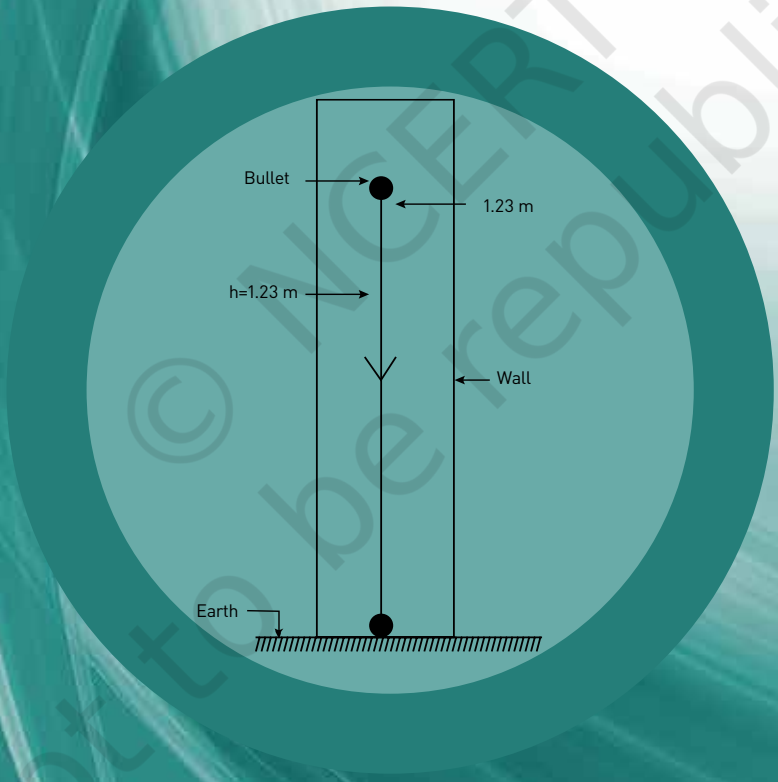
ISSN 0036-679X (print)
0972-5061 (online)

School Science

A Quarterly Journal of **SCIENCE EDUCATION**

Vol. 56 No. 1 **March 2018**



'g' may be calculated accurately using just one equation of motion

School Science | A Quarterly Journal of **Science Education**

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* This issue is printed in November 2022

ISSN 0036-679X (print)
0972-5061 (online)

Vol. 56 No. 1 **March 2018**

Contents

EDITORIAL

In the current issue of School Science we have included articles and research papers from various disciplines of Science and Mathematics. In the article entitled 'A Review of Pre-school Period via Play-based Learning—A stepping stone to Learning Science' the author stresses that the teacher should provide a congenial environment to the children to explore nature and the learning environment should be enriched with the materials capable of arousing the natural curiosity in children. In the research paper entitled 'Achievement of Students in Biology in Relation to Demographic Value' the authors reported that out of four demographic values i.e gender, locale, age and caste; only caste affects the biological achievement at formal operational stage.

The article 'Law against Drug: National and International Cooperation' discusses about drug trafficking that is a major challenge for peace and security of the nation.

In the article entitled ''g' by Dropping method', a simple method has been explained to calculate the value of acceleration due to gravitational force. It is the dropping method that can be demonstrated easily using a pendulum.

In the article 'Motion of a Ball from Crease to Boundary in a Game of Cricket' the author talks about how a ball hit by a batsman moves in an interesting manner by using numerical exemplars.

The article 'Sustainable Ecosystem: Forging a New Human–Plant Relationship' talks about the indispensable role of plants in our ecosystem including medicines, pollution control, phytoremediation etc; and also the management of these issues required at a global level for developing a sustainable ecosystem.

In the article 'Double Displacement Reaction is a Misnomer in Chemistry' the authors have discussed with examples as to why double displacement reaction is a misnomer in chemistry.

This issue also has its permanent features—Science News and Web Watch for our readers. We welcome comments and suggestions to enhance the quality of the journal.

A REVIEW OF PRE-SCHOOL PERIOD VIA PLAY-BASED LEARNING – A STEPPING STONE TO LEARNING SCIENCE

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The paper underlines the importance of early childhood period as it is considered as the foundation period for all kinds of development. The author stresses that the teachers and parents should provide congenial environment to the children to explore the nature and the learning environment is enriched with the materials capable of arousing the natural curiosity of children. She concludes that children are naturally scientists. Hence, the learning environment should be simulative and enriched with natural play materials that can arouse interest of children for learning science concepts.

Introduction

The recent decades have observed the promotion of scientific literacy of young children from various educational reforms. (Siry, et al. 2012). The first five years of life is considered as the most critical period because it sets the foundation for all the development, viz., physical, mental, emotional, intellectual, language, etc. Moreover, it is the period in which curiosity to learn is unending thus laying the foundation of learning. Recent researches show that pre-school children are well prepared for learning science concepts and it is the right period to provide basic science concepts through quality learning experiences and exploration.

Gelman (1990) establishes that science knowledge acquisition is rapid during the early years. The natural environment serves as an ideal space for earning premature experiences of science. Children have the ideas, beliefs and explanations of a variety of science concepts that they observed or experienced in their daily lives. Through play way methods and their observations, they learn about size, shape, colour, living and non-living things and immediate physical environment that provide the foundation for learning physical science, life science, etc.

Inquisitiveness of Children Driven by Science

To different people, science means different things. For some it's a list of facts, for others it's a body of knowledge, including facts, concepts and principles (Carin et al. 2003). More than a list of knowledge and facts, it is a process of continuously exploring the nature known as scientific investigation.

Our knowledge and understanding of the world is improved by science. It helps the kids to develop an innovative mind and run positive change. A young child has lots of queries such as "why is the rainbow colourful?", "What gives sky the blue colour?" And so on, which becomes an essential reason why Science education in early childhood is important (Yoon, et al. 2006). Young children are always exploring and building curious questions inside their mind. The more their queries are

given proper scientific explanation, the more their thirst will develop.

The content includes the fact that science pursuits are socially and physically positioned which is all carried by science happenings all around and the positive enthusiastic engagement of the child. An important state in this perspective is that the emerging knowledge of children is a continuous and under way process (Larsson, 2013), in which the focus is the expressed interests of children in the phenomenon occurring all around and the science involved with it.

Significance of Sciences at an Early Stage

Buckleitner (2002) pointed out the major benefits of learning science at early childhood which are life-skills development, inculcation of love for science, literacy and language development, encouraging enquiry and important thinking and enhancement of decision-making skills.

Science helps the students in some of their vital life skills development such as analytical approach to things, problem solving ability, good communication skill and so on. All the experimental results in science are not quick; some takes time to show the result which in turn teaches patience and perservance to students. Science has relevance in our everyday life so it is the most important subject a child can learn.

In the next decade an estimated 75 per cent of jobs within the fastest growing industries would require science, technology, engineering and arithmetic (STEM) skills. As a result, there has been a robust emphasis on STEM education in schools to organise students for the longer term. Science educators are fortunate therein they need a singular opportunity to instil a love for science within the early years, just by harnessing a child's natural curiosity. Creating amazing science experiences in early education will inspire children to require finding out more and exploring on their own.

Often young learners struggle to include detail into their writing. Scientific reporting encourages the young learners to write down accurate description of what they see and observe, a practice they can apply to all other forms of writing.

Enquiry and methodology are integral to science education and practice. Through scientific enquiry, the study of science enhances critical thinking skills which will be applied to any area of learning. Critical thinking cultivates curiosity and is important to understand and solve problems. It allows children to seek out meaning in their learning and make real-world connections that impact their lives.

Science teaches children to not take information without any consideration. It helps them separate fact from fiction. Children are taught to hunt information from multiple sources and to believe evidence to work out truth. This process provides a solid foundation for them to have independent opinions and take decisions, a skill that will serve them well throughout all facets of their life and academic pursuits.

The pivot is constructed as: "The preschool should endeavour to make sure that each child is able to develop his/her understanding of science and its relationship with nature, it should also include knowledge of plants, animals and simple chemical processes

and physical phenomenon." (Adbo, K., Vidal Carulla, C., 2020)

Measures of Government to Promote Literacy for Children at Pre-school Stage

The Government of India has had under consideration a national Early Childhood Care and Education (ECCE) to reiterate the commitment to promote inclusive, equitable and contextualized opportunities for promoting optimal development and active learning capacity in all children below the age of six years (ECCE Policy, 2013).

The members of the National Focus Group on ECE unequivocally agreed to call it the National Focus Group on ECCE rather than ECE. Within the context of the work of the National Focus Group, the rationale for replacing ECE by ECCE is as follows:

The period from birth till eight years of age is known as early childhood in a child's life, a period that presents a developmental continuum. The opposite reason for extending the span of infancy from six to eight years is to make sure a gradual and smooth transition from preprimary to primary education, which may be a structured and formal learning system requiring effective interface. The term 'care' has been added in recognition of the very fact that young children need care and nurturing. Additionally, to their health and nutritional needs, their psychosocial and emotional needs even have to be met adequately for his or her holistic development. Education is a process of acquiring learning, skills, habits, etc. It also indicates a crucial focus, viz., to organise the young child to enter the formal educational stream/system.

Thus, the term ECCE refers to a philosophy of providing opportunities/experiences to young children aged up to eight years so as to mark their holistic development, also as arranging and providing services and support systems to communities and families to satisfy the requirements of their young children. For the sake of convenience, and for purposes of programming and institutional location, ECCE is often divided into three sub-stages: birth to 2+, 3 to 5+, and 6 to 8+. Each sub-stage is often located during a different institutional setting.

The 86th Constitutional Amendment Act, 2002, which effectively releases the state from its obligation to provide care and education for kids below six years, is noted as a negative development.

The report cites a fragmented approach and divided responsibilities as reasons for this grim situation. It can be concluded that ECCE must be introduced within the framework of EFA and UEE, with accountability for all programmes for teenagers above three years lying with DEE & L, while programmes for youngsters below three years are going to be the responsibility of DWCD.

Play-based Learning is Purposeful Learning

The assumption that play is a frivolous use of classroom time and in opposition to rigorous instruction demeans its value and its vast potential (Harlen, 2001). "Many people, including some educators, believe that we need to choose between play-based learning opportunities and rigorous academic standards when integrating the two is very possible," says Concordia University-Portland adjunct professor, Angie Stratton. "For

example, a kitchen/cooking center could contain a water level also as measuring cups, dishes and 'pretend' food. Paper and pencils/ crayons/markers, etc., are often wont to write recipes, make lists, and make advertisements for a replacement restaurant (Martin D, 2003). The creative possibilities are endless. Not only does this play-based learning center address language arts standards, but it also touches upon speaking and listening standards as well."(Harlan, et al. 2004)

The designing of activities and the teaching-learning processes in preschool settings are specially accounted in play-based learning. During the early childhood education days, play is visualised as 'the foremost part of expansion of knowledge in the preschool years' which in turn supports emotional, social as well as intellectual developments. (Vygotsky, 2016)

Imagination is the Key

An important aspect of learning in play-based settings is imagination. Hedegaard (2016) defined the former as the interaction between a school's practices and the children's motive orientation. Imagination provides the idea to children to separate their emotions from events and activities. This is an essential part of learning and is the source of creativity that helps humans to 'imagine what they cannot see, conceptualise what they hear from others, and think about what they have not yet experienced' (Fleer 2015, p. 39).

From this view of the perspective of holistic development of children, the fact of an imaginary situation can be regarded as a path to developing abstract thought (Vygotsky 2016, p. 20). An important part of providing children with new experience is the transfer or sharing of experience from others to them but facts like raising questions about if, how, what and why of activities should also be included. It will help the children to extend their thinking beyond direct sensory experiences.

Ways for Play-based Learning

Markezich (1996) explains that the activities cover a range of scientific topics and utilize a variety of formats, often incorporating learning from other areas such as language, numeracy, and artistic and physical development. Examples include the following:

- Observing behaviour of safely contained items, for example, beads in plastic bottles.
- Handling and observing behaviour and interactions between substances such as oil and water, corn flour and water, corn flour and oil, and milk and washing liquid and using food colouring to enable these observations.
- Exploring density by investigating whether objects float or sink in a variety of different liquids.
- Making colour spinners or compartmentalised colour sorters.
- Using static electricity to move tissue paper shapes.
- Using creative activities to facilitate discussion and learning about the items being made. For example, making spiders with egg boxes and pipe cleaners.

Natural learning experiences for children are generally set by adults. Hence, it is their

responsibility to provide an interesting and rich environment to the children. The environment should be designed in such a way that the children get opportunity to learn through concrete experiences by using their sense organs. The teachers' understanding and approaches to science have deep influence in developing scientific curiosity among children. The learning environment should be simulative and enriched with natural play materials that can arouse interest of children for learning science concepts. There should be ample scope for observation and experimentation.

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ACHIEVEMENT OF STUDENTS IN BIOLOGY IN RELATION TO DEMOGRAPHIC VARIABLES

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The present study is aimed to investigate the achievements in Biology of Class XI students in relation to the demographic variables, i.e. gender, locale, age and caste. A sample of 300 students was randomly selected from six schools of Varanasi city in Uttar Pradesh. For obtaining the data, biology achievement was recorded by self-made achievement test. Statistical analysis was made by calculating mean, standard deviation, t-test and anova. The findings of the study suggest that there is a significant difference in the biology achievement of various caste categories of the students but other demographic variables such as gender, locale and age do not bring in any significant difference in biology achievement of Class XI students at formal operational stage.

Key Words: Achievement, Biology, Formal Operational Stage.

Introduction

Biology is a science in which the curriculum is continuously changed, new knowledge and emerging contents are introduced and they have an enormous impact on our lives. Each new discovery leads to more knowledge and we have to constantly learn new content and theory that develop not only our own understanding of biological concepts but also ways to teach that content to our students.

The quality of teaching and learning biology is a major challenge and concern for educators. General concern about biology achievement has been dominating in the minds of the parents for quite some time. There has always been emphasis on designing innovative instructional techniques that can easily be understood by students. A central and persisting issue is how to provide instructional environments, conditions, methods, and solutions that achieve learning goals for students with different skills and ability levels. In the recent times, there has been upsurge of newer concepts like constructivism dominating the teaching learning process.

However, newer techniques and methods alone cannot produce better learning and achievement. The educator must know crucial factors that affect student learning and build a bridge between goals and student performance. Identifying these factors will help to utilise limited resources including financial resources and time more effectively (Libienski and Gutierrez, 2008). In an effort to understand factors associated with biology achievement, researchers have focused on many factors (Beaton and Dwyer, 2002; Kellaghan and Madaus, 2002; Kifer, 2002). The impact of various demographic, social, economical and educational factors on students' biology achievement continues to be of great interest to the educators and researchers.

For instance, Israel, et al. 2001 concluded that parents' socio-economic status is correlated with a child's educational achievement. Another study by Jensen and Seltzer (2000) showed that factors, such as, individual study, parents' role, and social environment had a significant influence on 'further education' decisions and achievements of young students. A growing body of research provides additional factors which could have an impact on students' achievement such as gender, locale, family structure, parents' educational level, socio-economic status, parents' and students' attitudes toward school, and parents' involvement (Campbell. et al., 2000; Epstein, 1991). Three factors or predictors in biology achievement, are divided into sub factors: Demographic factors (gender, locale, age and caste), instructional factors (teacher competency, instructional strategies and techniques, curriculum, school context and facilities), and individual factors (self-directed learning, arithmetic ability, motivation, etc.).

Need and Significance

Identifying factors that affect achievements in biology is particularly important to effectively educate new generations. It also provides instructional designers better inputs for their design decisions. The curriculum developers and teachers are better equipped to handle students of different performance if they know the factors responsible for the same. As already stated, there have been growing interests in researches which can provide additional factors that could have an impact on students' biology achievement such as, gender, locale, family structure, parents' educational level, socio-economic status, parents' and students' attitudes toward school, and parents' involvement.

Many variables have long been studied as predictors of biology achievement. However, gender issues on biology achievement are studied most frequently by researchers (Keeves and Kotte, 1992; Jones, et al., 2000; Zeidan, 2010). Girls were superior to boys in intelligence and scholastic achievement (Shamshada, 1988). Rani Mohanraj. et al. (2005) reported that boys and girls did not differ significantly in their academic achievement. Singh (2006) in his study on fine arts students revealed that significant differences exist between boys and girls in their achievement in fine arts. Girls scored higher as compared to boys in the subject of fine arts. Swarnalatha and Janaki (2008) in their respective studies found no significant difference in the academic achievement of boys and girls.

In all, from cited studies, gender differences continue to provide contrasting findings. Some studies indicated that boys have higher achievement in particular area than girls whereas others show the reverse of it. However, the factors behind these differences are not clear. Hence, gender difference in biological achievement requires further study, especially within Indian classroom.

Similarly, locale has been another issue which has been presumed to be affecting the achievement of students. Gakhar, et al. (2004) found that rural students have higher academic achievement when compared with urban students. The location is supposed to affect the resources available to the students and thus seemed to be another variable which should be studied.

Further, age has been shown to be another factor in academic achievement. In a study (Stark and Gray, 1999) it was found that boys'

preferences for science topics shifted from biology to physics as the age of students increased, while girls' preference for biology topics was relatively high and less affected by age. This means that research in biology would explore different patterns in attitudes related with gender and/or age than other science courses. In a study, Baram-Tsabari and Yarden (2005) found that children's interest in human biology increases with age.

Lastly, caste is another issue which has been presumed to be affecting the achievement of students. The students from various caste categories have taken for prolonged and extensive studies.

The available body of research literature in the area left the researchers with demographic variables as suitable factors for research and thus an attempt was made to study these factors in the Indian context.

Objectives

The main objectives of this research paper were to study:

1. gender-wise differences in achievement in biology of Class XI students,
2. locale-wise differences in achievement in biology of Class XI students,
3. age-wise differences in achievement in biology of Class XI students, and
4. caste-wise differences in achievement in biology of Class XI students.

Hypotheses

The following were the research hypotheses framed for the study:

H_R1: There is a difference between the achievements in biology of male and female students of Class XI.

H_R2: There is a difference between the achievements in biology of rural and urban students of Class XI.

H_R3: There is a difference between the achievements in biology of different age group of students of Class XI.

H_R4: There is a difference between the achievements in biology of various caste categories of students of Class XI.

Null Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

$H_0$1: There is no significant difference between the achievements in biology of male and female students of Class XI.

$H_0$2: There is no significant difference between the achievements in biology of rural and urban students of Class XI.

$H_0$3: There is no significant difference between the achievements in biology of different age group of students of Class XI.

$H_0$4: There is no significant difference between the achievements in biology of various caste categories of students of Class XI.

Methodology

Method

Descriptive survey method was found the most suitable for testing hypotheses and was thus employed in the present research.

Tool

In order to achieve the objectives of the study, the investigator used an 'Achievement Test in Biology' (ATB), constructed and standardised by the investigator himself. Also a background information sheet was used to collect information on the different demographic variables.

Population

Students belonging to Class XI of biology group of different higher secondary schools affiliated to CBSE and under the administration of either CBSE or Banaras Hindu University of Varanasi city constituted the population of the study.

Sample

The sample of the study consisted of 300 students of Class XI of six different higher secondary schools of Varanasi city affiliated to CBSE and under the administration of either CBSE or Banaras Hindu University. Both the male and female students were included in the sample. The sample was selected by random sampling technique. The age of the students was in the range of 15 to 18 years.

Analysis and Findings

Data was analysed by using descriptive data analysis like mean and standard deviation. 't' test and analysis of variance (ANOVA) were calculated to test the hypotheses.

Effect of Gender on Achievement

To find out the effect of gender on achievement, t-test was used. Mean and S.D. of Class XI male and female students for achievement scores and results of t-test are given in Table 1.

Table 1

Significance of the difference between mean scores of achievement of male/female students

S. No.	Gender	N	Mean	S.D.	t-value	L.S.
1.	Male	202	28.79	7.37	0.818	$p \rightarrow 0.05$
2.	Female	98	28.03	7.62		

From Table 1, it is evident that mean scores of male (28.79) and female (28.03) for the scores on achievement do not differ significantly at 0.05 level ('t' (298) =1.97, $p \leftarrow 0.05$). Therefore, the null hypothesis that there is no significant difference between the achievements of male and female students is not rejected.

It is clear from the above table that gender does not seem to affect students' achievement in biology, a finding that is in accordance with relevant findings about Iranian secondary school students (Soltani and Nasr, 2010). Although Simonneaux, et al. (2005), found in a research that more girls than boys considered science as difficult and have lower achievement. Keeves and Kotte (1992), Jones, et al. (2000), Prokop, et al. (2007) and Usak, et al. (2009) suggested that biology is more popular among girls than among boys and have a higher achievement, but these results are not in accordance with our findings.

Effect of Locale on Achievement

To find out the effect of locale on achievement, t-test was used. Mean and S.D. of Class XI rural /urban students for achievement scores and results of t-test are given in Table 2.

From Table 2, it is evident that mean scores of rural (27.86) and urban (28.87) for the scores on achievement do not differ significantly at 0.05 level ('t' (298) =1.97, p←0.05). Therefore, the null hypothesis that there is no significant difference between achievement of rural and urban students is not rejected.

Thus, from the table it is evident that, there is no influence of locale on achievement in biology of higher secondary school students. But in some studies, it is one of the predictors of student's achievement (Narang, 1987; Ichado, 1998).

Effect of Age on Achievement

Analysis of variance was used to find out the effect of age difference on achievement. Mean and S.D. of Class XI of different age group of students on achievement scores are given in Table 3.

Table 2
Significance of the difference between mean scores of achievement of rural and urban students

S. No.	Locale	N	Mean	S.D.	t-value	L.S.
1.	Rural	97	27.86	7.34	1.10	p→0.05
2.	Urban	203	28.87	7.49		

Table 3
Mean and S.D. of different age group of students on achievement

S. No.	Age (in years)	N	Mean	S.D.
1.	15	42	27.55	7.78
2.	16	81	29.51	7.08
3.	17	149	28.30	7.75
4.	18	28	28.54	6.30

Table 4
ANOVA for the scores on achievement according to age

S. No.	Source of Variation	df	SS	MSS	F-ratio	L.S.
1.	Between age groups	3	125.41	41.80	0.752	p→0.05
2.	Within age groups	296	16445.03	55.56		
	Total	299	16570.44	55.42		

From Table 4, it is evident that the mean score of achievement of different age group of students do not differ significantly at 0.05 level of significance. Hence, the null hypothesis that there is no significant difference among the achievement of 15, 16, 17, and 18 years age group of students is not rejected at 0.05 level of significance.

Thus from the table, it has also been found that age also does not affect students' achievement in biology. Although Spall, et al. (2004) suggested that as the students grow older, they have less positive attitude towards biology and exhibit poor performance. But, this result was not found in this study, since no statistical significant differences were found among the different age groups of students in their achievement scores.

Effect of Caste on Achievement

Analysis of variance was used to find out the effect of caste difference on achievement. Mean and S.D. of different caste categories of Class XI students on achievement scores are given in Table 5.

From Table 6, it is evident that mean score of achievement of different caste categories of students differ significantly at 0.05 level of significance. Hence, the null hypothesis that there is no significant difference among achievement of general, OBC, SC, and ST caste categories of students is rejected at 0.05 level of significance.

From the above table, it is clear that only caste of the students as a demographic variable influence students' achievement in biology at the formal operational stage.

Conclusion

Identifying the demographic factors that possibly affect the biology achievements of students could help instructional designers and instructors to select the best instructional strategies to design the most effective and efficient instruction. From the results of the study, it can be concluded that among various demographic factors, only caste seem to affect the achievement in biology at formal operational stage.

Table 5
Mean and S.D. of different caste categories of students on achievement scores

S. No.	Caste	N	Mean	S.D.
1.	General	153	29.18	7.42
2.	OBC	90	29.04	7.68
3.	SC	39	27	7.41
4.	ST	18	23.94	4.24

Table 6
ANOVA for the scores on achievement according to caste

S. No.	Source of Variation	df	SS	MSS	F-ratio	L.S.
1.	Between caste groups	3	558.79	186.26	3.44	p<0.05
2.	Within caste groups	296	16011.64	54.09		
	Total	299	16570.44	55.42		

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LAW AGAINST DRUGS: NATIONAL AND INTERNATIONAL COOPERATION

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The problem of drug trafficking continues to take a significant toll on valuable human lives across the globe. With our vulnerable geographical position between the two major drug producing regions—the Golden Triangle and Golden Crescent, there are a number of challenges before the law enforcement agencies in India. The Government of India is well aware about the menace and our enforcement agencies in coordination with agencies of neighbouring countries are making all efforts to contain the problem.The Narcotics Control Bureau (NCB) is the nodal agency for matters relating to drug law enforcement. It acts as the national coordinator for intelligence and enforcement coordination with international agencies.

In addition, several educators acknowledged that drug abuse among students are important hurdle to the achievement of educational goals. Substance utilisation has also demonstrated to be connected with a number of negative education related consequences, including school drop-out. This has an impact on the area of education to make sure inclusive and equitable quality education for everyone and to achieve the new global 2030 Agenda for Sustainable Development.

Introduction

Proliferation of drug trafficking is no longer an isolated phenomenon. Though its *modus-operandi* carries regional uniqueness, its parasitic entrenchment in the socio-economic scenario is victimising the world populace at large. The threat is daunting and the connected challenges are massive. Rapid technological change and development of communication networks on one hand and breaking down of traditional time, distance and spatial barriers on the other, have worsened the situation. It has become important for the world to cooperate beyond the boundaries, learn from the shared experiences and fortify each other's efforts.

Opioids are the substances that cause the highest adverse impact, but cannabis remains the world's most widely used drug, with an annual prevalence of 3.8 per cent of the adult population, or an estimated 183 million people, having used cannabis in the past year. Amphetamines remain the second most normally used drug worldwide, with an estimated 35 million past-year users and the use of amphetamines, particularly methamphetamine, is perceived to be increasing in many sub-regions, including North America, Oceania and most parts of Asia.

Drug trafficking is a major challenge for peace, security and prosperity of nations. Drug trafficking and associated crimes have successfully stalled the growth trajectory at many places and have worked to waste precious human resources by forcing a marked section of the global population into addiction, illicit cultivation, etc. There are

primarily three United Nation's Conventions on drug related matters, namely, Single Convention on Narcotic Drug, 1961, Convention on Psychotropic Substances, 1971, UN Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances, 1988. These conventions have established mechanisms for international cooperation in the field of drug control. India is a signatory to all these conventions. India has been drawing attention of the global community for solid collective international action.

In the year 1990, SAARC countries signed a SAARC Convention against Psychotropic Substances at the regional level. The convention enjoins the member states to take stringent measures against drug trafficking and to facilitate exchange of information and research in the elimination of illegal drug menace. Further, SAARC Drug Offences Monitoring Desk (SDOMD) has been established with the objective of creating a data bank on all major drug offences in the SAARC region which would help member countries to improve their drug interdiction capabilities. India has also entered into Bilateral Agreement Memorandum of Understanding with countries for mutual cooperation.

The second Anti-drug Working Group meeting of Heads of Drug Control Agencies of BRICS was organised by India in the year 2016. The aim of the meeting was to evaluate the drug abuse situation in the member countries. This apart, it analyzed the legislations of BRICS member states as well as devise modalities for sharing the best practices of enforcement. Besides, the demand reduction is being followed in the member countries. The first BRICS Ministerial Meeting on Combating the Drug Threat was conducted in Moscow in April 2015. In this meeting, it was decided to create a BRICS Anti-drug Working Group. The Anti-drug Working Group has been established with an aim to address the issue on counteracting the illicit trafficking of narcotic drugs and psychotropic substances.

Role of School Education to Prevent Drug Abuse

Several educators have acknowledged that drug abuse among students is an important hurdle to the achievement of educational goals. It is linked with a broad range of negative impacts on young people's mental as well as physical health and on their well-being. Substance utilisation has also demonstrated to be connected with a number of negative education related consequences, including school drop-out of children. This has an impact on the area of education to make sure inclusive and equitable quality education for everyone and to achieve the global 2030 Agenda for Sustainable Development. There are a variety of factors that place children at a risk of drug abuse and its effects, including the atmosphere in which they reside. Education is a dais that involves children and provides them to evaluate and oppose such risks and stresses. The education segment, therefore, has a primary accountability to shield children and youth from drug abuse. This includes taking steps such as working to make sure that schools are free from tobacco, alcohol and other drugs; ensuring the main curriculum includes knowing abuse the risks related to drug and facilitates the development of students' and constructing the knowledge and skills of educators, parents and communities to empower as well as support the children to prevent drug abuse.

Over the years, there has been attention on the requirement to address young people's

well-being and conduct as a key and essential piece of the school curriculum. There has been growing concern about young people's conduct with respect to health associated behaviours including drugs, incorporating legal substances such as tobacco as well as alcohol. There is an increasing concern regarding the physical and mental health of the children and young people and how the school has a responsibility to make sure an affirmative result in this area. In addition, there has been growing pressure of the requirement for schools to be more associated with matters of behaviour that is accountable towards self as well as others. Besides, how they can make the individual and social capability towards our social system. This reminds us that the idea of what we should do within our school and prevention efforts have to include not only what we teach them but must reflect the requirement for an atmosphere where education and learning is a part of the school ethos.This apart, education appears as something that connects the entire school community including parents and various stakeholders.

It is the primary role of the school to impart knowledge.There is need to establish a sound value base in relation to health and drug use, not to change behaviours that may be determined by factors beyond the influence

of the school. Schools should report to the community on the achievement of educational outcomes that have been identified as contributing to the achievement of the broader health goal of preventing drug use.It is required to reduce adverse consequences to individuals and society. Students, school personnel, parents, prevention practitioners and referral agencies should collaborate to make decisions on drug policy and the management of drug incidents. There is a need for interactive teaching techniques such as discussions, brainstorming, decision-making, assertion training or role-playing new skills and active participation of all students. Educational schemes for the prevention of drug abuse should take into account the levels of drug abuse in society, risk and protective factors. It is necessary to interact with students in a way that acknowledges the reality of their backgrounds and experiences and creates opportunities for meaningful student input into education for drug abuse prevention methods. Students react positively when their individual needs and the needs of users and non-users are acknowledged. In addition, communication channels are kept open without drug use being condoned. Offering teachers professional development, consisting of an orientation to drug abuse prevention education that enables them to use a range of learning strategies, resources

and evaluation techniques appropriate to students' needs, rather than offering training only in the use of a specific resource. There is a need to ensure that schemes have greater impact and sustainability. Teachers should be offered the support of the school leaders as well as technical advice for sharing both successes and problems.

It is important that drug education programmes should be selected to complement the role of classroom teacher with external resources enhancing not replacing that role. The credibility of the teacher's role in meeting student needs may be compromised where externally developed programmes are imposed on schools. A life-skills approach is a way of interacting with children and young people that has the potential to lead drug abuse prevention learning outcomes and may ultimately influence student drug use. Life skills are best taught through interactive methods and are most effective when applied in potential drug use situations that are relevant to the social situations of students. Teacher training is an important component of any drug abuse prevention methods. Education for drug abuse prevention is more effective when teachers receive formal training. There must be focus on providing them with an orientation to drug abuse prevention education that enables them to select content and use a wide range of strategies to meet student needs.

Position in India

In India, the drug trafficking condition is largely attributed to two factors— external and internal. One of the prime external factors happens to be India's close proximity to the major opium producing regions of South West and South East Asia known as the 'Golden Crescent' (Afghanistan, Pakistan and Iran) and the 'Golden Triangle' (Myanmar, Thailand and Lao People's Democratic Republic), respectively. The geographical location of India as such makes it vulnerable to transit, trafficking and consumption of opium derivatives in various forms along the known trafficking paths. As far as cannabis is concerned, it is a weed that is largely cultivated in large parts of the country and one of the most commonly abused substances in India. In addition, the enforcement agencies have detected and dismantled many clandestine laboratories associated with manufacturing of synthetic drugs.

According to recent trends, the synthetic drugs are now replacing the natural and semi-synthetic drugs that have been abused over decades. Despite strict controls and monitoring put in place for certain pharmaceutical products, there is evidence indicating their diversion for abuse. There is diversion of pharmaceutical preparations and prescription drugs containing psychotropic and controlled substances and their smuggling to neighboring nations. The other factors prevalent are involvement of foreign nationals in trafficking of Ketamine, an anesthetic from India to certain parts of South East Asia.

In Indian scenario, the salient features of drug trafficking may be summarised such as diversion of opium from illicit cultivation and indigenous production of low quality heroin. Trafficking of opiates from South West Asia to India may also be considered. Trafficking of hashish from Nepal, lllicit cultivation of opium and cannabis in some pockets; diversion of precursor chemicals and other controlled substances; attempts to establish illicit meth labs in association with foreign operatives;

diversion of pharmaceutical preparations and prescription drugs containing psychotropic substances are also some features. Internet pharmacies and misuse of courier services and involvement of foreign nationals in trafficking and distribution networks are other significant concerns.

It may be mentioned that drugs have legitimate chemical, industrial and pharmaceutical applications. India is the biggest supplier of licit demand for opium required primarily for medicinal purpose in the world. The Government of India permits licit cultivation of poppy on notified tracts to meet legitimate industrial requirements. The government regularly undertakes destruction operations of illicit poppy. Apart from drugs obtained from botanical sources, there are also synthetic drugs such as ATS (amphetamine-type stimulants) and 'precursors'. Precursors are substances or solvents that are used for clandestine manufacture of synthetic drugs. These are chemicals that can be used in the manufacture of illicit narcotic drugs and psychotropic substances.

Law Enforcement against Drugs

Drug trafficking does not recognise national boundaries. Trafficking from one country to another or from one region to another depends upon various factors, the most important being the nature of supply and demand. It is important for drug law enforcement officers to understand the various kinds of drugs that can possibly be abused. The categorisation and classification of narcotic drugs and psychotropic substances, therefore, assume importance as an essential ingredient in drug law enforcement.

In India, Article 47 of the Constitution of India provides that "... the State shall endeavour to bring about prohibition of the consumption except for medicinal purposes of intoxicating drinks and of drugs which are injurious to health."

In our country, the Narcotic Drugs and Psychotropic Substances (NDPS) Act was enacted in 1985. It constitutes the statutory framework for drug law enforcement. The Parliament of India enacted the NDPS Act by consolidating the earlier legislations like the Opium Act, 1857; the Opium Act 1878 and the Dangerous Drugs Act, 1930. The Act also incorporated provisions designed to implement India's obligation under different international conventions.

Offences under the NDPS Act envisages graded punishments having a maximum of twenty years imprisonment and fine upto ₹ 20 lakhs. The Act also has a provision for death penalty in certain cases of repeat offences and provides for the seizure and forfeiture of drug related potential assets not only of the accused but also of his associates and relatives. In 1989, certain significant amendments were made in the Act by the Government of India to provide for the forfeiture of property derived from drug trafficking and for control over chemicals and substances used in the manufacture of narcotic drugs and psychotropic substances. In 2001, some further amendments were incorporated by the Government of India in the NDPS Act with a view to introduce a graded punishment, to rationalise the sentence structure to establish the laundering of the proceeds of drug trafficking as a criminal offence, and to provide a statutory basis for investigative techniques, such as, controlled delivery. In 2014, with a view to further

strengthen the provisions of the principal Act, amendments incorporated by the Government of India in the NDPS Act, made a provision for taking the entire quantity of drug seized in a case for determining the quantum of punishment and not the pure drug content; expanded the scope of provisions for tracing and seizing of illegally acquired properties pursuant to drug trafficking activity and to broad base the definition of illegally acquired property so that it becomes more difficult for drug traffickers to enjoy the fruits of drug trafficking activity.

Under the NDPS Act, 1985, rules have been framed to regulate cultivation, manufacture, import and export of narcotic drugs and psychotropic substances. Further to prevent diversion of precursor chemicals from wide industrial use for illicit manufacturing of narcotic drugs and psychotropic substances, the Narcotic Drugs and Psychotropic Substances (Regulations of Controlled Substances) Order, 2013 has been framed under Section 9A of the NDPS Act by the government.

The Prevention of Illicit Traffic in Narcotic Drugs and Psychotropic Substances (PITNDPS) Act, enacted in 1988, provides for preventive detention of proclaimed and potential offenders. The Act was amended by the government in 1993 and 1996 to address the various aspects to drug related problems.

Drug-trafficking and money laundering are closely related crimes. Control of money laundering activities is an effective preventive measure against trafficking of drugs. The main sources of money laundering in our country result from a range of illegal activities committed within and outside India, which include *inter alia* drug trafficking, transnational organised crime and counterfeiting of Indian currency. The Government of India has criminalised money laundering by enacting the Prevention of Money Laundering Act, 2002 (PMLA) in accordance with international norms to curb movement of illicit funds, as amended from time to time.

In India, the Narcotics Control Bureau is the national nodal agency for matters relating to the drug law enforcement. Given the federal nature of India's polity and the size and geographical dispersal of drug related problems, a number of agencies at the national and state level such as the Central Bureau of Narcotics (CBN), the Directorate of Revenue Intelligence (DRI), the Customs, Excise, the Central Bureau of Investigation (CBI), State Police and the Border Security Force, State Excise, have been empowered to enforce the NDPS Act. The Narcotics Control Bureau, established in 1986, acts as the national coordinator in matters relating to drug law enforcement. The bureau's responsibilities include administrative coordination with different Union ministries, state government departments and central and state law enforcement agencies for effective implementation of the various regulatory, prohibitory, penal and administrative provisions of the NDPS Act. The Narcotics Control Bureau also acts as the nodal agency for intelligence and enforcement coordination with international enforcement agencies.

The Central Bureau of Narcotics (CBN) was set up in 1950. The CBN is responsible for all aspects of the opium industry including cultivation of poppy plant and preventing illicit precursor trafficking. The responsibilities of CBN also include tracing and freezing of illegally acquired property as per the provisions of the NDPS Act, issuing licenses

and no objection certificate (NOC) for the manufacture of synthetic narcotic drugs and import and export of a select number of precursors. The pre-export notification regime is enforced by the Central Bureau of Narcotics with respect to precursors such as acetic anhydride and pseudo-ephedrine.

To fight drug-trafficking, the enforcement measures include coordination and capacity building to coordinate the efforts of different law enforcement agencies and impart specialised training. These measures include setting up of Multi Agency Centre (MAC) at the national level represented by 22 national intelligence agencies, Subsidiary Multi-Agency Centre (SMAC) at the state level, Economic Intelligence Councils (EIC) at the national level, and Regional Economic Intelligence Councils (REICs). Meetings are also organised by the NCB and coordination at the national and regional levels. Assistance is provided to states for enforcing anti-drug measures and are given with drug test kits.

A three-pronged strategy is required to check drug trafficking, i.e. supply reduction, demand reduction and regulation of licit trade. Supply reduction refers to dealing with the illicit production and trafficking of drugs. While demand reduction addresses the problem from the perspective of addicts and general public especially the vulnerable youth. Many (though not all) narcotic drugs and psychotropic substances also have several medicinal uses. Regulating legal production and trade is also necessary to prevent diversion of licit narcotic drugs into illicit channels while ensuring unhindered supply for medical needs.

The Government of India has created a strong system for identification of areas of illicit cultivation of opium and cannabis using satellite images and organising destruction of such crops in coordination with state and district administration and paramilitary forces. In the year 2016, this has led to record destruction of opium crops cultivated in an area of about 6442 acres. This is an 85 per cent increase over the previous, which has prevented about one lakh kgs of opium from coming into illicit market. Reducing the demand for illicit drugs is a crucial-component in the overall approach for dealing with drug problem. The measures include building awareness and educating the people about the ill effects of drug abuse through various propaganda campaigns, community based intervention for motivation and counselling. This apart, the measures also include identification, treatment and rehabilitation of drug addicts, training of volunteers, service providers and other stakeholders for building of a committed and skilled cadre, etc.

Based on the Financial Action Task Force (FATF) guidelines, the Financial Intelligence Unit—India (FIU—IND) has been set up in the country by the government which is the Central National Agency for receiving, processing, analysing and disseminating information relating to suspect financial transactions (STR). The FIU-IND is also responsible for coordinating and strengthening efforts of national and international intelligence in pursuing the efforts against money laundering terrorist financing and related crimes.

In India, there are a number of institutions which are working in the field of drug demand reduction at national, state, regional and local levels. These include the National Centre for Drug Abuse Prevention (NCDAP), the National

Drug Dependence Treatment Centre (NDDTC) established under the All India Institute of Medical Science (AIIMS) and the National Institute of Mental Health and Neuro Sciences (NIMHANS). In August 2016, the Ministry of Social Justice and Empowerment assigned the work of conducting a national survey of extent and pattern of substance use to the National Drug Dependence Treatment Centre, AIIMS. The survey will be carried out in about 25 per cent of the districts in each state. The survey will include a household sample survey and respondent driven sampling survey. The work of the survey is in progress.

The UN General Assembly in a Resolution passed in December 1987 proclaimed 26 June as the International Day against Drug Abuse and Illicit Trafficking. On the occasion of 26 June, the Ministry of Social Justice and Empowerment and the NCB organised various activities like street shows, cultural programmes, run against drug abuse, *padyatras*, painting, slogan writing competition, pledge taking ceremonies, advertisement in prominent national dailies, etc., in the country.

In order to recognise the efforts and encourage excellence in the field of prevention of substance (drug) abuse and rehabilitation of its victims, the Department of Social Justice and Empowerment had published a Notification in the Gazette of India on 31 December 2012 about the 'Scheme of national awards for outstanding services in the field of prevention of alcoholism and substance (drug) abuse'. Later, the scheme has been revised and the notification was published in the Gazette of India on 30 December 2015. The scheme is applicable to institutions and individuals working in the field of prevention of alcoholism and substance (drug) abuse. The awards are conferred on the awardees in a function to be held in New Delhi on 26 June of every alternate year, on the occasion of the International Day Against Drug Abuse and Illicit Trafficking. So far three national awards functions have been held on 26 June 2013, 26 June 2014 and 26 June 2016.

The Government of India is committed to eradicating illicit trade in drugs and organised crime of all kinds. The government has adopted a multi-pronged strategy for dealing with this twin evil of combating drug trafficking and related crimes. The strategy requires involvement of drug enforcement agencies and security agencies as well as the civil society. The government is unambiguously committed in this matter and supports all international initiatives on curbing the menace of drug-trafficking.

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'g' BY DROPPING METHOD

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Introduction

I have provided two methods for finding the value of 'g' (acceleration due to gravity). Both of these are my original ones. One is based on the principle of projectile(Verma, M.L.,2015) and other on the free dropping of bullet from height 1.23 m.

'g' by Dropping Method

This experiment is very useful for lower class students. They can easily perform this experiment. They can easily understand the concepts of acceleration due to gravity and gravitational force. This experiment gives us accurate value of g. The performance of this experiment is very simple and easy. There is no costly apparatus used to perform this experiment. The errors of simple pendulum and bar pendulum are totally removed by this experiment.

Principle

We Know that

$$h = ut + \frac{1}{2}at^2$$

But if initial velocity, u=0 and a=g

Then $h = \frac{1}{2}gt^2$

Or $g = \frac{2h}{t^2}$

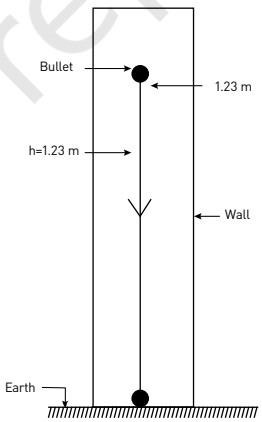
Method

Now, knowing the values of h and t, we can easily calculate the value of 'g'.

A line is marked on the wall at height 1.23 meters from the earth as shown in the figure.

1. Dropping of One Bullet

Observing the watch carefully, one bullet is dropped from the height 1.23 meters to the earth, when the second hand of watch reaches at the sign 12. Also time is noted when bullet hits the earth, In other words, we observe or measure the time taken by bullet to reach the earth, suppose it is t sec.



Generally, I have seen that second hand of watch takes $\frac{1}{2}$ second in the rest position and

$\frac{1}{2}$ second in jumping. Thus, completed one second.

Observations and calculation

Height is fixed in this experiment and that is 1.23 meters

or h =1.23 meters.

and time taken, $t = \frac{1}{2}$ sec.

Now, we know that:

$$g = \frac{2h}{t}$$

Putting the values of hand t we get:

$$g = \frac{2 \times 1.23h}{\left(\frac{1}{2}\right)} = 2.46 \times 4$$

or g= 9.84 metre/sec^2

2. Dropping of Ten Bullets

Dropping of ten bullets is more suitable than one bullet. It is easy to perform the experiment. Observing the watch carefully, when the second hand of the watch reaches at the sign 12, then one bullet is dropped. The second bullet is dropped after 5 seconds from the dropping of the first bullet, similarly all remaining 8 bullets are dropped getting the same time interval of 5 seconds.

Now observing the time of 10th bullet's collision on the earth, it is noted:

Now suppose total time in this process is T second, number of bullets dropped is N and time interval taken after one bullet dropping is n. Therefore, time taken by one bullet to reach the surface of the earth,

$$t = \frac{T - (N-1)n}{N} \text{sec}$$

Observations and calculation

I get the readings in this experiment which is given below:

1. T = 50 second
2. N = 10
3. n = 5sec.
4. h = 1.23 meters

$$\therefore t = \frac{5(10-1) \times 5}{10} = \frac{50 - 9 \times 5}{10} = \frac{5}{10}$$

$$\therefore t = \frac{1}{2} \text{sec.}$$

Now we know:

if u = 0

Then $g = \frac{2h}{t}$

Now, putting the values of hand t

We get, $g = \frac{2 \times 1.23}{\left(\frac{1}{2}\right)} = 2.46 \times 4 = 9.84 m/\text{sec}$

Sources of Error and Precautions

1. The time should be noted carefully because accuracy depends on it.
2. Ten bullets are suitable for this experiment.
3. First bullet should be dropped when the second hand of watch reaches at the sign of 12 marked at the dial.
4. Second and other 8 bullets should be dropped when second hand of watch completing 5 second's sign marked on the dial.
5. Time should be noted carefully when the 10th bullet impacts on the earth.

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MOTION OF A BALL FROM CREASE TO BOUNDARY IN A GAME OF CRICKET

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This is a model to calculate the motion of a ball hit by a batsman to score a boundary. The ball hits the ground, bounces several times and then grazes the ground to reach the boundary line evading intercept by any fieldsman. With given initial velocity, time taken by the ball to cross the boundary line covering the distance between the batsman and the ball touching the boundary line is determined. Herein the minimum initial velocity of the batted ball and its corresponding direction to strike a 'four' are also determined. Some numerical examples are also cited.

1. Introduction

The author earlier innovated two models of projectile motion of a cricket ball for 'bowled out' and 'caught out' respectively Maitra, 2007). In this design, a projectile motion of a cricket ball crashed by a batsman followed by its bouncing motion on the ground and thereafter rectilinear motion grazing the ground till it crosses or touches the boundary line, without being stopped by any fielder.

2. Equations of Motion of the Ball in Air

Let the batsman play a shot and the ball leaves the bat with a velocity u downwards at angle α to the horizontal.If it strikes the ground descending a height h and covering a horizontal distance R_0 in time T_0, escaping any intervention by a fieldsman, then its equations of motion in the air, whose resistance is neglected and where g is the acceleration due to gravitation, are given by

$$h = (u \sin \alpha)T_0 + \frac{1}{2}gT_0^2 \quad (1)$$

$$R_0 = u \cos \alpha \, T_0 \quad (2)$$

Eliminating T_0 betweeen (1) and (2) we can find

$$R_0 = (u/g)(-u \sin \alpha + \sqrt{u^2 \sin^2 \alpha + 2gh}) \cos \alpha \quad (3)$$

$$T_0 = (-u \sin \alpha + \sqrt{u^2 \sin^2 \alpha + 2gh}) / g \quad (4)$$

3. Equations of Motion of the Ball on the Ground

Overall motion of the ball discussed in this section consists of its successive bounces from the ground followed by its rectilinear motion on the ground till it reaches the boundary line to credit the batsman with a boundary ,i.e., four runs. Let the ball played by the batsman hit the ground with velocity v at angle β to the horizontal, the coefficient of elasticity between the ball and the ground being e; then one gets

$$v^2 \sin^2 \beta = u^2 \sin^2 \alpha + 2gh \quad (5)$$

Because of gravity in the vertical direction which is also the line of impact, the horizontal component of the velocity of the ball is constant so that

$$u\cos\alpha = v\cos\beta \quad (6)$$

Case 1. Theoretically the ball executes many rebounds, so to say infinitely many rebounds before its vertical component of the velocity vanishes. By Newton's law of collision, the vertical component of the velocity after first rebound from the ground is $ev\sin\beta$. Further in view of the velocity of rise being equal to the velocity of fall the subsequent vertical components of velocities of the ball due to successive rebounds, say, up to the nth rebound is given by

$$ev\sin\beta,\ e^2v\sin\beta,\ e^3v\sin\beta\ \ldots\ e^nv\sin\beta \quad (7)$$

Since the time of fall is equal to the time of rise, the total time elapsed up to the nth rebound is given by

$$T' = 2(ev\sin\beta + e^2v\sin\beta + e^3v\sin\beta \ldots e^nv\sin\beta)/g$$

(vide G.P. series)

$$= \frac{2e}{g}.\frac{1-e^n}{1-e}v\sin\beta \quad \text{(By use of ([5]))}$$

$$= \frac{2e}{g}.\frac{1-e^n}{1-e}\sqrt{u^2\sin^2\alpha + 2gh} \quad (8)$$

whereas the total distance described along the ground in this time is obtained as

$$R' = (u\cos\alpha)T' = \frac{2eu}{g}.\frac{1-e^n}{1-e}\sqrt{u^2\sin^2\alpha + 2gh}(\cos\alpha) \quad (9)$$

If the horizontal distance from the just-ball of the boundary line compatible with motion of the smashed ball that reaches/crosses the boundary line after completion of n bounces be S_1 to score a boundary,

$$R_0 + R' \geq S_1 \quad (10)$$

Case 2. While watching a cricket match, it is observed that the smitten ball moves on bouncing, stops bouncing and then moves on the ground in a rectilinear path to reach or cross the boundary line for 'four' runs.

Before the ball ceases to any further bounce, there arises a textbook problem of Dynamics, 3 giving infinitely many rebounds such that in consideration of (8) and (9) it covers a horizontal distance R1 in time T_1 due to bouncing:

$$R_1 = \lim_{\to\infty}\frac{2eu}{g}.\frac{1-e^n}{1-e}\sqrt{u^2\sin^2\alpha + 2gh}(\cos\alpha)$$

$$= \frac{2eu}{g}.\frac{1}{1-e}\sqrt{u^2\sin^2\alpha + 2gh}\cos\alpha$$

$$\left(e<1, e^n \to 0 \text{as } n\to\infty\right)$$

$$T' = \lim_{n\to\infty}\frac{2e}{g}.\frac{1-e^n}{1-e}\sqrt{u^2\sin^2\alpha + 2gh}$$

$$= \frac{2e}{g}.\frac{1}{1-e}\sqrt{u^2\sin^2\alpha + 2gh} \quad (11)$$

After the ball stops bouncing, it begins to move on the ground obviously towards the boundary, of course, if any fields man is unable to stop it. Let f be the frictional resistance of the ground per unit mass of the ball that crosses the boundary line with velocity u0 travelling in this context a distance R_2 in time T_2 : (12)

$$R_2 = \frac{u^2\cos^2\alpha - u_0^2}{2f} \quad (13)$$

$$T_2 = \frac{u\cos\alpha - u_o}{f} \quad (14)$$

Thus in consonance with (3),(4),(11),(12),(13) and (14) the total horizontal distance travelled by the ball and the time reckoned from the instant of striking the ball by the batsman are given by

$$S = R_0 + R_1 + R_2 = [(-u\sin\alpha + \epsilon\sqrt{u^2\sin^2\alpha + 2gh})/g + \frac{u^2\cos^2\alpha - u_0^2}{2fu\cos\alpha}]u\cos\alpha \quad (15)$$

With $\epsilon = \frac{1+e}{1-e}$

$$T = T_0 + T_1 + T_2 = (-u\sin\alpha + \epsilon\sqrt{u^2\sin^2\alpha + 2gh})g + \frac{u\cos\alpha - u_0}{f} \quad (16)$$

Or
$$s = (u\cos\alpha)\left(T + \frac{u_0}{f}\right) - \frac{u^2\cos^2\alpha + u_0^2}{2f} \quad (17)$$

Now let us express the velocity, i.e., exit velocity u of the ball from the contact with the bat in terms of the distance S:

$$\{-\frac{g\left(s + \frac{u_0^2}{2f}\right)}{(u\cos\alpha)} + u\sin\alpha = \epsilon\sqrt{u^2\sin^2\alpha + 2gh} + \frac{g}{2f}\cos\alpha$$

$$\left\{\frac{g\left(s + \frac{u_0^2}{2f}\right)}{(u\cos\alpha)} + u\left(\sin\alpha - \frac{g}{2f}\cos\alpha\right)\right\} = \epsilon^2\left(u^2\sin^2\alpha + 2gh\right)$$

which, because of substitutions

$$A = \frac{g\left(s + \frac{u_0^2}{2f}\right)}{(u\cos\alpha)}, B = \sin\alpha - \frac{g}{2f}\cos\alpha$$

$$C^2 = \epsilon^2\sin^2\alpha \text{ and } D = 2\epsilon^2 ghl \quad (18)$$

turns out to be

$$\left(\frac{A}{U} + Bu\right)^2 = C^2u^2 + D$$

or, $(C^2-B^2)u^4-(2AB-D)u^2-A^2=0$, $C > B,\ 2AB > D, \epsilon >$

$mu^4-2nu^2-A^2 = 0$

$$u = \sqrt{\frac{n + \sqrt{n^2 + m\left(A^2\right)}}{m}} \quad (19)$$

4. Maximum Distance Covered by the Ball During Successive Bounces

In this section is determined the maximum distance the ball can cover on the ground while it is bouncing 'up and down' and the optimum angle of striking to the horizontal by the batsman. Then with given initial velocity u, to crack a boundary, recalling (10) and (11), the following inequality holds

$$R_0 + (R_1)max \geq S_1 \quad (20)$$

However for maximum or minimum of R_1

$$\frac{dR_1}{d\alpha} = 0 \quad (21)$$

or, equivalently $\frac{d(R_1^2)}{(\cos 2\alpha)} = 0$ (22)

And such (11) is rewritten as

$$\frac{R_1^2g^2}{4e^2}(1-e)^2 = \frac{u^4}{4}\sin^2 2\alpha + ghu^2(1+\cos 2\alpha)$$

$$= \frac{u^4}{4}\left(1-\cos^2 2\alpha\right) + ghu^2(1+\cos 2\alpha)$$

so that by use of (22) one gets

$$\cos 2\alpha = \frac{2gh}{u^2} \quad \cos\alpha_{opt} = \frac{1}{2}\cos^{-1}\left(\frac{2gh}{u^2}\right) \quad (24)$$

or, $\cos\alpha_{opt} = \sqrt{\frac{1}{2}\left(1 + 2\frac{gh}{u^2}\right)}$ $\sin\alpha_{opt} = \sqrt{\frac{1}{2}\left(1 + 2\frac{gh}{u^2}\right)}$

$$\frac{d^2R_1^2}{d(\cos 2\alpha)^2} < 0 \quad (25)$$

And hence by use of (11),(12) and (25), the maximum horizontal distance covered by the bounces is obtained as

$$(R_1)_{max} = \frac{e(u^2 + 2gh)}{g(1-e)} \quad (23)$$ (26)

in time T_1 $\alpha_{opt} = \sqrt{\frac{1}{2}\left(1 + 2\frac{gh}{u^2}\right)}$ (26.1)

with fixed height and initial velocity u.

5. Minimum Velocity for a given Horizontal Distance to be covered by Bounces

We can show that with a fixed distance R_1 on the ground to be described by bounces of ball having its initial height h, there exist a minimum velocity of the ball and the corresponding angle of projection. So from equation (23),for maximum or minimum of u ie u^2 we get

$$\frac{d(u^2)}{(\cos 2\alpha)} = 0 \quad (27)$$

Hence differentiating (23) and using (27), one gets

$$ghu^2 - \frac{u^4}{4}(2\cos 2\alpha) = 0$$

$$u^2_{min} = \frac{2gh}{\cos 2\alpha_{opt}} \quad (28)$$

Now differentiating (23) twice with respect to $(\cos 2\alpha)$ subject to (27) we obtain

$$\left[\frac{u^2}{2}\left\{1-(\cos 2\alpha)^2\right\} + gh(1+\cos 2\alpha)\right]\frac{d^2(u^2)}{d(\cos 2\alpha)^2} = \frac{u^2}{2}$$

which implies $\frac{d^2(u^2)}{d(\cos 2\alpha)^2} > 0$ (29)

which ratifies the minimum velocity given by (28)

To determine u_{min} and α_{opt} explicitly we employ (28) in (23):

$$\frac{R_1^2 g^2}{\alpha e^2}(1-e)^2 = u^2(1+\cos 2\alpha).$$

$$\left\{\frac{u^4}{4}(1-\cos 2\alpha) + gh\right\}$$

$$= u^2\left(1 + \frac{u^2}{2gh}\right)\left\{\frac{u^2}{4}\left(1 - \frac{u^2}{2gh}\right) + gh\right\}$$

$$= \left(u^2 + 2gh\right)^2 / 4$$

$$\frac{R_1 g(1-e)}{e} = u^2 + 2gh$$

$$u_{min} = \sqrt{\frac{g}{e}\{R_1(1-e) - 2he\}} \quad (30)$$

which in consequence of (28) gives

$$\cos^2\alpha_{opt} = \frac{2he}{R_1(1-e) - 2he} \quad (31)$$

or, $\cos^2\alpha_{opt} = \frac{R_2(1-e)}{2\{R_1 g(1-e) - 2he\}}$

$$\alpha_{opt} = \cos^{-1}\sqrt{\frac{(1-e)}{2\{R_1 g(1-e) - 2he\}}} \quad (32)$$

which suggests that if h=0 or $h \to 0, \alpha_{opt} = 45^0$ or $\alpha_{opt} \to 45^0$ then it reduces to a textbook problem. It is observed that with fixed velocity the maximum bouncing-horizontal- distance or with fixed bouncing-horizontal-distance the minimum velocity can be determined from either of equations (26) and (30).

6. Time Taken by the Ball to Reach the Boundary

Eliminating u_0 between (15) and (16) the time taken to reach the boundary line by the ball slapped by the batsman is given by

$$T = (-u\sin\alpha + \epsilon\sqrt{u^2\sin^2\alpha + 2gh})$$

$$\frac{1}{g} + \frac{1}{f}[u\cos\alpha - \{\frac{u^2}{2f}\cos^2\alpha - s - (v\sin\alpha + \epsilon$$

$$\sqrt{u^2\sin^2\alpha + 2gh)}\frac{u\cos\alpha}{g})^{\frac{1}{2}}\sqrt{2f}] \qquad e<1, \epsilon>1 \tag{33}$$

From, (33), it is ascertained that greater the horizontal component of the batted velocity, lesser the time for the ball to reach the bouncing.

7. Minimum Initial Velocity to Strike a 'Four'

At the sight of equation (15) or its another form, with given initial angle $\propto$, the velocity of the ball depends upon h,S, ϵ and g. Nevertheless intuitively there exists angle $\propto_{opt}$ of projection by the batsman to achieve a 'Four' with a minimum-velocity of the ball, for which we need to put $\frac{du}{d\alpha} = 0$ from (15) and then to find the corresponding value of $\propto$. But this gives a complicated equation involving sin $\propto$ and cos $\propto$. In order to avoid such complication we neglect h because h«S in equation (15) which is rewritten as

$$\frac{A}{u^2} = (\epsilon - 1)\frac{\sin 2\alpha}{2} + \frac{\lambda}{2}(1+\cos 2\alpha) + \frac{\sqrt{2gh}}{2}(1+\cos 2\alpha)\epsilon$$

$$\left(\text{writing } \sqrt{u^2\sin^2\alpha + 2gh} \cong u\sin\alpha + \sqrt{2gh}\cos\alpha \le \sqrt{u^2\sin^2\alpha + 2gh}\right)$$

$$\text{or } \frac{2A}{u^2} = (\epsilon - 1)\sin 2\alpha + (1+\cos 2\alpha)\left(\lambda + \epsilon\sqrt{2gh}lu\right) \tag{35}$$

$$\text{Where } A = g(S + \frac{u_0^2}{2f}), \lambda = \frac{g}{2f} \tag{36}$$

For minimum or maximum of u, ie, for maximum or minimum of $\frac{1}{u^2}$ we have formed equation (35)

$$\frac{d\left(\frac{1}{u^2}\right)}{d\alpha} = 0$$

$$(\epsilon - 1)\cos 2\alpha - (\lambda + \epsilon\frac{\sqrt{2gh}}{u_{min}})\sin 2\alpha \tag{37}$$

$$\text{or, } \tan 2\alpha = \frac{(\epsilon - 1)}{\lambda + \epsilon\frac{\sqrt{2gh}}{u_{min}}} = \mu \tag{38}$$

Ultimately to evaluate u_{min} and $\propto_{opt}$ with desired accuracy a method of approximation is adopted.

Since h«S implying $\epsilon.\frac{\sqrt{2gh}}{u_{min}} << \lambda$, relation gives

$$\tan 2\alpha_{opt} = \frac{(\epsilon - 1)}{\lambda} \tag{39}$$

$$\text{so that } \sin 2\alpha = \frac{\mu}{\sqrt{1+\mu^2}},\ \cos 2\alpha = \frac{\mu}{\sqrt{1+\mu^2}} \tag{40}$$

which on substitution into (35) yields

$$u_{min}^2 = \frac{2\sqrt{1+\mu^2}A}{(\epsilon - 1)\mu + \left(\lambda + \epsilon\frac{\sqrt{2gh}}{u_{min}}\right)(1+\sqrt{1+\mu^2})} \tag{41}$$

Denoting

$(\epsilon - 1)\mu + \lambda\left(1+\sqrt{1+\mu^2}\right), \epsilon\left(1+\sqrt{1+\mu^2}\right)$ and $2A\sqrt{1+\mu^2}$ by E,2F and G, respectively (41) reduces to a quadratic equation

$$Eu_{min}^2 + 2\sqrt{2gh}Fu_{min} - G = 0 \tag{42}$$

whose solution gives

$$u_{min} = \frac{\sqrt{2gh}F + \sqrt{2ghF^2 + GE}}{E} \tag{43}$$

which involves h, however small it is in comparison to S.

Substituting (41) into (38), we can obtain more accurate value of α_{opt}.

8. Numerical Examples

Rearranging (15) we can find the velocity u_0 with which the ball can reach the boundary line and using (16) the time taken to reach it.

$$u_0 = \left[(-u\sin\alpha + \epsilon\sqrt{(u^2\sin^2\alpha + 2gh)}\frac{u\cos\alpha}{g} + \frac{u^2}{2f}\frac{\cos^2}{2}\alpha - S \right]^{1/2} \sqrt{2f} \quad (44)$$

Example 1. Let us suppose the initial velocity of the ball=u=25 metre per second, i.e., 90 kilometre per hour. Radius S of the cricket ground=65 metres. Then from (44) and (16) with some realistic values of ϵ and α, the velocity with which the ball passes the boundary line=u0=22.47metre/sec in timeT=3.138 seconds.

But in case of the lifted batted- ball at angle α above the horizontal line,in the foregoing equations α is to be replaced by--α.

Example 2. With u=20 metre/sec, i.e., 72 kms/hour, similarly,u_0=11.97metre/sec, T=4.57seconds.

Example 3. With u=30 metre/second,i.e., 72 km/hours, similarly u_0=27.47,T=2.58 seconds.

Example 4. With u=35 metre/sec , i.e., 126km/hour, similarly u_0=2 metre/ses T=4.16 seconds.

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SUSTAINABLE ECOSYSTEM: FORGING A NEW HUMAN – PLANT RELATIONSHIP

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Introduction

It is impossible to imagine a life in isolation on this planet. Different forms of lives are associated with flora, fauna and atmosphere around them in the ecosystem. Being the producer, plants play a key role in the ecosystem.

One of the most interesting features of life on this planet is its extraordinary diversity. We share planet Earth with countless other species who provide us essential goods for life including food, drugs, industrial products, genetic resources and much more.

Earlier we were dependent on forests for all our needs. However, over time agriculture and industries emerged as new means to fulfil our desired needs. A harmonious balance among different biotic and abiotic components of an ecosystem is highly essential. However, over industrialisation and growth of the human population as well as the increased requirements of food and other essentials have stressed the natural system. It has given rise to the pollution of air, water and soil and degraded many habitats which has threatened the survival of many species.

The plants check air pollution by reducing the amount of carbon dioxide in the air and supplying oxygen through photosynthesis. Plants help cleaning up of synthetic chemicals and bacteria from water and soil as well as help in minimising undesirable noise pollutions. They prevent soil erosion, filter dust and cool atmosphere in neighbour hoods.

For wildlife, the plants can be their food source as well as their home. In fact plants play a crucial role in almost all the aspects of life. They support us as good friends through thick and thin. Majority of the environmental issues created due to unbalanced growth can also be solved with the help of technologies, treaties and trees.

Ecosystem

Numberless species and their environment mutually interact to form an ecosystem. Ecosystem is a functional unit comprising abiotic and biotic components. The study of the relationships of living organisms with their environmental abiotic and biotic (other species) components is called ecology. It is mainly the study of organisms, populations, communities and biomes. Light, temperature, water and soil are abiotic factors to which the organisms are adapted in different ways.

The populations of different species in a habitat interact mutually in different ways like

competition (both species suffer), predation and parasitism (one benefits and the other suffers) and mutualism (both species benefit).

The sun powers all the ecosystems on the earth. The energy flow from the sun to producers and subsequently to consumers is unidirectional. The plants are called producers as they produce food from solar energy and provides to all other organisms. The other organisms that consume producers are called consumers. The consumers can be called primary consumers or secondary consumers depending on their sequence in the chain.

The food chains unite to form a bigger food web. The chain or web shows interdependency of organisms. According to the source of their food, organisms occupy a specific place in the food chain that is called trophic level. Producers belong to the first trophic level and herbivores to the second trophic level and so on. However, only 10 per cent energy is transferred to the next trophic level.

Biodiversity

Our living world is amazingly diverse. Since the history of origin of the life on earth goes back to approximately 3.8 billion years, it has given ample opportunity to the life forms to diversify. This diversification is known as biodiversity. It comprises all the diversity that exists at different levels of biological organisation—macromolecules, cells, tissues, organs, organisms, population, communities, ecosystems and biomes.

Biodiversity gives strength to the life. Biodiversity at the level of genes, species and ecosystems of a region are more significant. The variation of genes in a given species is known as genetic diversity .It gives the population an ability to adapt to the environment and to respond to the forces of natural selection. The species diversity is a measure of the variety of species within a region (number of species per unit area). Ecosystem diversity refers to the number of niches, tropic levels and different ecological processes that sustain the flow of energy, food webs and nutrients cycles.

Some 1.5 million species have been identified and recorded on the planet, however, more than 6 million species are yet to be identified and named. Since the tropics provide most ideal conditions for life to grow, the highest species diversity is found in the tropics which decreases towards the poles. India figures among the 12 countries with mega diversity in the world. The communities with higher diversity are more stable, productive and resistant to biological invasions. Biodiversity is essential for maintenance of ecosystem and their sustainable utilisation. Some of the benefits of biodiversity are given in Table 1.

Table 1
Benefits of Biodiversity

Ecosystem services	Prevention and mitigation	Food security	Medicine
(a) Biodiversity maintains gaseous composition of the atmosphere.	(a) Forests and grassland protect landscapes against erosion, nutrient loss, and landslides.	(a) Biodiversity provides the vast majority of our foodstuff.	(a) Biodiversity is a rich source of substances with therapeutic properties.
(b) Controls climate by forest and oceanic systems.	(b) Ecosystems bordering flooding river reduce the damage caused by floods.	(b) The uniqness of wild biodiversity guards against the failure of agricultural.	(b) It has aesthetic value and cultural significance like ecotourism, bird watching, wildlife, and gardening.
(c) Supports pollination of plants.		(c) Source of new crops and bio-pesticides.	
(d) Soil formation and protection.			
(e) Balancing biogeochemical cycles.			

However, this biological diversity of the planet Earth is on decline due to human activities. It is believed that the earth has already witnessed five episodes of mass extinction of species in the past. Today, nearly 15,500 species worldwide are facing the risk of extinction and with this trend within 100 years the number of the species might be reduced to half.

There are four major causes behind extinction of species – habitat loss, over exploitation, invasion of alien species and co-extinction. The rain forest cover has reduced from 14 per cent of the earth's land surface to its half. Overexploitation by humans is the major reason of species extinction in the recent history of life.

Humans obtain numerous benefits from the nature ranging from food, firewood to medicines and other industrial products. Besides, every species has its unique significance and role. Thus, the nations having rich biodiversity can reap its benefits. Besides, it is a moral responsibility to protect and pass on the biological legacy to the next generations.

The World Conservation Union has attempted to categorise the species according to their risk profile into eight red list categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, lower risk, data deficient, and not evaluated.

Biodiversity conservation has gained importance over time. The conservation strategy may be *in situ* or *ex situ*. In the earlier type of conservation, the endangered species are protected in their natural habitat with a view to protect entire ecosystem. Worldwide, 34 'biodiversity hotspots' have been identified for intensive conservation. The zoos, the gene bank, and germ plasm are examples of *ex situ* conservation.

Forests : The Provider

Forests provide homes to about 300 million people and livelihoods to about 1.6 billion people around the world. Hunter-gatherer, farming, timber, industrial products, etc. are some of the livelihoods associated with forests. Trade in forest products was estimated at $327 billion in 2004.Tropical forests provide a large number of medicinal plants worth about $108 billion a year.

For the rural poor, the forest meets their basic subsistence needs for food, fuel, water and medicine. Growing population is a risk to the healthy forest. However, when forest is managed sustainably it can help in developing forest-based enterprises and services and alleviate poverty of the forest dwellers. Traditional forest related knowledge preserved in the indigenous cultures over centuries is true wealth.

India is endowed with a diverse range of forests. It varies from the forests of Kerala in the South to the alpine pastures of Ladakh, from the desert of Rajasthan in the west to the evergreen forests in the North East. India follows a policy of keeping one-third of the country's total land area under forest and tree cover. These forests sustain a wide range of plant and animal species.

Agronomy: Making Most of Plants Production

With evolution, the agriculture replaced forests as main source of food supplies. The science and technology of producing and using plants is called Agronomy. With the application of agronomic knowledge of irrigation and drainage, crop rotation, plant breeding, soil management, weed and pest control, the production of plants have significantly improved. Biotechnology has helped in promoting and expediting the development of desired traits in plants. It has ensured better food security.

However, water crisis, land degradation, climate change, and different agricultural diseases are posing a threat to achieving food security. Modern technologies have helped increase the food security. Beginning in the late 1960s, the Green Revolution offered much needed solutions to increase the food security. It refers to new researches and development of technologies that increased agricultural production. Application of high-yielding varieties (HYV) of crops, expansion of irrigation facilities, use of new technologies, fertilizers, and pesticides have multiplied the outcomes. As an impact of green revolution, the rice yields in India grew three times to six tons per hectare by the mid 1990s.

Interestingly, the genome of the crops are being altered favourably to address various challenges including water crisis, land degradation and climate change. The crops can be enriched with nutritional values and disease resistance power. Genetically modified foods and fibers are slowly gaining acceptace.

Medicines from Plants

Plants have been depended upon throughout the human history for various cures. Through evolution plants have acquired the ability to produce many compounds to perform various biological functions, including defense against insects, fungi and herbivores. The medicinal properties are basically determined by the secondary metabolites. These are compounds that are not required for normal growth and development but synthesised in specialised cells at particular developmental stages in select medicinal plant species.

A large number of such compounds have been isolated so far. About 25 per cent of the medicines in the global market are sourced from plants. It is assumed that some 25,000 species of plants are used in traditional medicines worldwide which is used by native peoples. It is not known as to how many such medicinal plants are hidden in the forests. Apart from forests, medicinal plants are cultivated on commercial basis to meet the increased demands. Some well known common medicines derived from the plants are listed in Table 2.

The drugs like inulin, quinine, morphine, codeine and digoxin are obtained from the plants. A number of glyco proteins present in Aloevera gel have been reported to have antitumor and antiulcer effects and positive proliferation effect on human dermal cells. The saponins are used in preparation of cosmetics as it tightens the connective tissues.

Table 2
Medicines from Plants

Medicine	Action/Clinical Use	Plant Source
Atropine	Anticholinergic	Atropa belladonna
Codeine	Analgesic, antitussive	Papaversomniferum
Colchicine	Antitumor agent, anti-gout	Colchicum autumnale
Digitoxin	Cardiotonic	Digitalis purpurea
Digoxin	Cardiotonic - used for treatment of atrial fibrillation and heart failure.	Digitalis purpurea
Papain	Proteolytic, mucolytic	Carica papaya
Quinidine	Antiarrhythmic	Cinchona ledgeriana
Quinine	Antimalarial, antipyretic	Cinchona ledgeriana
Salicin	Analgesic	Salix alba
Taxol	First drug of choice in several tumorous cancers including breast cancer.	Pacific Yew tree (Taxusbrevifolia)
Vinblastine	Antitumor, antileukemic agent. The first drug of choice in many forms of leukemia.	Catharanthusroseus (Madagascar Periwinkle)
Vincristine	Antitumor, Antileukemic agent.	Catharanthusroseus

Pollution— a New Age Threat

Pollution has emerged as a new age threat to plants and animals. It is basically an undesirable byproduct of unplanned growth of industry, agriculture and human population. Pollution affects human life, plant productivity besides degrading the ecosystems and modifying climatic patterns. The climate change results in the loss of biodiversity and resilience of all ecosystems, and reduces the productivity of the whole ecosystem (Grimm, et al., 2013). It influences the life cycle of animals, such as migration, blooming, and mating. It also destroys habitats, food webs and increases the risk of extinction of species.

As per the report of World Health Organisation (WHO), around 80 per cent of the urban population are facing poor air quality. The air pollution has been classified as a carcinogenic to humans. The impact of air pollution is huge in terms of health. Outdoor pollution alone is responsible for 1.3 million premature deaths yearly (WHO, 2013).

One of the simplest ways to reduce the effects of pollution is to increase green cover on the planet. The plants provide safe and sustainable solutions to some of the biggest environmental problems.

Phytoremediation — Plant-based Technology

Phytoremediation is a new method for cleaning up pollution and wastes with the help of plants. It is gaining popularity in the waste management field because of its eco-compatibility.

Phytoremediation process enhances the plant's natural uptake capabilities using different strategies.Phytoremediation is used for remediating polluted water, soil and air. In phytoextraction, such hyperaccumulators plants are used which can absorb metallic pollutants from the contaminated sites through the roots and translocate them to the shoots. In Phytostabilisation, those plants are used in which their roots interacts with microbes to immobilise organic and inorganic contaminants by binding them to soil particles and consequently check contaminants from mixing with ground water. In Phytofiltration plant roots absorb or adsorb pollutants from water and aqueous waste streams (Prasad and Freltas, 2003).

Recently scientists have successfully incorporated two genes from bacteria which can consume RDX in two grass species namely switchgrass (Panicumvirgatum) and creeping bentgrass (Agrostisstolonifera). The grasses are capable of removing all the RDX from the soil without retaining any toxic chemical in their leaves or stems. The RDX is a military explosive and a man made pollutant. It causes seizures and organ damage and is known as a potential human carcinogen. The plants could be the only affordable and sustainable solution to cleaning up RDX from polluted sites on world wide scale. Thus, using genetic engineering, the plants can be taught to over express certain genes for phytoremediation.

Role of Treaties and Technologies

The effect of pollution, loss of biodiversity and climate change is felt across the political and geographical boundaries. The management of the same requires an integrated global response. The nations across the globe sign environmental treaties or agreements to find a collective solution for the safety of the

planet and humanity. It has emerged that the principles of common but differentiated responsibilities may help the nations unite towards a common cause.

In 1972, Stockholm, Sweden, hosted the first United Nations Conference on Human Environment. The conference introduced for the first time the idea of relationship between development and environment.

Depletion of ozone layer in stratosphere enveloping the earth was a serious risk some time back. However, as a result of the Montreal Agreement (1987), the production and use of the most of the harmful Ozone Depleting Substances (ODSs) have been phased out globally. For this reason this agreement is known as one of the most successful environmental treaties which mobilised the member states to act in the interests of human safety to protect from severe ozone depletion and an impending hazard (Velders, et al., 2007).

International treaties like Rio Earth Summit (1992), Kyoto Protocol (1997) and Paris Agreement (2015) are major initiatives in this direction. The Convention on Biological Diversity (CBD) or Biodiversity Convention, a multilateral treaty was opened for signature at Rio in 1992 and entered into force in 1993. It aims at biodiversity conservation, its sustainable use, and fair sharing of genetic resources. It has two supplementary agreements as shown in Fig 1.

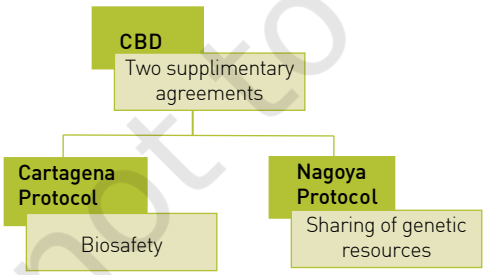

Fig 1. CBD and supplementary agreements

The historic Paris Agreement intends to combat climate change through reducing carbon emission. It aims at keeping the global temperature rise well below 2 degrees Celsius this century and also to strive further for 1.5 degrees Celsius above pre-industrial levels.

USA and Europe have successfully arrested the pollution level. During 1980-2014, the Gross Domestic Product (GDP) of the USA increased 147 per-cent, the population grew by 41 per cent and energy consumption grew 26 per cent. However, during the same period, total emissions of the six major air pollutants reduced by 63 per cent (EPA, 2016). This observation busted the myth that pollution cannot be checked without compromising with the economic growth.

Thus, apart from treaties, the future technologies give immense hope. A breakthrough in storing and transporting energy, improved nuclear safety and biotechnologically modified photosynthesis could change the game plan completely. Ambitious plans of generating green energy as well as increasing the efficiency in the use of energy (like use of LED lights) has successfully helped meet the demands of millions. Thus, the treaties, as well as the technologies have the potential to reduce the burden on the environment and planet.

Conclusions

The plants are indispensable for our existence. For developing sustainably we need to care for the plants and the environment. Educating the society about how to behave responsibly towards the environment is the core of education for sustainable

development. The education inspires in adopting new behaviours and practices to secure the future through addressing a variety of problems.

A small individual step may integrate globally to a sizeable result. Eating locally grown foods may help cut down on energy consumption significantly. If food wastage could be reduced through rational use and better distribution management, 14 per cent emission of the green house gases in 2050 would be avoided. As per an estimate, as much as 30-40 per cent of food produced is never used (Hic, et.al., 2016).

The climate change seems imminent if humankind takes it lying down. The extent of the climate change impacts will also depend on how different regions adapt to climate change. A wide spectrum of adaptation measures may be required to adapt to the climate change ranging from improved town planning to increase green spaces in residential area.The studies are required to develop resilient crops to withstand extreme weather and better health care to make the poor survive the climate shocks. Creation of a carbon sink through additional forest and tree cover may lower the carbon emissions.

World experience shows that adoption of cleaner technologies aid to the low carbon development. Success in cutting of emissions and reversal of pollution trends in certain regions of the world are some of the good signs.

Despite the threat of climate change looming large, the technological development, international treaties, national policies as well as individual efforts are going to bring about major differences. However, all this may begin with developing a new outlook towards the environment and forging a new human–plant relationship.

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'DOUBLE DISPLACEMENT REACTION' IS A MISNOMER IN CHEMISTRY

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The introductory science curriculum deals with physical and chemical changes. Under the chemical changes, various chemical changes/ reaction types, including single displacement and double displacement, are discussed separately. However, on keen observation and analysis, one can conclude that both types can be termed as simply displacement/replacement reactions.

Keywords: School science curriculum, misconception, types of chemical reactions, single and double displacement/replacement, precipitation, neutralization, gas formation

Introduction

School science curriculum worldwide generally includes chemical reactions in which combination, decomposition, displacement (single and double), combustion, etc., are explained. (Soult A , 2020; Encyclopedia.com, 2022)

Single displacement reaction is usually generalized as

$A^+B^- + C \rightarrow C^+B^- + A$

$CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s)$

In this reaction , reactants contain Cu^{2+}, SO_4^{2-} ions and Zn(s) and products Zn^{2+} and SO_4^{2-} and Cu(s). Here only one new product i.e Cu(s) is formed and SO_4^{2-} ion is common in both reactants and products , hence justify the term 'Single-displacement' reaction.

Now let us consider double displacement reaction which is generalized as

$A^+B^- + C^+D^- \rightarrow A^+D^- + C^+B^-$

If we take the following example

$NaNO_3(aq) + KCl(aq) \rightarrow NaCl(aq) + KNO_3(aq)$.....(i)

Here reactants and products both contain Na^+ , NO_3^-, K^+ and Cl^- ions. Hence this is not an example of chemical reaction at all but it's a mixture of ions. In some references (Shriver, 1998; Flexbooks 2.0, 2022)double-displacement/replacement is further classified into the following three types:

1) Precipitation reaction

$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$.....(ii)

In this reaction, a new product, i.e., $BaSO_4(s)$, is formed by replacing the Cl^- ion of $BaCl_2$ with SO_4^{2-} ion from Na_2SO_4. Here Na^+ions and Cl^- ions are present both in the reactants and products. So it should be taken as the example of single displacement/replacement only.

2) Neutralization reaction

$CH_3COOH(aq) + NH_4OH(aq) \rightarrow CH_3COONH_4(aq) + H_2O(l)$.....(iii)

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(aq)$.....(iv)

In reaction (iii), reactants contain undissociatedCH_3COOH / NH_4OH along with CH_3COO^-, OH^-, H^+, and NH_4^+ ions. Products contain CH_3COO^-, $NH4^+$ ions, and undissociated H_2O. So only one new product, i.e., H_2O, is formed. So again, it should be taken as the example of single displacement /replacement only. Similarly, for reaction (iv), only one new product, H_2O, is formed by a single displacement/ replacement process, and Na^+, Cl^- ions are common in both reactants and products.

3) Gas formation reaction

Na2S(aq) + 2HCl(aq)→ H2S(g)+2NaCl(aq) (v)

In this reaction too Na+ and Cl- are common to both reactants and products. A new product H2S(g) is formed by the displacement Cl- by S2- ions.

Conclusion

Looking back to examples (i)-(v), it is clear that all the examples are given under the terminology' double-displacement/ replacement' are basically examples of single displacement/ replacement reaction. Therefore, it is recommended that the term double-displacement/replacement not be used as basic chemical terminology; instead, simply displacement/replacement reaction suffices the purpose.

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SCIENCE NEWS

New Treatment for Severe Asthma

According to Statistics Canada, 8per cent of Canadians aged 12 or older–approximately 2.4 million people–have been diagnosed with asthma. Of that, approximately 25 per cent are considered to be severe cases of asthma.

Current treatments for severe asthma often include high doses of corticosteroids, such as prednisone, to control exacerbations. Reducing the need for corticosteroids with alternative treatments is preferable, since these medications are associated with serious side effects from prolonged use–including multi-organ toxicities and immunosuppression.

Dr Parameswaran Nair, staff respirologist at St. Joseph's Healthcare Hamilton and professor of medicine at McMaster University, along with a team of researchers found that an antibody called dupilumab is effective in treating severe asthma in place of high doses of prednisone. The results were published in the *New England Journal of Medicine*, one of the world's most influential medical publications.

Researchers sought participants who had been using oral corticosteroids (prednisone) to treat severe asthma for at least six months prior to the study. In addition to their standard regimen of corticosteroids, patients received either dupilumab or a placebo during the 24 week trial. The corticosteroid dose was gradually reduced during weeks four to 20, and maintained at a low level for the final four weeks.

"The ability of dupilumab to increase lung function as markedly as it did in this study, even in the face of [corticosteroid] withdrawal, indicates that it appears to be inhibiting key drivers of lung inflammation," the researchers noted.

Dupilumab works to treat asthma by blocking two specific proteins (called interleukin-4 and interleukin-13) that are associated with inflammation of the airways.

This technique was based on Dr Nair's previous work published in the *New England Journal of Medicine* in 2009 and in 2017. Those studies found that blocking another protein, interleukin-5, allowed patients with high

eosinophil levels in their blood and airways to reduce their corticosteroid dose. Eosinophils are a type of white blood cell involved with the production of interleukins. High eosinophil levels are directly linked to an increased risk of severe asthma.

Unlike the previous studies, dupilumab was shown to be effective regardless of patients' eosinophil levels. Despite the reduced prednisone dose, patients in this study not only experienced a decrease in asthma exacerbations, but their lung function also improved significantly.

"Ultimately, our goal is to find new treatment pathways that allow us to circumvent the use of corticosteroids," said Dr Nair. "Since dupilumab showed a significant improvement on asthma control regardless of eosinophil levels, we may be able to use this treatment for a wider range of patients than we previously thought possible. This might be due to the broad effects on inflammation in asthma of the two proteins that we were able to block with dupilumab. The treatment was not associated with any serious side effects."

Dr Nair and his team presented the details of their study at the American Thoracic Society's international conference in San Diego this past week. There, researchers and clinicians from around the world gathered to discuss respiratory illnesses and the latest breakthroughs in treatment.

"This work highlights the clinical and research excellence in pulmonary diseases that exists at St Joseph's and the Firestone Institute," explained Dr Jack Gauldie, vice president (research) at St. Joseph's Healthcare Hamilton and a professor emeritus of McMaster University.

"Dr Nair is one of the world's best clinicians in the field of severe asthma and his studies on modification of immune regulation, targeting two important immune factors, bring an immense impact directly from the lab to the patient in managing this difficult and dangerous form of asthma. We are immensely proud of these advances in pulmonary medicine."

Social Media use Increases Depression and Loneliness, Study Finds

Few prior studies have attempted to show that social-media use harms users' well-being, and those that have either put participants in unrealistic situations or were limited in scope, asking them to completely forego Facebook and relying on self-report data, for example, or conducting the work in a lab in as little time as an hour.

"We set out to do a much more comprehensive, rigorous study that was also more ecologically valid," says Hunt, associate director of clinical training in Penn's Psychology Department.

To that end, the research team, which included recent alumni Rachel Marx and Courtney Lipson and Penn senior Jordyn Young, designed their experiment to include the three platforms most popular with a cohort of undergraduates, and then collected objective usage data automatically tracked by iPhones for active apps, not those running the background.

Each of 143 participants completed a survey to determine mood and well-being at the study's start, plus shared shots of their iPhone

battery screens to offer a week's worth of baseline social-media data. Participants were then randomly assigned to a control group, which had users maintain their typical social-media behaviour, or an experimental group that limited time on Facebook, Snapchat, and Instagram to 10 minutes per platform per day.

For the next three weeks, participants shared iPhone battery screenshots to give the researchers weekly tallies for each individual. With those data in hand, Hunt then looked at seven outcome measures including fear of missing out, anxiety, depression, and loneliness.

"Here's the bottom line," she says. "Using less social media than you normally would leads to significant decreases in both depression and loneliness. These effects are particularly pronounced for folks who were more depressed when they came into the study."

Hunt stresses that the findings do not suggest that 18- to 22-year-olds should stop using social media altogether. In fact, she built the study as she did to stay away from what she considers an unrealistic goal. The work does, however, speak to the idea that limiting screen time on these apps could not hurt.

"It is a little ironic that reducing your use of social media actually makes you feel less lonely," she says. But when she digs a little deeper, the findings make sense. "Some of the existing literature on social media suggests there's an enormous amount of social comparison that happens. When you look at other people's lives, particularly on Instagram, it's easy to conclude that everyone else's life is cooler or better than yours."

Because this particular work only looked at Facebook, Instagram, and Snapchat, it is not clear whether it applies broadly to other social-media platforms. Hunt also hesitates to say that these findings would replicate for other age groups or in different settings. Those are questions she still hopes to answer, including in an upcoming study about the use of dating apps by college students.

Despite those caveats, and although the study did not determine the optimal time users should spend on these platforms or the best way to use them, Hunt says the findings do offer two related conclusions it could not hurt any social-media user to follow.

For one, reduce opportunities for social comparison, she says. "When you're not busy getting sucked into clickbait social media, you're actually spending more time on things that are more likely to make you feel better about your life." Secondly, she adds, because these tools are here to stay, it's incumbent on society to figure out how to use them in a way that limits damaging effects. " In general, I would say, put your phone down and be with the people in your life.

—Melissa G. Hunt is the associate director of clinical training in the Department of Psychology in the School of Arts and Sciences at the University of Pennsylvania.

—Rachel Marx and Courtney Lipson graduated from the University of Pennsylvania in 2018.

—Jordyn Young is a member of the University of Pennsylvania Class of 2019.

Melting Arctic Sea Ice during the Summer of 2018

As sea ice in the Arctic retreats further and melts faster every decade, scientists are racing to understand the vulnerabilities of one of the world's most remote and unforgiving places. A study appearing July 29 in the journal *Heliyon* details the changes that occurred in the Arctic in September of 2018, a year when nearly 10 million kilometres of sea ice were lost over the course of the summer. Their findings give an overview at different timescales of how sea ice has receded over the 40 years of the satellite era and show how the summer's extensive decline is linked to global atmospheric processes as far south as the tropics.

At the peak of its melting season, in July 2018, the Arctic was losing sea ice at a rate of 105,500 square kilometres per day – an area bigger than Iceland or the state of Kentucky. "On the ground, I am sure it would have looked like an excellent summer month in the Arctic, in general, but over the past four decades, September sea-ice loss has accelerated to a rate of 12.8 per cent per decade and 82,300 square kilometres per year," says co-author Avinash Kumar, a senior scientist at the National Centre for Polar and Ocean Research (NCPOR) in India.

The researchers followed the warm water currents of the Atlantic north to the Arctic Ocean and tracked the ice as it subsequently retreated through the Chukchi, East Siberian, Laptev, Kara, and Barents seas. Thanks to higher temporal resolution and greater satellite coverage than had previously been available, they could also measure the ice's decline through variables such as its thickness, concentration, and volume in addition to its extent throughout the Arctic. This dramatic loss of sea ice culminated at the end of the boreal summer, when in September, the ice had been reduced to a mere third of its winter extent.

Then, the team compared the decline to the previous four decades of data. "In the summer of 2018, the loss of sea ice was three times higher than the reported loss at the beginning of the satellite era," says Kumar. "Our study shows that both the minimum sea-ice extent and the warmest September records occurred in the last twelve years."

"Every year, news pops up of a new record of high temperature or fastest loss of sea ice in the Arctic region, but in the global system, each portion of the planet receiving climate feedback will lead to changes in the other parts as well," Kumar says. "If the sea-ice decline continues at this pace, it can have a catastrophic impact by raising air temperatures and slowing down global ocean circulation." These global impacts are partly why he became interested in trying to decipher the mysteries of the polar regions as a doctoral student studying the coastal zone in India. Now, he works at NCPOR, whose scientific programs, he says, are "truly trans-hemispheric, cutting across from north to south."

The researchers also turned their attention to the atmosphere, where they were able to gain insight into the processes that contribute to the loss of Arctic sea ice. They found not only that September of 2018 was the third warmest on record, but that there was a temperature difference within the Arctic itself: the temperature of the air above the Arctic Ocean (~3.5°C) was slightly higher than that of the Arctic land (~2.8°C).

Their findings provide further evidence that ocean warming around the globe has influenced the natural cycle of the wind and pressure patterns in the Arctic. El Niños, or warm phases in long-term temperature cycles stemming from tropical regions, have long been known to drive extreme weather events around the world and are occurring with greater frequency as the world warms. El Niño cycles in the equatorial Pacific Ocean can carry warm air and water from tropical circulations to the Arctic, spurring the sea ice to melt. As the ice retreats, it cascades the Arctic into a positive feedback loop known as Arctic amplification, whereby the reduced ice extent gives way to darker ocean waters that absorb more of the sun's radiation. As it retains more heat, temperatures rise and more ice melts, causing the Arctic region to heat up faster – about four times so – than the rest of the world.

"If the decline of sea ice continues to accelerate at a rate of 13 per cent per decade in September, the Arctic is likely to be free of ice within the next three decades," Kumar says. And just as sea-ice retreat is largely the result of anthropogenic pressures from across the globe, its impacts will be felt worldwide: this work adds to the mounting body of evidence that changes in the Arctic sea ice could be detrimental to weather patterns spanning the globe. He says, "The changes taking place in the Arctic can lead to other changes in lower latitudes, such as extreme weather conditions. The world should be watching tropical countries like India, with our research centre saddled close to the beaches of Goa, and trying to understand– even in a small way–more about climate change and the polar regions."

This work was supported by the National Centre for Polar and Ocean Research, Goa, the Ministry of Earth Science, New Delhi, and the University Grants Commission, New Delhi.

Rainforest Destruction from Gold Mining Hits All-time High in Peru

Small-scale gold mining has destroyed more than 170,000 acres of primary rainforest in the Peruvian Amazon in the past five years, according to a new analysis by scientists at Wake Forest University's Center for Amazonian Scientific Innovation (CINCIA).

That's an area larger than San Francisco and 30 per cent more than previously reported.

"The scale of the deforestation is really shocking,"said Luis Fernandez, executive director of CINCIA and research associate professor in the department of biology. "In 2013, the first comprehensive look at Peruvian rainforest lost from mining showed 30,000 hectares. Five years later, we have found nearly 100,000 hectares of deforested landscape."

The scientists at CINCIA, based in the Madre de Dios region of Peru, have developed a new data fusion method to identify areas destroyed by this small- or artisanal-scale mining. Combining existing CLASlite forest monitoring technology and Global Forest Change data sets on forest loss, this new deforestation detection tool is 20-25 per cent more accurate than those used previously.

Both CLASlite and the Global Forest Map use different kinds of information from light waves to show changes in the landscape. "Combining the two methods gives us really good information about the specific kind of

deforestation we're looking for," said Miles Silman, associate director of science for CINCIA and director of Wake Forest's Center for Energy, Environment, and Sustainability (CEES). Silman has researched biodiversity and ecology in the Western Amazon and Andes for more than 25 years.

Artisanal-scale gold mining has been hard to detect because its aftereffects can masquerade as natural wetlands from a satellite view. But the damage is extensive. Small crews of artisanal miners do not expect to hit the mother lode. Rather, miners set out to collect the flakes of gold in rainforest.

"We're not talking about huge gold veins here," Fernandez said. "But there's enough gold in the landscape to make a great deal of money in a struggling economy. You just have to destroy an immense amount of land to get it."

To get the gold, they strip the land of trees or suck up river sediment, and then use toxic mercury to tease the precious metal out of the dirt. The results are environmentally catastrophic.

"You take out everything aboveground–vast amounts of rainforest – and then you take the soil, run it through a sluice and wash away all that is good in it. What you have left is an alien environment," Silman said. "All the scenery should look like broccoli. It looks like desert."

Artisanal-scale gold mining took root in the Peruvian Amazon in the early 2000s, coinciding with construction of a new modern highway connecting Peru and Brazil. The Interoceanic Highway made Peru's once remote rainforest and protected lands accessible to anyone. Where it used to take two weeks by all-terrain vehicle to travel from Cuzco to Puerto Maldonado, the capital of Madre de Dios, during the rainy season, it now takes only six hours aboard an air-conditioned luxury bus.

Because artisanal-scale gold mining requires no heavy machinery and thus involves minimal outlay, it has provided a revolving-door opportunity for poor workers from the Andean highlands to seek their fortune in Madre de Dios. When they return home, they leave a patchwork of mercury-polluted ponds and sand dunes, the landscape denuded of trees and most other vegetation.

CINCIA has partnered with Peru's Ministry of the Environment to try to understand how the new tool developed by its scientists can be used to identify deforestation caused by artisanal-scale gold mining and take effective action to curb the damage.

"We want to integrate high-quality scientific research into the processes the government is using for environmental conservation in Madre de Dios," Fernandez said. "If they can institutionalize these technological innovations, they can more reliably address threats to the rainforest. You have to respond quickly and you have to respond effectively."

CINCIA scientists also are studying native species that can be used for post-mining reforestation. The 115-acre experiment at CINCIA's headquarters is the largest in the Americas.

Pluto Should Be Reclassified as a Planet, Experts Say

In 2006, the International Astronomical Union, a global group of astronomy experts, established a definition of a planet that

required it to 'clear' its orbit, or in other words, be the largest gravitational force in its orbit.

Since Neptune's gravity influences its neighbouring planet Pluto, and Pluto shares its orbit with frozen gases and objects in the Kuiper belt, that meant Pluto was out of planet status. However, in a new study published online Wednesday in the journal *Icarus*, UCF planetary scientist Philip Metzger, who is with the university's Florida Space Institute, reported that this standard for classifying planets is not supported in the research literature.

Metzger, who is lead author on the study, reviewed scientific literature from the past 200 years and found only one publication – from 1802 – that used the clearing-orbit requirement to classify planets, and it was based on since-disproven reasoning.

He said moons such as Saturn's Titan and Jupiter's Europa have been routinely called planets by planetary scientists since the time of Galileo.

"The IAU definition would say that the fundamental object of planetary science, the planet, is supposed to be defined on the basis of a concept that nobody uses in their research," Metzger said. "And it would leave out the second-most complex, interesting planet in our solar system." "We now have a list of well over 100 recent examples of planetary scientists using the word planet in a way that violates the IAU definition, but they are doing it because it's functionally useful," he said. "It's a sloppy definition," Metzger said of the IAU's definition. "They didn't say what they meant by clearing their orbit. If you take that literally, then there are no planets, because no planet clears its orbit."

The planetary scientist said that the literature review showed that the real division between planets and other celestial bodies, such as asteroids, occurred in the early 1950s when Gerard Kuiper published a paper that made the distinction based on how they were formed.

However, even this reason is no longer considered a factor that determines if a celestial body is a planet, Metzger said.

Study co-author Kirby Runyon, with Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, said the IAU's definition was erroneous since the literature review showed that clearing orbit is not a standard that is used for distinguishing asteroids from planets, as the IAU claimed when crafting the 2006 definition of planets.

"We showed that this is a false historical claim," Runyon said. "It is therefore fallacious to apply the same reasoning to Pluto," he said. Metzger said that the definition of a planet should be based on its intrinsic properties, rather than ones that can change, such as the dynamics of a planet's orbit. "Dynamics are not constant, they are constantly changing," Metzger said. "So, they are not the fundamental description of a body, they are just the occupation of a body at a current era."

Instead, Metzger recommends classifying a planet based on if it is large enough that its gravity allows it to become spherical in shape.

"And that's not just an arbitrary definition," Metzger said. "It turns out this is an important milestone in the evolution of a planetary body, because apparently when it happens, it initiates active geology in the body."

Pluto, for instance, has an underground ocean, a multilayer atmosphere, organic

compounds, evidence of ancient lakes and multiple moons, he said.

"It's more dynamic and alive than Mars," Metzger said. "The only planet that has more complex geology is the earth."

Children's Violent Video Game Play Associated with Increased Physical Aggressive Behaviour

Although most researchers on the subject agree that playing violent video games appears to increase physical aggression, a vocal minority continues to dispute this. To examine issues raised by the counterclaims on this topic, Dartmouth researchers conducted a meta-analysis of 24 studies from around the world from 2010 to 2017 with over 17,000 participants, ages nine to 19 years-old. The studies all examined how violent video game play affected changes in real-world physical aggression over time, ranging from three months to four years. Examples of physical aggression included incidents such as hitting someone or being sent to the principal's office for fighting, and were based on self-reports by children, parents, teachers and peers.

Dartmouth's study examined three specific critiques of the literature on video game play and aggression:

- To address claims that previous meta-analyses overestimate the association of violent video game play and aggression because they include 'non-serious' measures of aggression, this meta-analysis was limited to studies that measured reports of overt, physical aggression over time. Despite this more stringent criterion, findings supported the hypothesis that playing violent games is associated with subsequent increases in physical aggression.
- To investigate claims that effects are often inflated because many studies do not take into account other variables predictive of aggressive behaviour, Dartmouth researchers compared analyses that included or did not include information on such variables and found that taking these data into account had only a minor effect on the size of the observed relation between violent video game play and aggression.
- To evaluate claims that the estimated effect of violent game play on aggression is inflated because of a bias against publishing studies that fail to find a relation of violent game play and aggression, Dartmouth researchers conducted a variety of different tests and found no evidence of publication bias.

In addition to providing evidence that violent video game play is associated with increased aggression over time, the study also reports that this effect appears to be significantly different for various ethnic groups: the largest effect was observed among white participants, with some effect noted among Asians and no effect observed among Hispanics. Although speculative, the authors suggest that this effect may reflect a greater emphasis on maintaining empathy toward victims of aggression among Eastern and Hispanic cultures in contrast to an emphasis on 'rugged individualism' in Western cultures.

"Although no single research project is definitive, our research aims to provide the

most current and compelling responses to key criticisms on this topic. Based on our findings, we feel it is clear that violent video game play is associated with subsequent increases in physical aggression," said lead author Jay G. Hull, the Dartmouth Professor of Psychological and Brain Sciences, and associate dean of faculty for the social sciences at Dartmouth.

"The most notable critic of the violent video game aggression literature conducted studies in primarily Hispanic populations and found no evidence of this association. If all of my studies showed null findings, I too, would be skeptical," said co-author James D. Sargent, the Scott M. and Lisa G. Stuart Professor of Pediatric Oncology and director of the C. Everett Koop Institute at Dartmouth. "I hope our findings prompt skeptics to reevaluate their position, especially since some of our other research indicates that violent video game play may increase deviance with implications for multiple risk behaviours," added Sargent.

The study builds on the research team's growing body of work that investigates the impact of video games on children's behaviour, including the link between mature-rated, risk-glorifying video games and deviant behaviour (e.g., smoking, drinking, and risky sex) and the association between playing these type of video games and reckless driving among teens.

Forensics: New Tool Predicts Eye, Hair and Skin Colour from a DNA Sample of an Unidentified Individual

The tool is designed to be used when standard forensic DNA profiling is not helpful because no reference DNA exists against which to compare the evidence sample.

The HIrisPlex-S DNA test system is capable of simultaneously predicting eye, hair and skin colour phenotypes from DNA. Users, such as law enforcement officials or anthropologists, can enter relevant data using a laboratory DNA analysis tool, and the webtool will predict the pigment profile of the DNA donor.

"We have previously provided law enforcement and anthropologists with DNA tools for eye color and for combined eye and hair color, but skin color has been more difficult," said forensic geneticist Susan Walsh from IUPUI, who co-directed the study. "Importantly, we are directly predicting actual skin color divided into five subtypes – very pale, pale, intermediate, dark and dark to black – using DNA markers from the genes that determine an individual's skin coloration. This is not the same as identifying genetic ancestry. You might say it's more similar to specifying a paint color in a hardware store rather than denoting race or ethnicity."

"If anyone asks an eyewitness what they saw, the majority of time they mention hair color and skin color. What we are doing is using genetics to take an objective look at what they saw," Walsh said.

The innovative high-probability and high-accuracy complete pigmentation profile webtool is available online without charge.

The study, "HIrisPlex-S System for Eye, Hair and Skin Colour Prediction from DNA: Introduction and Forensic Developmental Validation," is published in the peer-reviewed journal *Forensic Science International: Genetics.*

"With our new HIrisPlex-S system, for the first time, forensic geneticists and genetic anthropologists are able to simultaneously generate eye, hair and skin color information

from a DNA sample, including DNA of the low quality and quantity often found in forensic casework and anthropological studies," said Manfred Kayser of Erasmus MC, co-leader of the study.

Synthetic Microorganisms Allow Scientists to Study Ancient Evolutionary Mysteries

Scientists at Scripps Research and their collaborators have created microorganisms that may recapitulate key features of organisms thought to have lived billions of years ago, allowing them to explore questions about how life evolved from inanimate molecules to single-celled organisms to the complex, multicellular lifeforms we see today.

By studying one of these engineered organisms—a bacterium whose genome consists of both ribonucleic acid (RNA) and deoxyribonucleic acid (DNA)—the scientists hope to shed light on the early evolution of genetic material, including the theorized transition from a world where most life relied solely on the genetic molecule RNA to one where DNA serves as the primary storehouse of genetic information.

Using a second engineered organism, a genetically modified yeast containing an endosymbiotic bacterium, they hope to better understand the origins of cellular power plants called mitochondria. Mitochondria provide essential energy for the cells of eukaryotes, a broad group of organisms—including humans—that possesses complex, nucleus-containing cells.

The researchers report engineering the microbes in two papers, one published on 29 October, 2018 in the *Proceedings of the National Academy of Sciences* (PNAS) and another published on 30 August, 2018 in the *Journal of the American Chemical Society* (JACS).

"These engineered organisms will allow us to probe two key theories about major milestones in the evolution of living organisms—the transition from the RNA world to the DNA world and the transition from prokaryotes to eukaryotes with mitochondria," says Peter Schultz, PhD, senior author on the papers and president of Scripps Research. "Access to readily manipulated laboratory models enables us to seek answers to questions about early evolution that were previously intractable."

The origins of life on earth have been a human fascination for millennia. Scientists have traced the arc of life back several billion years and concluded that the simplest forms of life emerged from earth's primordial chemical soup and subsequently evolved over the eons into organisms of greater and greater complexity. A monumental leap came with the emergence of DNA, a molecule that stores all of the information required to replicate life and directs cellular machinery to do its bidding primarily by generating RNA, which in turn directs the synthesis of proteins, the molecular workhorses in cells.

In the 1960s, Carl Woese and Leslie Orgel, along with DNA pioneer Francis Crick, proposed that before DNA, organisms relied on RNA to carry genetic information, a molecule similar to but far less stable than DNA, that can also catalyze chemical reactions like proteins. "In science class, students learn that DNA leads to RNA which in turn leads to proteins—that's a central dogma of biology—but the RNA world hypothesis turns that on its head," says

Angad Mehta, PhD, first author of the new papers and a postdoctoral research associate at Scripps Research. "For the RNA world hypothesis to be true, you have to somehow get from RNA to a DNA genome, yet how that might have happened is still a very big question among scientists."

One possibility is that the transition proceeded through a kind of microbial missing link, a replicating organism that stored genetic information as RNA. For the JACS study, the Scripps Research-led team created Escherichia coli bacteria that partially build their DNA with ribonucleotides, the molecular building blocks typically used to build RNA. These engineered genomes contained up to 50 per cent RNA, thus simultaneously representing a new type of synthetic organism and possibly a throwback to billions of years ago.

Mehta cautions that their work so far has focused on characterizing this *chimeric* RNA-DNA genome and its effect on bacterial growth and replication but hasn't explicitly explored questions about the transition from the RNA world to the DNA world. But, he says, the fact that E. coli with half of its genome comprised of RNA can survive and replicate is remarkable and seems to support the possibility of the existence of evolutionarily transitional organisms possessing hybrid RNA-DNA genomes. The Scripps Research team is now studying how the mixed genomes of their engineered E. coli function and plans to use the bacteria to explore a number of evolutionary questions.

For instance, one question is whether the presence of RNA leads to rapid genetic drift-large changes in gene sequence in a population over time. Scientists theorize that massive genetic drift occurred quickly during early evolution, and the presence in the genome of RNA could help explain how genetic change occurred so quickly.

In the paper published in *PNAS*, the researchers report engineering another laboratory model for an evolutionary milestone thought to have occurred more than 1.5 billion years ago. They created a yeast dependent for energy on bacteria living inside it as a beneficial parasite or 'endosymbiont.' This composite organism will allow them to investigate the ancient origins of mitochondria-tiny, bacteria-like organelles that produce chemical energy within the cells of all higher organisms.

Mitochondria are widely thought to have evolved from ordinary bacteria that were captured by larger, single-celled organisms. They carry out several key functions in cells. Most importantly, they serve as oxygen reactors, using O_2 to make cells' basic unit of chemical energy, the molecule ATP. As crucial as mitochondria are to cells, their origins remain somewhat mysterious, although there are clear hints of descent from a more independent organism, widely assumed to have been a bacterium.

Mitochondria have a double-membrane structure like that of some bacteria, and—again, like bacteria—contain their own DNA. Analyses of the mitochondrial genome suggest that it shares an ancient ancestor with modern Rickettsia bacteria, which can live within the cells of their hosts and cause disease. Stronger support for the bacterial origin of mitochondria theory would come from experiments showing that independent bacteria could indeed be transformed, in an evolution-like progression, into mitochondria-like symbionts. To that end,

the Scripps Research scientists engineered E. coli bacteria that could live in, depend upon, and provide key assistance to, cells of Saccharomyces cerevisiae, also known as baker's yeast.

The researchers started by modifying E. coli to lack the gene encoding thiamin, making the bacteria dependent on the yeast cells for this essential vitamin. At the same time, they added to the bacteria a gene for ADP/ATP translocase, a transporter protein, so that ATP produced within the bacterial cells would be supplied to their yeast—cell hosts—mimicking the central function of real mitochondria. The team also modified the yeast so that their own mitochondria were deficient at supplying ATP. Thus the yeast would be dependent on the bacteria for normal, mitochondria-based ATP production.

The team found that some of the engineered bacteria, after being modified with surface proteins to protect them from being destroyed in the yeast, lived and proliferated in harmony with their hosts for more than 40 generations and appeared to be viable indefinitely. "The modified bacteria seem to accumulate new mutations within the yeast to better adapt to their new surroundings," says Schultz.

With this system established, the team will try to evolve the E. coli to become mitochondria-like organelles. For the new E. coli endosymbiont, adapting to life inside yeast could allow it an opportunity to radically slim its genome. A typical E. coli bacterium, for example, has several thousand genes, whereas mitochondria have evolved a stripped-down set of just 37.

The Scripps Research team rounded out the study with further gene-subtraction experiments, and the results were promising: they found they could eliminate not just the E. coli thiamin gene but also the genes underlying the production of the metabolic molecule NAD and the amino acid serine, and still get a viable symbiosis.

"We are now well on our way to showing that we can delete the genes for making all 20 amino acids, which comprise a significant part of the E. coli genome," says Schultz. "Once we've achieved that, we'll move on to deleting genes for the syntheses of cofactors and nucleotides, and within a few years we hope to be able to get a truly minimal endosymbiotic genome."

The researchers also hope to use similar endosymbiont-host systems to investigate other important episodes in evolution, such as the origin of chloroplasts, light-absorbing organelles that have a mitochondria-like role in supplying energy to plants.

Novel Hiv Vaccine Candidate is Safe and Induces Immune Response in Healthy Adults and Monkeys

New research published in *The Lancet* shows that an experimental HIV-1 vaccine regimen is well-tolerated and generated comparable and robust immune responses against HIV in healthy adults and rhesus monkeys. Moreover, the vaccine candidate protected against infection with an HIV-like virus in monkeys.

Based on the results from this phase 1/2a clinical trial that involved nearly 400 healthy adults, a phase 2b trial has been initiated in southern Africa to determine the safety and efficacy of the HIV-1 vaccine candidate in 2,600 women at risk for acquiring HIV. This

is one of only five experimental HIV-1 vaccine concepts that have progressed to efficacy trials in humans in the 35 years of the global HIV/AIDS epidemic.

Previous HIV-1 vaccine candidates have typically been limited to specific regions of the world. The experimental regimens tested in this study are based on 'mosaic' vaccines that take pieces of different HIV viruses and combine them to elicit immune responses against a wide variety of HIV strains.

"These results represent an important milestone. This study demonstrates that the mosaic Ad26 prime, Ad26 plus gp140 boost HIV vaccine candidate induced robust immune responses in humans and monkeys with comparable magnitude, kinetics, phenotype, and durability and also provided 67 Per cent protection against viral challenge in monkeys," says Professor Dan Barouch, Director of the Center for Virology and Vaccine Research at Beth Israel Deaconess Medical Center and Professor of Medicine at Harvard Medical School, Boston, USA who led the study.

He adds: "These results should be interpreted cautiously. The challenges in the development of an HIV vaccine are unprecedented, and the ability to induce HIV-specific immune responses does not necessarily indicate that a vaccine will protect humans from HIV infection. We eagerly await the results of the phase 2b efficacy trial called HVTN705, or 'Imbokodo', which will determine whether or not this vaccine will protect humans against acquiring HIV."

Almost 37 million people worldwide are living with HIV/AIDS, with an estimated 1.8 million new cases every year. A safe and effective preventative vaccine is urgently needed to curb the HIV pandemic.

In the 35 years of the HIV epidemic, only four HIV vaccine concepts have been tested in humans, and only one has provided evidence of protection in an efficacy trial — a canarypox vector prime, gp120 boost vaccine regimen tested in the RV144 trial in Thailand lowered the rate of human infection by 31 Per cent but the effect was considered too low to advance the vaccine to common use.

A key hurdle to HIV vaccine development has been the lack of direct comparability between clinical trials and preclinical studies. To address these methodological issues, Barouch and colleagues evaluated the leading mosaic adenovirus serotype 26 (Ad26)-based HIV-1 vaccine candidates in parallel clinical and pre-clinical studies to identify the optimal HIV vaccine regimen to advance into clinical efficacy trials.

The APPROACH trial recruited 393 healthy, HIV-uninfected adults (aged 18-50 years) from 12 clinics in east Africa, South Africa, Thailand, and the USA between February 2015 and October 2015. Volunteers were randomly assigned to receive either one of seven vaccine combinations or a placebo, and were given four vaccinations over the course of 48 weeks.

To stimulate, or 'prime', an initial immune response, each volunteer received an intramuscular injection of Ad26.Mos.HIV at the start of the study and again 12 weeks later. The vaccine containing 'mosaic' HIV Env/Gag/Pol antigens was created from many HIV strains, delivered using a nonreplicating common-cold virus (Ad26).

To 'boost' the level of the body's immune response, volunteers were given two additional vaccinations at week 24 and 48 using various combinations of Ad26.Mos.HIV or a different vaccine component called Modified Vaccinia Ankara (MVA) with or without two different doses of clade C HIV gp140 envelope protein containing an aluminium adjuvant.

Results showed that all vaccine regimens tested were capable of generating anti-HIV immune responses in healthy individuals and were well tolerated, with similar numbers of local and systemic reactions reported in all groups, most of which were mild-to-moderate in severity. Five participants reported at least one vaccine-related grade 3 adverse event such as abdominal pain and diarrhea, postural dizziness, and back pain. No grade 4 adverse events or deaths were reported.

In a parallel study, the researchers assessed the immunogenicity and protective efficacy of the same Ad26-based mosaic vaccine regimens in 72 rhesus monkeys using a series repeated challenges with simian-human immunodeficiency virus (SHIV) – a virus similar to HIV that infects monkeys.

The Ad26/Ad26 plus gp140 vaccine candidate induced the greatest immune responses in humans and also provided the best protection in monkeys–resulting in complete protection against SHIV infection in two-thirds of the vaccinated animals after six challenges.

The authors note several limitations, including the fact that that the relevance of vaccine protection in rhesus monkeys to clinical efficacy in humans remains unclear. They also note that there is no definitive immunological measurement that is known to predict protection against HIV-1 in humans.

Writing in a linked Comment, Dr George Pavlakis and Dr Barbara Felber from the National Cancer Institute at Frederik, Maryland, USA say: "Efficacy studies are necessary to determine protective ability in humans and also for the discovery of correlates of protection and for determining whether the same or different immune correlates apply for different vaccine regimens. It remains to be determined whether improved efficacy over RV144 will be achieved by either of the present efficacy trials (NCT02968849; NCT03060629). New vaccine concepts and vectors are in development and can progress to efficacy trials, which is an important process since development of an AIDS vaccine remains urgent. Despite unprecedented advances in HIV treatment and prophylaxis, the number of people living with HIV infection continues to increase worldwide. Implementation of even a moderately effective HIV vaccine together with the existing HIV prevention and treatment strategies is expected to contribute greatly to the evolving HIV/AIDS response. It is therefore essential that a commitment to pursue multiple vaccine development strategies continues at all stages."

This study was funded by Janssen Vaccines and Prevention BV, US National Institutes of Health, Ragon Institute of MGH, MIT and Harvard, Henry M Jackson Foundation for the Advancement of Military Medicine, US Department of Defense, and International AIDS Vaccine Initiative.

Viruses – Lots of Them – are Falling from the Sky

An astonishing number of viruses are circulating around the earth's atmosphere – and falling from it – according to new research from scientists in Canada, Spain and the U.S.

The study marks the first time scientists have quantified the viruses being swept up from the earth's surface into the free troposphere, that layer of atmosphere beyond earth's weather systems but below the stratosphere where jet airplanes fly. The viruses can be carried thousands of kilometres there before being deposited back onto the earth's surface.

"Every day, more than 800 million viruses are deposited per square metre above the planetary boundary layer – that's 25 viruses for each person in Canada," said University of British Columbia virologist Curtis Suttle, one of the senior authors of a paper in the International Society for Microbial Ecology Journal that outlines the findings.

"Roughly 20 years ago we began finding genetically similar viruses occurring in very different environments around the globe," says Suttle "This preponderance of long-residence viruses travelling the atmosphere likely explains why it is quite conceivable to have a virus swept up into the atmosphere on one continent and deposited on another.

Bacteria and viruses are swept up in the atmosphere in small particles from soil-dust and sea spray.

Suttle and colleagues at the University of Granada and San Diego State University wanted to know how much of that material is carried up above the atmospheric boundary layer above 2,500 to 3,000 metres. At that altitude, particles are subject to long-range transport unlike particles lower in the atmosphere.

Using platform sites high in Spain's Sierra Nevada Mountains, the researchers found billions of viruses and tens of millions of bacteria are being deposited per square metre per day. The deposition rates for viruses were nine to 461 times greater than the rates for bacteria.

"Bacteria and viruses are typically deposited back to earth via rain events and Saharan dust intrusions. However, the rain was less efficient removing viruses from the atmosphere," said author and microbial ecologist Isabel Reche from the University of Granada.

The researchers also found the majority of the viruses carried signatures indicating they had been swept up into the air from sea spray. The viruses tend to hitch rides on smaller, lighter, organic particles suspended in air and gas, meaning they can stay aloft in the atmosphere longer.

Leg Exercise is Critical to Brain and Nervous System Health

In a new take on the exercise truism 'use it, or lose it,' researchers show neurological health is an interactive relationship with our muscles and our world.

Ground breaking research shows that neurological health depends as much on signals sent by the body's large, leg muscles to the brain as it does on directives from the brain to the muscles. Published today in *Frontiers in Neuroscience*, the study

fundamentally alters brain and nervous system medicine – giving doctors new clues as to why patients with motor neuron disease, multiple sclerosis, spinal muscular atrophy and other neurological diseases often rapidly decline when their movement becomes limited.

"Our study supports the notion that people who are unable to do load-bearing exercises – such as patients who are bed–ridden, or even astronauts on extended travel–not only lose muscle mass, but their body chemistry is altered at the cellular level and even their nervous system is adversely impacted," says Dr Raffaella Adami from the Università degli Studi di Milano, Italy.

The study involved restricting mice from using their hind legs, but not their front legs, over a period of 28 days. The mice continued to eat and groom normally and did not exhibit stress. At the end of the trial, the researchers examined an area of the brain called the sub-ventricular zone, which in many mammals has the role of maintaining nerve cell health. It is also the area where neural stem cells produce new neurons.

Limiting physical activity decreased the number of neural stem cells by 70 per cent compared to a control group of mice, which were allowed to roam. Furthermore, both neurons and oligodendrocytes – specialized cells that support and insulate nerve cells – didn't fully mature when exercise was severely reduced.

The research shows that using the legs, particularly in weight-bearing exercise, sends signals to the brain that are vital for the production of healthy neural cells, essential for the brain and nervous system. Cutting back on exercise makes it difficult for the body to produce new nerve cells – some of the very building blocks that allow us to handle stress and adapt to challenge in our lives.

"It is no accident that we are meant to be active: to walk, run, crouch to sit, and use our leg muscles to lift things," says Adami. "Neurological health is not a one-way street with the brain telling the muscles 'lift,' 'walk,' and so on."

The researchers gained more insight by analyzing individual cells. They found that restricting exercise lowers the amount of oxygen in the body, which creates an anaerobic environment and alters metabolism. Reducing exercise also seems to impact two genes, one of which, CDK5Rap1, is very important for the health of mitochondria – the cellular powerhouse that releases energy the body can then use. This represents another feedback loop.

These results shed light on several important health issues, ranging from concerns about cardio-vascular impacts as a result of sedentary lifestyles to insight into devastating diseases, such as spinal muscular atrophy (SMA), multiple sclerosis, and motor neuron disease, among others.

"I have been interested in neurological diseases since 2004," says co-author Dr Daniele Bottai, also from the Università degli Studi di Milano. "The question I asked myself was: is the outcome of these diseases due exclusively to the lesions that form on the spinal cord in the case of spinal cord injury and genetic mutation in the case of SMA, or is the lower capacity for movement the critical factor that exacerbates the disease?"

This research demonstrates the critical role of movement and has a range of potential implications. For example, missions to send astronauts into space for months or even years should keep in mind that gravity and load-bearing exercise play an important role in maintaining human health, say the researchers.

"One could say our health is grounded on earth in ways we are just beginning to understand," concludes Bottai.

Engineering a Plastic-eating Enzyme

Scientists have engineered an enzyme which can digest some of our most commonly polluting plastics, providing a potential solution to one of the world's biggest environmental problems.

The discovery could result in a recycling solution for millions of tonnes of plastic bottles, made of polyethylene terephthalate, or PET, which currently persists for hundreds of years in the environment.

The research was led by teams at the University of Portsmouth and the US Department of Energy's National Renewable Energy Laboratory (NREL) and is published in *Proceedings of the National Academy of Sciences* (PNAS).

Professor John McGeehan at the University of Portsmouth and Dr Gregg Beckham at NREL solved the crystal structure of PETase – a recently discovered enzyme that digests PET – and used this 3D information to understand how it works. During this study, they inadvertently engineered an enzyme that is even better at degrading the plastic than the one that evolved in nature.

The researchers are now working on improving the enzyme further to allow it to be used industrially to break down plastics in a fraction of the time.

Professor McGeehan, Director of the Institute of Biological and Biomedical Sciences in the School of Biological Sciences at Portsmouth, said: "Few could have predicted that since plastics became popular in the 1960s huge plastic waste patches would be found floating in oceans, or washed up on once pristine beaches all over the world.

"We can all play a significant part in dealing with the plastic problem, but the scientific community who ultimately created these 'wonder-materials', must now use all the technology at their disposal to develop real solutions."

The researchers made the breakthrough when they were examining the structure of a natural enzyme which is thought to have evolved in a waste recycling centre in Japan, allowing a bacterium to degrade plastic as a food source.

PET, patented as a plastic in the 1940s, has not existed in nature for very long, so the team set out to determine how the enzyme evolved and if it might be possible to improve it.

The goal was to determine its structure, but they ended up going a step further and accidentally engineered an enzyme which was even better at breaking down PET plastics.

"Serendipity often plays a significant role in fundamental scientific research and our discovery here is no exception," Professor McGeehan said.

"Although the improvement is modest, this unanticipated discovery suggests that there

is room to further improve these enzymes, moving us closer to a recycling solution for the ever-growing mountain of discarded plastics."

The research team can now apply the tools of protein engineering and evolution to continue to improve it.

The University of Portsmouth and NREL collaborated with scientists at the Diamond Light Source in the United Kingdom, a synchrotron that uses intense beams of X-rays 10 billion times brighter than the sun to act as a microscope powerful enough to see individual atoms.

Using their latest laboratory, beamline I23, an ultra-high-resolution 3D model of the PETase enzyme was generated in exquisite detail.

Professor McGeehan said: "The Diamond Light Source recently created one of the most advanced X-ray beamlines in the world and having access to this facility allowed us to see the 3D atomic structure of PETase in incredible detail. Being able to see the inner workings of this biological catalyst provided us with the blueprints to engineer a faster and more efficient enzyme."

Chief Executive of the Diamond Light Source, Professor Andrew Harrison, said: "With input from five institutions in three different countries, this research is a fine example of how international collaboration can help make significant scientific breakthroughs.

"The detail that the team were able to draw out from the results achieved on the I23 beamline at Diamond will be invaluable in looking to tailor the enzyme for use in large-scale industrial recycling processes. The impact of such an innovative solution to plastic waste would be global. It is fantastic that UK scientists and facilities are helping to lead the way."

With help from the computational modelling scientists at the University of South Florida and the University of Campinas in Brazil, the team discovered that PETase looks very similar to a cutinase, but it has some unusual features including a more open active site, able to accommodate human-made rather than natural polymers. These differences indicated that PETase may have evolved in a PET-containing environment to enable the enzyme to degrade PET. To test that hypothesis, the researchers mutated the PETase active site to make it more like a cutinase.

And that was when the unexpected happened – the researchers found that the PETase mutant was better than the natural PETase in degrading PET.

Significantly, the enzyme can also degrade polyethylene furandicarboxylate, or PEF, a bio-based substitute for PET plastics that is being hailed as a replacement for glass beer bottles.

Professor McGeehan said: "The engineering process is much the same as for enzymes currently being used in bio-washing detergents and in the manufacture of biofuels – the technology exists and it's well within the possibility that in the coming years we will see an industrially viable process to turn PET and potentially other substrates like PEF, PLA, and PBS, back into their original building blocks so that they can be sustainably recycled."

The paper's lead author is postgraduate student jointly funded by the University of Portsmouth and NREL, Harry Austin.

He said: "This research is just the beginning and there is much more to be done in this area. I am delighted to be part of an international team that is tackling one of the biggest problems facing our planet."

New Smart Contact Lens for Diabetics Introduced

This breakthrough has been jointly conducted by Professor Jang-Ung Park in the School of Materials Science and Engineering and Professor Franklin Bien in the School of Electrical and Computer Engineering at UNIST in collaboration with Professor Jung Heon Lee in the School of Advanced Materials Science and Engineering at Sungkyunkwan University.

According to the research team, this innovative smart lens with built-in pliable, transparent electronics can monitor glucose levels from tears in the eye. The device has not yet been tested in humans. However, the research team expects that the release of this device will offer diabetics a pain-free way to measure their glucose levels with the blink of an eye. Their findings have been published in *Science Advances* on 25 January, 2018.

For patients with diabetes, monitoring and controlling blood sugar levels are extremely important because having high blood glucose levels for extended periods of time can lead to a host of diabetes complications. An enzyme based finger-pricking method is the most commonly used technology in diabetic assessment. However, such approach has been said to reduce compliance among diabetic patients.

In the last several decades, many attempts have been made to monitor glucose levels in tears with smart contact lenses, but they are often not used due to poor wearability.

To solve contact lens discomfort issues, Professor Park and his research team have unveiled a new smart contact lens that uses electrodes made up of highly stretchable and transparent materials. This clear, flexible lens also contains a glucose sensor that sends electrical signals to an LED. With this sensor, patients can transmit their health information in real-time using the embedded wireless antenna in the lens. Electric power that activates the LED pixel and the glucose sensor is wirelessly transmitted to the lens through the antenna. After detecting the glucose concentration in tear fluid above the threshold, this LED pixel turns off.

In the study, the research team has successfully tested their prototype lens on a live rabbit via non-invasive in-vivo testing. The rabbit showed no signs of abnormal behaviour during repeated eye blinks and the LED pixel turned off when tear fluids with glucose concentration was over the threshold. In addition, during the wireless operations, this smart contact lens could still maintain the eye temperature stably without abrupt heating.

"These smart contact lenses are made of transparent nanomaterials and therefore do not obstruct the wearer's view," says Jihun Park in the Combined M.S./Ph.D. of Materials Science and Engineering, the first author of the study. "Besides, because the system uses wireless antenna to read sensor information, no separate power source, like battery is required for the smart contact lens sensors."

"The in vivo tests using a live rabbit ... provided the substantial promise of future smart contact lenses for noninvasive health care monitoring using human eyes and tears," says the research team.

"Our smart contact lens provides a platform for wireless, continuous, and noninvasive monitoring of physiological conditions, as well as the detection of biomarkers associated with ocular and other diseases," says Professor Park. "It also offers the potential for expanded applicability in other areas, such as smart devices for drug delivery and augmented reality."

He adds, "We are now a step closer to the implementation of a fictional idea for a smart contact lens in the films, like "Minority Report" and "Mission: Impossible."

Ecosystems Are Getting Greener in the Arctic

Researchers develop technique to better predict how plants in cold regions respond to warming

In recent decades, scientists have noted a surge in Arctic plant growth as a symptom of climate change. But without observations showing exactly when and where vegetation has bloomed as the world's coldest areas warm, it is difficult to predict how vegetation will respond to future warming. Now, researchers at the U S Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) and UC Berkeley have developed a new approach that may paint a more accurate picture of Arctic vegetation and our climate's recent past – and future.

In a study published online on 20 August in *Nature Climate Change*, the researchers used satellite images taken over the past 30 years to track – down to a pixel representing approximately 25 square miles – the ebb and flow of plant growth in cold areas of the northern hemisphere, such as Alaska, the Arctic region of Canada, and the Tibetan Plateau.

The 30-year historic satellite data used in the study were collected by the National Oceanic and Atmospheric Administration's Advanced Very High Resolution Radiometre. The data was processed by Boston University, and is hosted on NEX – the NASA Earth Exchange data archive.

At first, the satellite data showed what they expected – that as Arctic climates warmed, tree and plant growth increased. After comparing these observations with state-of-the-art climate models developed for CMIP5 – the Coupled Model Intercomparison Project Phase 5 – what they discovered next surprised them.

Their data analysis revealed that 16 per cent of earth's vegetated land where plant growth was limited by cold temperatures three decades ago is no longer predominantly temperature-limited today, a result that was not reproduced by the CMIP5 models tested. "Our findings suggest that CMIP5's predictions may have significantly underestimated changes in the Arctic ecosystem, and climate models will need to be improved to better understand and predict the future of the Arctic," said first author Trevor Keenan, a faculty scientist in Berkeley Lab's Earth and Environmental Sciences Area and an assistant professor in UC Berkeley's department of Environmental Science, Policy, and Management.

Keenan and Riley used the satellite data to build a new observational benchmark that quantifies the growing expanse of vegetated land in the northern hemisphere. They also estimated changes in the proportion of the

earth's surface where plant growth will no longer be limited by cold temperatures over the 21st century. Keenan and Riley project that by the year 2100, only 20 per cent of vegetated land in the northern hemisphere will still be limited by cold conditions that have been in place there for centuries; the remaining 80 per cent will no longer experience sufficiently cold temperatures, and with earlier springs, plants will grow sooner, in unexpected places and to an unexpected degree.

"Although the greening might sound like good news as it means more carbon uptake and biomass production, it represents a major disruption to the delicate balance in cold ecosystems," said Keenan. "Temperatures will warm sufficiently so that new species of trees could move in and compete with vegetation that had previously dominated the landscape. This change in vegetation would also affect insects and animals that relied on native vegetation for food."

Scientists collaborating through the World Climate Research Programme developed the CMIP5 models to help researchers around the world gain a better understanding of the relationship between carbon emissions and global warming, among other goals. International consortiums such as the IPCC (International Panel on Climate Change) have also used CMIP5 projections to inform policy decisions. Keenan said that while the CMIP5 models provided researchers with a broad overview of the problem, they do not always accurately represent the important roles plants play in reflecting light back into the atmosphere, sending water back into the atmosphere, and absorbing carbon dioxide.

"No one has looked at high-latitude systems from this angle before as they are very complex, but they're important as they control multiple feedbacks to the earth system," said co-author William Riley, a senior scientist in Berkeley Lab's Earth and Environmental Sciences Area.

Now that Keenan and Riley have established a standard approach for assessing climate models, they plan to explore how they can use more advanced statistical techniques, such as machine learning, to quantify how soil organic matter properties, atmospheric carbon dioxide, wildland fires, and temperature, will affect climate in the 21st century.

Southern California Coast Emerges as a Toxic Algae Hot Spot

New research shows domoic acid from ocean algae is a growing problem

A new, comprehensive survey led by USC scientists shows the Southern California coast harbors some of the world's highest concentrations of an algal toxin dangerous to wildlife and people who eat local seafood.

Episodic outbreaks of algae-produced toxins make headlines every few years when stricken marine animals wash ashore between Santa Barbara and San Diego. The USC research is the most thoroughgoing assessment yet and reveals the growing scale of the problem over the last 15 years. The researchers say their findings can help protect human health and environment by improving methods to monitor and manage harmful algal blooms.

The findings are a 'smoking gun' linking domoic acid produced by some types of algae to deaths of marine birds and mammals, according to David Caron, a biologist at the

USC Dornsife College of Letters, Arts and Sciences, and postdoctoral researcher Jayme Smith, the study's main authors.

"We are seeing an increase in harmful algal blooms and an increase in severity," Caron said. "The Southern California coast really is a hot spot and our study also shows that the concentrations of particulate domoic acid measured in the region are some of the highest – if not the highest – ever reported." The findings appear in *Harmful Algae*.

Domoic acid is produced by microscopic Pseudo-nitzschia, needle-like diatoms in the water; half of the species in its genus can produce the neurotoxin. It can stain the ocean, a condition generically called 'red tide,' although this particular toxin is brown. The substance accumulates in shellfish and moves up the food chain, where it attacks the nervous system of fish, birds, seals and sea lions. It can cause amnesic shellfish poisoning (ASP) in people. ASP symptoms include rapid onset of headaches, abdominal pain, cramping, nausea or vomiting; severe symptoms include permanent short-term memory loss, seizures, coma or shock in 48 hours. Although human fatalities are rare, the California Department of Public Health monitors coastal waters and shellfish for the toxin.

The research encompasses the years 2003 to 2017 between Santa Barbara and the Mexico border, and includes new samples and tests collected over the past three years to supplement historical data. The study suggests that while natural processes lead to the formation of blooms, they could be exacerbated by nutrients discharged from human-made sources, including runoff and sewage outfalls.

Among the key findings:

- Pseudo-nitzschia is the culprit behind domoic acid. It's been present along the Southern California coast for decades, but its role in wildlife mortality is recent and increasing.
- The world's highest domoic acid measurement in water occurred near San Pedro in March 2011. It was 52.3 micrograms per litre – about five times higher than a level of concern.
- Through the years, researchers found a strong correlation between domoic acid in the water and impaired marine wildlife on shore.
- Domoic acid is ever-present offshore, either in shellfish or the water. Some years it is abundant, while other years it is scarce.
- Conditions are worse in the spring, due to seasonal upwelling of nutrients that spur plankton growth. The toxin is less abundant in the summer and winter.
- Domoic acid in shellfish can occur at high concentrations off the coast of San Diego, Orange and Los Angeles counties, but it tends to be more prevalent in Ventura and Santa Barbara counties due to local environmental conditions.
- Man-made sources of nutrients contribute to algal blooms, but that does not explain disparities in time and location of some of the domoic acid outbreaks. Other environmental factors are likely in play.
- The algae and its toxin diminish on the West Coast when water temperatures

exceed 68 degrees Fahrenheit, apparently due to temperature sensitivity of the microorganisms.

Also, a warming Pacific Ocean appears to be helping spread Pseudo-nitzschia species farther north. For example, harmful algal blooms have been widespread along the west coast of North America from Central California to Alaska in the past two years, according to the study. Separately, harmful algae blooms have been reported along the Gulf Coast this summer and the governor of Florida declared a state of emergency for affected counties last week.

The USC study brings together diverse data and observations that shed light on the environmental conditions that promote harmful algal blooms. Of note, an extreme drought across the US. Southwest between 2014 and 2016 resulted in very low concentrations of domoic acid off the Southern California coast. The findings imply a link between surface waters flowing to the ocean, or other drought-related conditions, and coastal algal blooms.

Those nuances and uncertainties need further exploration to explain the regional and year-to-year variations favouring toxic algae – key steps before more reliable health forecasts can occur, the USC scientists say.

"Our findings summarize our present level of understanding with respect to this important animal and human health risk in Southern California waters and identify several avenues of research that might improve understanding, prediction and eventually prevention of these harmful events," Smith said.

Source: *Science Daily Online*

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.

- http://www.earthtimes.org/

  This website covers news and issues affecting the environment, education, society, business, culture, media, nature, politics, and population.

- https://www.nwf.org/

  This website focuses its efforts on five core issue areas: Endangered Habitat, Water Quality, Land Stewardship, Wetlands, and Sustainable Communities.

- https://grist.org/

  Grist is an online magazine which focuses on environmental news and commentary, with a humorous and ironic twist. A veteran in the environmental media landscape since 1999, Grist covers a myriad of topics from politics and business to food and climate.

- https://bookriot.com/

  This website is largest independent editorial book site in North America, and home to a host of media, from podcasts to newsletters to original content, all designed around diverse readers and across all genres.

- https://saveourenvironment.org/

  This website's goal is to increase public awareness of environmental issues. Press releases, reports, and fact sheets expose environmental issues.

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To Our Contributors

School Science is a journal published quarterly by the National Council of Educational Research and Training, New Delhi. It aims at bringing within easy reach of teachers and students the recent developments in science and mathematics and their teaching, and serves as a useful forum for the exchange of readers' views and experiences in science and mathematics education and science projects.

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Published by the Head, Publication Division, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016 and printed at Chaar Dishayen Printers (P) Ltd., G 40-41, Sector-3, NOIDA 201 301 (UP)

R.N. 7455/63

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Journal of Indian Education A Quarterly Journal of Education	₹45.00	180.00
भारतीय आधुनिक शिक्षा (त्रैमासिक) (Bhartiya Aadhunik Shiksha) A Quarterly Journal in Hindi	₹50.00	200.00
Primary Teacher A Quarterly Journal for Primary Teachers	₹65.00	260.00
प्राथमिक शिक्षक (त्रैमासिक) (Prathmik Shikshak) A Quarterly Journal in Hindi for Primary Teachers	₹65.00	260.00

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