases is to identify the causative agent. In the 1960's, Baruch Blumberg determined that one form of blood-borne hepatitis was caused by a virus that became known as Hepatitis B virus, and the discovery led to the development of diagnostic tests and an effective vaccine. Blumberg was awarded the Nobel Prize in Physiology or Medicine in 1976 for this discovery.

At that time, Harvey J. Alter at the US National Institutes of Health was studying the occurrence of hepatitis in patients who had received blood transfusions. Although blood tests for the newly-discovered Hepatitis B virus reduced the number of cases of transfusion-related hepatitis, Alter and colleagues worryingly demonstrated that a large number of cases remained. Tests for Hepatitis A virus infection were also developed around this time, and it became clear that Hepatitis A was not the cause of these unexplained cases.

It was a great source of concern that a significant number of those receiving blood transfusions developed chronic hepatitis due to an unknown infectious agent. Alter and his colleagues showed that blood from these hepatitis patients could transmit the disease to chimpanzees, the only susceptible host besides humans. Subsequent studies also demonstrated that the unknown infectious agent had the characteristics of a virus.

Alter's methodical investigations had in this way defined a new, distinct form of chronic viral hepatitis. The mysterious illness became known as "non-A, non-B" hepatitis.

Identification of Hepatitis C virus

Identification of the novel virus was now a high priority. All the traditional techniques for virus hunting were put to use but, in spite of this, the virus eluded isolation for over a decade. Michael Houghton, working for the pharmaceutical firm Chiron, undertook the arduous work needed to isolate the genetic sequence of the virus. Houghton and his co-workers created a collection of DNA fragments from nucleic acids found in the blood of an infected chimpanzee. The majority of these fragments came from the genome of the chimpanzee itself, but the researchers predicted that some would be derived from the unknown virus. On the assumption that antibodies against the virus would be present in blood taken from hepatitis patients, the investigators used patient sera to identify cloned viral DNA fragments encoding viral proteins. Following a comprehensive search, one positive clone was found. Further work showed that this clone was derived from a novel RNA virus belonging to the *Flavivirus* family and it was named Hepatitis C virus. The presence of antibodies in chronic hepatitis patients strongly implicated this virus as the missing agent.

The discovery of Hepatitis C virus was decisive; but one essential piece of the puzzle was missing: could the virus alone cause hepatitis? To answer this question the scientists had to investigate if the cloned virus was able to replicate and cause disease. Charles M. Rice, a researcher at Washington University in St. Louis, along with other groups working with RNA viruses, noted a previously uncharacterized region in the end of the Hepatitis C virus genome that they suspected could be important for virus replication. Rice also observed genetic variations in isolated virus samples and hypothesized that some of them might hinder virus replication. Through genetic engineering, Rice generated an RNA variant of Hepatitis C virus that included the newly defined region of the viral genome and was devoid of the inactivating genetic variations. When this RNA was injected into the liver of chimpanzees, virus was

detected in the blood and pathological changes resembling those seen in humans with the chronic disease were observed. This was the final proof that Hepatitis C virus alone could cause the unexplained cases of transfusion-mediated hepatitis.

Significance of this Nobel Prize-awarded discovery

The Nobel Laureates' discovery of Hepatitis C virus is a landmark achievement in the ongoing battle against viral diseases. Thanks to their discovery, highly sensitive blood tests for the virus are now available and these have essentially eliminated post-transfusion hepatitis in many parts of the world, greatly improving global health. Their discovery also allowed the rapid development of antiviral drugs directed at hepatitis C. For the first time in history, the disease can now be cured, raising hopes of eradicating Hepatitis C virus from the world population. To achieve this goal, international efforts facilitating blood testing and making antiviral drugs available across the globe will be required.

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Harvey J. Alter was born in 1935 in New York. He received his medical degree at the University of Rochester Medical School, and trained in internal medicine at Strong Memorial Hospital and at the University Hospitals of Seattle. In 1961, he joined the National Institutes of Health (NIH) as a clinical associate. He spent several years at Georgetown University before returning to NIH in 1969 to join the Clinical Center's Department of Transfusion Medicine as a senior investigator.

Michael Houghton was born in the United Kingdom. He received his PhD degree in 1977 from King's College London. He joined G. D. Searle & Company before moving to Chiron Corporation, Emeryville, California in 1982. He relocated to University of Alberta in 2010 and is currently a Canada Excellence Research Chair in Virology and the Li Ka Shing Professor of Virology at the University of Alberta where he is also Director of the Li Ka Shing Applied Virology Institute.

Charles M. Rice was born in 1952 in Sacramento. He received his PhD degree in 1981 from the California Institute of Technology where he also trained as a postdoctoral fellow between 1981-1985. He established his research group at Washington University School of Medicine, St Louis in 1986 and became full Professor in 1995. Since 2001 he has been Professor at the Rockefeller University, New York. During 2001-2018 he was the Scientific and Executive Director, Center for the Study of Hepatitis C at Rockefeller University where he remains active.

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Lingering Doubts……???

DO SOME PLANTS REALLY GIVE OXYGEN WHOLE DAY AND NIGHT?

The COVID-19 pandemic has reinstated the importance of oxygen (O_2) gas for the existence of human beings across the globe. The O_2 gas constitutes ~ 21% of earth's atmosphere and is essential for respiration. However, where does this O_2 come from in our atmosphere?

The main source of this oxygen is the process called photosynthesis performed by blue-green algae, algae and plants. Photosynthesis involves conversion of solar energy into chemical energy of food that can be used by all life forms. The other raw materials required for photosynthesis are carbon-dioxide (CO_2) and water as well as the green color chlorophyll pigment present in the chloroplasts that absorbs the incident solar energy. How does O_2 then come into the picture?

To understand this, we must appreciate the process of photosynthesis in a little detail (Fig. 1).

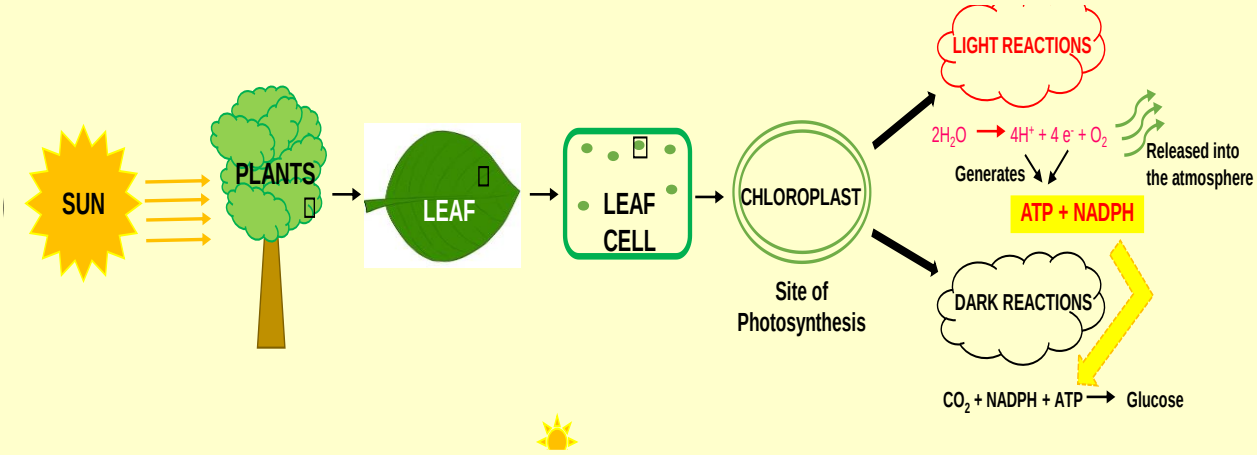

Fig.1: Illustration depicting the process of photosynthesis (A) Fixation of solar energy by plants (The black boxed portions are enlarged in the next step)

This process involves two distinct steps:

1) Light reactions during which the solar energy is intercepted by the chlorophyll molecules.
2) Dark reactions where the absorbed CO_2 is converted to food.

During the light reactions, absorption of solar energy leads to excitation of chlorophyll molecules wherein electrons move to the higher energy states. These excited electrons are finally thrown out of chlorophylls leading to an electron-vacancy in them! Sad. Poor chlorophylls! How do they recover the lost electrons? Water comes to their rescue. The splitting of water generates four protons (which create a proton build up), two electrons (that go to the excited chlorophyll) and molecular oxygen is released in the process! Wow! The Chlorophylls are now recycled and happy to reabsorb yet another ray of the sunshine (Photon to be precise). Does it convey that light is required for evolution of molecular oxygen during photosynthesis? Indeed, this is so (Fig. 2). Oxygen is released by the photoautotrophs due to the splitting of water during the light reactions of photosynthesis and hence this will happen only during the daytime!!

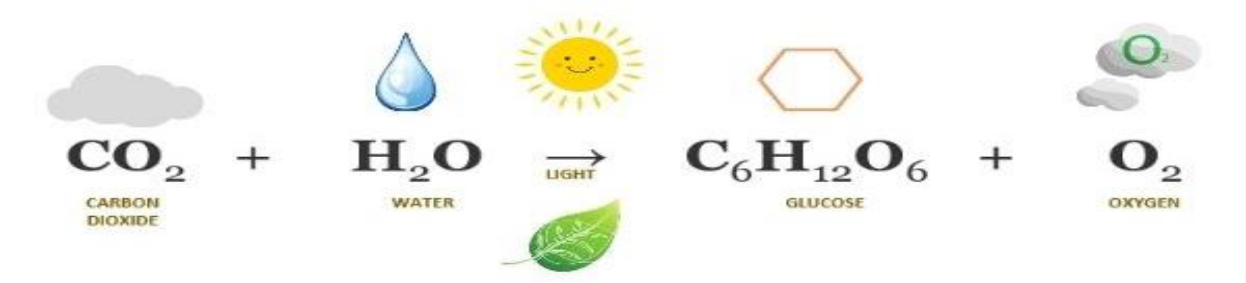

Fig 2: The chemical reaction of photosynthesis

Some plants such as *Aloe vera* are claimed to evolve oxygen even at night, in the absence of light. However, this is not true. For better understanding of this concept, we must know what happens to CO_2 in the dark reactions. It combines with a 5-carbon containing compound and forms glucose in a multi-step enzyme catalyzed pathway called as C3 cycle (The first stable product of CO_2 fixation is a 3-carbon containing organic acid). Most land plants are C3 type and have light and dark reactions happening simultaneously inside the chloroplast with CO_2 coming in from stomata and the O_2 diffusing out. However, some plants have a photosynthetic adaptation termed CAM (Crassulacean Acid Metabolism, named after the Crassulaceae family of plants in which it was first discovered) to thrive under difficult climates such as in arid regions. In order to reduce transpirational water loss, such plants keep their stomata closed during the day and open them at night. As a result, CO_2 can enter inside the plant in the night.

Now here comes a dilemma. Light reactions and their products ATP and NADPH are available during the day whereas CO_2 is available at night! In order to resolve this, the plants convert or store this CO_2 as organic acids such as malic acid. During the daytime, when the light reactions happen, the CO_2 from the organic acids is released and utilized for dark reactions of photosynthesis in C3 cycle. So, in CAM plants stomata open at night only for taking up CO_2 not for releasing oxygen! What then happens to the O_2 that is evolved during the day time in CAM plants? It may be utilized for respiration.

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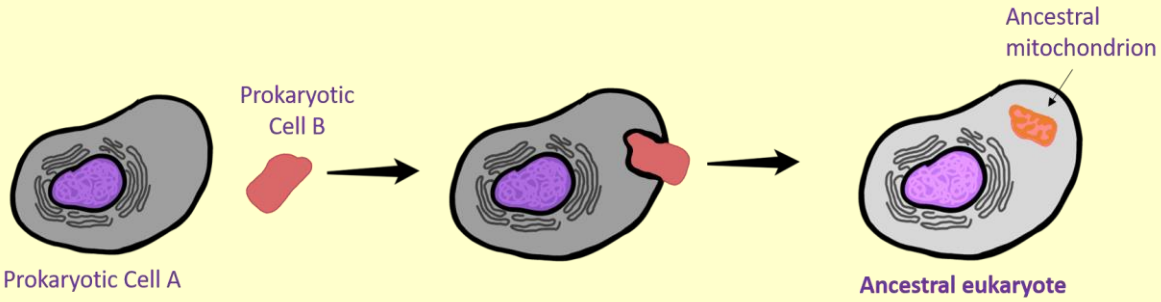
FRIEND OR FOE?

Imagine the earth 2 billion years ago. The atmosphere would have been deadly for us - made mostly of carbon dioxide, ammonia, methane and water vapour with little free oxygen. The vast oceans were teeming with primitive, unicellular prokaryotes and fibers of cyanobacteria. During these exciting times, our two players - Prokaryotic Cell A and Prokaryotic Cell B had an encounter. Although both cells were prokaryotic, they had some differences (a) Cell A was larger in size than Cell B, and (b) Cell B could metabolize oxygen which Cell A could not. It's unclear what exactly happened between the two. It's possible that Cell A "ate" Cell B by swallowing it whole, or Cell B "infected" Cell A as a parasite would. Arguably, the two cells were not friends at the time. Regardless of how it happened, the result was clear: there was now a completely new cell, with B sitting inside of A. This new Cell AB was the first ever or *ancestral* eukaryote.



Over the next billion years, free oxygen levels in the atmosphere steadily increased, making the air toxic for many unicellular creatures that inhabited earth at the time. But the eukaryotic cell flourished thanks to the successful partnership it had developed between its two constituents. Cell A used Cell B's ability to metabolize oxygen to cope with the increasing oxygen in the air. In return, Cell B found free food and protection from the environment by sitting inside the larger Cell A. It was a win-win! They had entered into a state of symbiosis, one so strong that they began functioning as a single unit (the ancestral eukaryote) with the remnants of Cell B as its ancestral

mitochondrion. Fast forward a few million years and this eukaryotic cell was so successful that it became the building block of all plants and animals with its mitochondrion as its powerhouse. Cells A and B might have been foes before they met - or perhaps just bumped into each other by chance. However, they became the best of friends.

One need not travel back in time or zoom so far down a microscope to observe a biological symbiosis. All around us, we see various organisms like dogs, birds, insects, plants etc, all of which influence our lives. Although we cannot see them, we are also constantly surrounded by a plethora of microorganisms such as bacteria, fungi and viruses that live on us and inside us. So, we do not live in a world of isolation; interacting with other biological organisms is the rule, not the exception. Sometimes, there is more to organisms 'living together' than meets the eye - the presence of one species could strongly influence the other. All possible combinations of players - plants, animals or microorganisms can live in a symbiosis as friends (mutualism), foes (parasitism) or sometimes without influencing each other (commensal). Symbioses are seen frequently in nature and play a vital role in shaping our natural world and the human world. In fact, symbioses are so close to home that they even shape the food we eat.

For instance, could you imagine living without rotis or parathas? We would not have these delicacies without wheat. Wheat is grown by farmers who toil in the fields to keep their crops healthy. However, one of the diseases that plagues these essential crops is wheat rust, caused by a fungus belonging to the genus *Puccinia.*

Photo: Wheat rust disease caused by Puccinia (Photo Curtsy: https://globalrust.org)

Puccinia is a foe to the wheat crop, infecting it and stealing valuable nutrients from it. Wheat rust can devastate large crop plantations in a short time and cause huge agricultural losses for farmers. As if this were not bad enough, using chemical fungicides against it may be unsafe for farmers, too expensive or harmful to the environment. So how could one begin to solve this problem?

Fortunately, most plants including crop plants have natural friends: mycorrhizal fungi or *mycorrhizae*. Mycorrhizae form close networks with the roots of the plant and allow for an exchange of nutrients, supplying the plant with nitrogen and phosphorus and taking photosynthetic products in return. They may also fight off competing fungi like the rust-causing *Puccinia* by targeting them with harmful chemicals. The host plant also provides physical support on which the fungus can grow. All in all, the plant grows faster and healthier in the presence of the mycorrhizae. Apparently, this is another win-win!

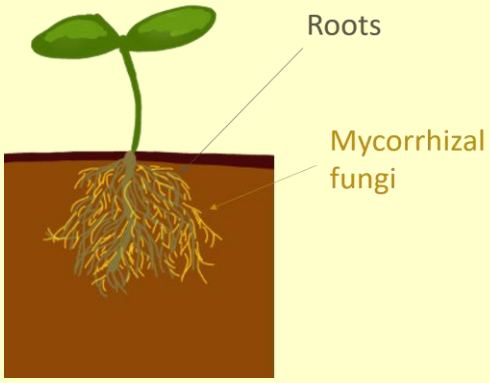


Photo: Mycorrhizae fungi associated with roots. (Photo Curtsey https://fungi.com)

But is it?

Before we rush to the fields to add mycorrhizal fungi to the soil, we would need to ask ourselves if they could be counted on to *always* be a friend to the host plant. Firstly, the soil already contains a plentiful supply of phosphorus and nitrogen (fertilizers added by

the farmers). Secondly, what would happen if there were no more disease-causing fungi to fight off? Would the wheat crop's 'friend' then become a foe - simply making the wheat crop pay the cost of giving away its photosynthetic products without the benefit of protection against foes and freely obtained nutrients?

Everywhere we look in the natural world, we see fascinating examples of symbioses. But we cannot paint organisms entirely as friends or foes of each other as these relationships may change with time and *ecological context.* Our questions should instead be - under what conditions do organisms become friends or foes? Under what conditions can a friend become a foe (or vice versa) or remain in a successful friendship for billions of years, as we have with our mitochondria? And finally, what secret symbioses lie beneath the grand biological events we see around us, like the emergence of new flora and fauna or disease epidemics?

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Students Corner…

DEFORESTATION-A MAN MADE DISASTER

What is deforestation? When forests are cut down to clear land for agriculture, grazing, livestock, settlements, timber, or to produce charcoal is called deforestation. The most concentrated deforestation occurs in tropical forest. The Union of Concerned Scientist [UCS] reports that only four commodities are responsible for tropical deforestation: beef, soy, palm oil and wood products.

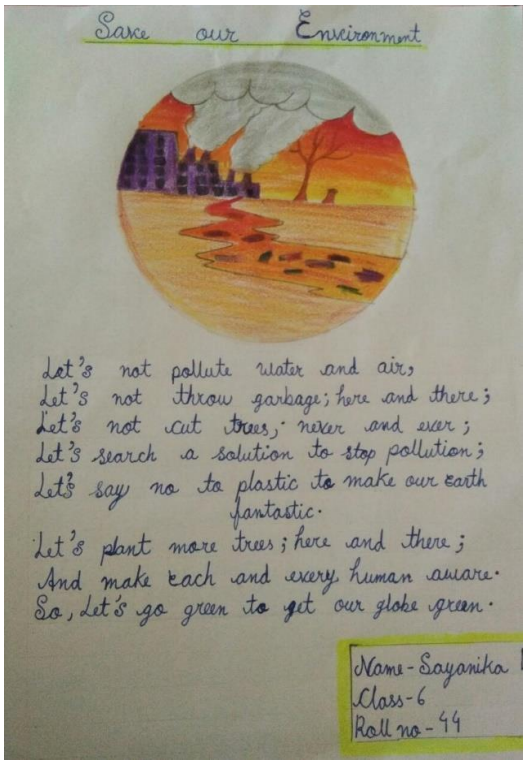
Forest still covers 31% of the world's land area but they are disappearing at an alarming rate. Between 1990 and 2016, the world lost 5,02,000 square miles (1.3 million square kilometers) of forest, according to the World Bank – an area larger than South Africa. Since humans started cutting down forest, 46% of trees have been fallen (Nature, 2015). About 17% of the Amazon Rainforest has been destroyed over the past 50 years and average 2,400 trees are cut each minute.

What are the effects of deforestation in climatic conditions? The removal of trees without sufficient reforestation has resulted in habitat damage and biodiversity loss. Deforestation causes extinction, changes in climatic condition, desertification and displacement of population, as observed by current conditions and in past through the fossil records. Deforestation also increases negative feedback cycles contributing to global warming, drought, soil erosion and also depletion of ground water.

Why trees are important in flood prone areas? Some trees like mangrove reduce flooding as their aerial roots retain sediments and prevents erosion, while the roots, trunks and canopy reduce the force of oncoming waves and storm surge and thus

reduce flooding. Mangrove trees are the natural defenses of flood and tsunami, but unfortunately these trees are cut down to produce charcoal.

Human diseases caused by deforestation: - over the past two decades, a growing body of scientific evidence suggests that deforestation creates a condition for a range of deadly pathogens - such as Nipah and Lassa viruses and the parasites that causes Malaria and Lyme disease. The main thing is that we all know what are the consequences of deforestation, but we are still doing this mistake. I only request that spread awareness and plant trees and also recycle paper, as lots of trees are cut for production of paper and if trees will disappear no life will be supported on earth. So, we have to take actions quickly.



* **Poem and illustration** by

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THE ENDLESS LOOP CALLED TIME

While growing up almost everyone has heard the term 'Time Travelling'. As the term states, it simply means going or travelling in different part of the timeline. Since the first time this topic was picked up by H. G. Wells, the debating about its existence and possibility has been going on till this day. With many theories and stories all around the internet, many people believe it is a mythical thing and many believe in its very existence and possibility. But the real question is that, does the thing we call 'time' actually exist? If it does, then is it infinite?

When we think about it, what actually is 'time'? Literally and scientifically speaking, it's just a term invented by us humans to explain/define the continuous progress of existence and events in the past, present and future regarded as a whole! Then does the past and future we talk about everyday exist? Scientifically speaking it actually doesn't. As confusing it sounds, it is a topic which can't be just simply satisfied with either baseless theories or with the current level of technology.

There have also been many theories about the fact that out there in the space, somewhere, 4 dimensional objects/beings exist. As it may sound very weird for us that, "what can be the 4^{th} dimension other than length, width and height?", but actually there is one! Many scientists believes that the 'time' can be the '4^{th} dimension', but it is very likely that we might never find/learn about the 4-dimensional objects/ creatures. Why you ask? let's put it in a simple and digestible explanation. Have you ever seen an Ant jump in your whole life? You may have seen them roaming in all the four directions but when we think about it, we have never seen them jump. Theories explain that it might be because the Ants are living in a '2 dimensional' life, which means they have the length and breadth but aren't capable of movements in the 3^{rd} dimension known as

Height. Like that in case of Human beings (animals) we are able to do movements in all the 3 dimensions! With this theory, that creatures with different dimensional capability can never imagine living a life with a totally new form of Dimension, rather explain why learning about creatures/object with more than 3 dimension is being impossible for us to figure out.

As we fear, this might be true that we will always be in the dark and might never figure out more about time and will always be stuck with our evidence-less imagination like wormholes and DeLorean.

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Note: EduREKA magazine has been started for last three years and efforts are being made to involve students and teachers to write the article. Team EduREKA happily acknowledging special efforts taken by school teacher **Ms. Daison Jacob**. This teacher of Kendriya Vidhlaya, Golaghat, Assam took efforts and made the students write the article for students' corner. Initial screening of the articles was done at school and 03 articles were sent to EduREKA. We are very pleased with the efforts by the teacher and expects similar efforts from schools of different part of country.

Let us appreciate the spirit of teacher and students for making it happen.

DON'T MISS IT……

COMING UP IN NEXT ISSUE

(Year 3, Issue 2, July to September 2021)

1. **INTERESTING STORIES OF ACCIDENTAL INNOVATIONS**
2. **NOBLE WINNERS 2020 PHYSICS & CHEMISTRY**
3. **STUDENT'S CORNER**
4. **TEACHER'S PAGE**
5. **LINGERING DOUBTS**
6. **FROM MY BOOK SHELF….SCIENCE AND EDUCATION BASED BOOKS**

DO YOU HAVE A INTERESTING EDUCATIONAL STORY???
SHARE WITH US!!!!

On the eve of World Environment day (5th June) let us protect nature and mother earth.