

EVERYMAN'S SCIENCE

Vol. LII No. 3 (August'17 - September'17)

EDITORIAL ADVISORY BOARD

- Dr. Surendra Kumar Singh** (*Nagpur*)
Prof. Poduri Nagaraja Rao (*Hyderabad*)
Dr. Rakesh Kumar Srivastava (*Navi Mumbai*)
Prof. K. S. Rangappa (*Mysore*)
Dr. Devesh Walia (*Shillong*)
Dr. Arunkanti Biswas (*Kolkata*)
Dr. Subrat Sharma (*Almora*)
Dr. M. Sundaresan (*Coimbatore*)
Prof. Dinesh Kumar (*Faridabad*)
Dr. M. Xavier James Raj (*Thiruvananthapuram*)
Prof. Anup Kumar Bhattacharya
(*Kishanganj*)
Prof. V. Ravishankar Rai (*Mysore*)
Prof. Manisha Gupta (*Lucknow*)
Dr. Akhilesh Kumar Pandey (*Bhopal*)

COVER PHOTOGRAPHS

Past General Presidents of ISCA

- 1. Prof. Asis Datta** (2004)
- 2. Prof. N.K. Ganguly** (2005)
- 3. Dr. I.V. Subba Rao** (2006)
- 4. Prof. Harsh Gupta** (2007)
- 5. Prof. R. Ramamurthi** (2008)
- 6. Dr. T. Ramasami** (2009)

For permission to reprint or reproduce any portion of the journal, please write to the Editor-in-Chief.

EDITORIAL BOARD

Editor-in-Chief

Dr. Ashok Kumar Saxena

Area Editors

Dr. (Mrs.) Vijay Laxmi Saxena
(*Biological Sciences*)

Prof. Arun Kumar
(*Earth Sciences*)

Dr. Manoj Kumar Chakrabarti
(*Medical Sciences including Physiology*)

Prof. H.P. Tiwari
(*Physical Sciences*)

Dr. Rashmi Sinha
(*Social Sciences*)

General Secretary (Membership Affairs)
Prof. Gangadhar

General Secretary (Scientific Activities)
Prof. Premendu P. Mathur

Editorial Secretary

Dr. Amit Krishna De

Printed and published by Dr. Ashok Kumar Saxena on behalf of Indian Science Congress Association and printed at T. C. Dutta Merchants Pvt. Ltd., P-23/24, Radha Bazar Street, Kolkata - 700 001 and published at Indian Science Congress Association, 14, Dr. Biresw Guha Street, Kolkata - 700 017, with Dr. Ashok Kumar Saxena as Editor.

Annual Subscription : (6 issues)

Institutional ₹ 500/- ; Individual ₹ 300/-

Price: ₹ 20/- per issue

CONTENTS

EDITORIAL :

Kinanthropometry in Anthropology

Rashmi Sinha

148

ARTICLES :

E-revolution: An Approach to Qualitative E-content and E-learning

Anjali Sharma and Neha Rawat

150

Mobile App: A Potential Tool for Enhancing Research Impact in Far Flung Areas and Rural Sector

Atul, Pranshuta, Chander Mohan and Rashmi Sharma

166

Nano Food Fortification

T. Kathiravan, Moses J. A. and C. Anandharamakrishnan

171

Sustainable Sugarcane Initiative (SSI) - The Choicest Method of Sugarcane Cultivation in India

G. Mani, D.Thirusendura Selvi and S. Utharasu

176

Scientific Story of Our Laughter, Crying and Stress

Nivedita Acharjee

186

Calcium and Vitamin D through Diet for Healthy Bones

Mithun Rudrapal and Dipak Chetia

190

Consumption of Heavy Metals Contaminated Vegetables: A Threat to Human Health

Anupa Yadav

196

KNOW THY INSTITUTIONS

200

CONFERENCES / MEETINGS / SYMPOSIA / SEMINARS

202

S & T ACROSS THE WORLD

205

ISCA PRESIDENTIAL ADDRESS (2004 TO 2009)

| President | Title of Presidential Address* |
|---|--|
| Prof. Asis Datta 91 st Indian Science Congress 2004, Chandigarh | Science and Society in the Twenty First Century: Quest for Excellence |
| Prof. N.K. Ganguly 92 nd Indian Science Congress 2005, Ahmedabad | Health Technology as Fulcrum of Development for the Nation |
| Dr. I.V. Subba Rao 93 rd Indian Science Congress 2006, Hyderabad | Integrated Rural Development: Science and Technology |
| Prof. Harsh Gupta 94 th Indian Science Congress 2007, Annamalainagar | Planet Earth |
| Prof. R. Ramamurthi 95 th Indian Science Congress 2008, Visakhapatnam | Knowledge based Society using Environmentally Sustainable Science and Technology |
| Dr. T. Ramasami 96 th Indian Science Congress 2009, Shillong | Science Education and Attraction of talent for Excellence in Research |

* Available in the Book "The Shaping of Indian Science" Published by University Press (India) Pvt. Ltd., 3-5-819 Hyderguda, Hyderabad 500 029.

As per decision of Council meeting held on May 03, 2014, Presidential Address will not be printed henceforth in Everyman's Science as they are already printed in the above mentioned book.

EDITORIAL**Kinanthropometry in Anthropology**

Kinanthropometry comprising three Greek words *kinein* (to move), *anthropos* (man) and *metrein* (to measure) emerged as a new scientific discipline in early 1970's. It refers to the dynamic relationship and quantitative interface between human structure and function, a scientific vocation dealing with body measurements in a varied morphological perspectives. Considered as the cross point between anatomy and movement, applications of Kinanthropometry involves series of human body measurements and computing them into various indices. As a matter of fact, Kinanthropometry is analogous to mechanistic approach to human motion i.e. anthropometry. However, the studies in kinanthropometry are confined to width, length and girth measurements instead of alterations that arise in the human physique out of physical training.

Kinanthropometry's application concerns issues related to growth, nutrition, exercise and performance. It renders indispensable structural basis for the consideration of athletic performance by placing the athlete into objective focus and facilitating in evaluation of the individual structural status or quantification of differential growth and training influences. Infact, the unveiling and advancement in the concept of body compartments study from the study of corpses led to the progressively accurate quantification of the living human physique. Kinanthropometry together with anthropometry, somatotyping, human anatomy and physiology signifies one such method. In the present-day setting, the development of sports and physical education of any country is much dependent on the betterment of sport sciences which have come a long way and have immensely contributed in the developed countries. Combining the inherent

approach using both applied and basic sciences, the standard of sports and competitive performance can be developed. The value of morphological characteristics in the carrying out of sports event has surely been acknowledged. It becomes imperative to admit and study the morphology of the sportsperson so that an assessment can be made of how close their physique and morphology is as compared to the champions at different levels; and this can be achieved by taking into account the physique of the Olympic players as bench mark for concerned events. Though, its obvious that old records are being overtaken by new records and studies reflecting human getting bigger, larger and maturing faster; still an ideal to excel in an event can be drawn. Here comes the role of kinanthropometry where the research findings are of profound implication in creating the pre- requisite as well as trainable characteristics of sportsperson and athletes. Hence, kinanthropometry provides for quantification of differential growth and training influences of athletes, offering the fundamental structural basis for the reflection of athletic performance. Nonetheless, the performance in any event of sports is an outcome of multifaceted and complex range of variables, which takes into account physiological, biomechanical and skill traits and many other factors within different sports. The application of kinanthropometry also includes the standards for physical recruitment in the armed forces as well as streamlining and improving the fundamental measurement scale for manufacturing uniform using the reference developed using research in the discipline. The uniform manufacturers can make use of the information provided by kinanthropometry and somatotyping of the body configurations to

fine-tune their patterns and sizing system. The application of kinanthropometry also involves phenotype as well as the morphological change of the discipline personnel with physical training. By

making use of the kinanthropometry the relationship between genetic, physical exercises and body shape of these disciplined force personnel can be ascertained.

*Dr. Rashmi Sinha
Indira Gandhi National Open University,
New Delhi*

*It is strange that only extraordinary men make the discoveries,
which later appear so easy and simple
- Georg C. Lichtenberg*

E-REVOLUTION: AN APPROACH TO QUALITATIVE E-CONTENT AND E-LEARNING

Anjali Sharma* and Neha Rawat**

Information and communication technology (ICT) has become the indispensable need of the hour. No area is untouched by its reach. In its initial days, it was used for research and training purposes for military and academia. But now, all fields business, entertainment, education, public communication and administration are reaping its gains. The life line of ICT is e-content. e-content exists in various forms like audio, video, images or text. It can simply be defined as any electronic material created with various media available for display on internet. Surprisingly, e-content has gained immense popularity just in a span of three decades. The most prime reasons for this is that e-content makes communication effective by of its qualities of being up-to-date and flexible always.

INTRODUCTION

The present write-up is an attempt to unfold the journey of e-content from its origin to its implementation emphasizing need of qualitative e-content in present scenario. It is already understood that e-learning and e-content are inseparable partners. They move on the wheels of Information and Communication Technology (ICT). To develop a conceptual picture about the theme it is essential to begin from the origin of ICT tracing its history and role in development of e-content. This history of ICT will develop insight about e-revolution which actually nothing but change in approach in development of e-content from quantity to quality orientation.

Today, there is a paradigm shift from vender-centered approach to user-centered approach in e-content development. e-content has brought an e-revolution where anyone from celebrity to common man can share information on open forums of internet blogging, comments, debates, social awareness videos, pictures and news. It has brought an era of attitude modification and shaping of masses. The article puts forward a vision that generating e-content of such standards does not mean just converting any data into digital form. It is

*Department of Education, Tezpur University, Assam,
**Department of Education, University of Rajasthan, Jaipur,
E-mail: dranjali1975@gmail.com

actually a systematic process of thinking an innovative idea, converting it into a story line, putting characters into it, making choice of right media components like text, audio, animation and deciding points of interaction to achieve instructional goals. Here comes the need of proper Instructional design in picture. So article further discusses about Instructional System Design (ISD) models required for the development of quality e-content. It is finally concluded that e-content thus produced choosing appropriate ISD model according to user needs can help in developing qualitative e-content which would be deductive, vivid, interactive, interoperable, reusable and economical, all at the same time. The focal points of discussion of the article are as follow:-

- 1) Journey of e-content,
- 2) E-content: Concept, Types and Partnership of e-Learning and e-content,
- 3) E-revolution: Development of qualitative e-content,
- 4) Key Characteristics of qualitative e-content

JOURNEY OF E-CONTENT: A HISTORICAL ACCOUNT

Before providing a brief account of historical development of e-content, it is essential to understand the term e-content. The letter "e" before

e-content unquestionably qualifies it for the most generic definition of such terms where we put “e” before a word like e-mail, e-learning etc. e-content is any electronic information created with the help of various media transmitted through any network-based and internet-driven system. On closely analysing the definition, it is apparent that the first requirement of e-content development is mixing of various conventional and new age media like text, audio, video, images, animations etc. Second requirement for e-content is need of a network and a technology for the transmission of information. Keeping in mind these requirements, tracing back the exact point of origin of e-content becomes a multifarious work. It indicates that the earliest point of origin of e-content would have been the origin of wide-area telecommunication, internet technology and finally mobile telephony. With the advent of all these technologies and media devices, there occurred constant advancement in e-content also. Therefore to create a comprehensive picture of history of origin of e-content it is essential to give an account of origin of all of the above. To develop an insight of the journey of e-content, three major phases of the history of Information and Communication Technology have been deeply probed. On this basis, following three stages of growth of e-content can be enlisted:-

- 1 Primitive Age of ICT and E-content
- 2 Middle Age of ICT and E-content
- 3 Modern Age of ICT and E-content

Each of the above periods of development of e-content has distinct features in terms of form of e-content evolved out of need of media prevalent in that period and means of transmission of this e-content. These periods of time can be called generations or ages of e-content as each ascending stage has advance forms and transmission mode of e-content from earlier ones. Let us look closely at each of these stages with pyramidal Figure 1:

1. Primitive Age of ICT and E-content :Birth of Wired Tele-Communication

Origin of Wired Tele-communication has been the most primitive stage of e-content .The transmission media used in this age was wire-based

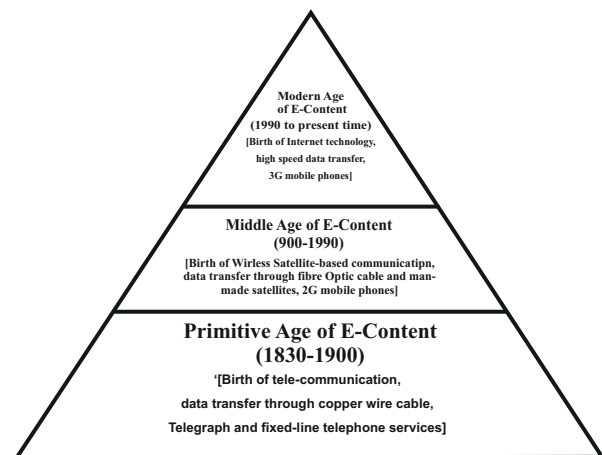


Figure 1: Journey of E-content through advancement of ICT.

using primarily electric copper wire cable. This wire-based technology from 1830 to 1900 ushered path to inventions of various significant electrical machines which in turn helped in shaping primitive forms of e-content. To trace gradual evolution of e-content from wired technology, let us overview major advancements in telecommunications of this age and then relate them to the existing forms of e-content. The major electrical inventions that contributed to the evolution of E-content have been electrical telegraph and telephone. Out of them, telegraph came first in the form of commercially viable electrical telegraph. It was developed by William Fothergill Cooke in partnership with Charles. It started operating over twenty-one kilometres of the Railway lines from Paddington station to West Drayton station of London on 9 April, 1839. It became the first electrical device which used electrical wire cable for exchange of messages for long distance telecommunication. In the same decade in 1837 Morse has presented the simplified version of the electrical telegraph using highly efficient Morse with just two wires. Based on technology of harmonic telegraph, the electric telephone was invented in the 1870s to exchange voice messages. In 1878 and 1879, the first commercial telephone services were set up on both sides of the Atlantic in the cities of New Haven, Connecticut, London and England. The technology grew quickly from this point, with inter-city lines

being built and telephone exchanges in every major city of the United States by the mid-1880s¹.

Evolving forms of e-content during this age has been text and audio. The primary mean of transmission of data of this period was through a wired network of electrical copper wire. It was not very widely spread in that age. Transmission at this time was mainly wired and efforts all around the world were going on to get a commercially viable wireless technology. The main forms of data were text and audio used for public communication. Telegraph machine and electrical telephone had become the popular way of sending messages.

Middle Age of ICT and E-content: Wireless Satellite and Mobile Telephony

Middle age of evolution of e-content has been from year 1900 to 1990. The single most significant event of this age has been onset of wireless communication with the launch of satellite communication. Therefore the most historical event of this period has been launch of world's first active communication satellite, Telstar 1 in 1962. This satellite was built by Telstar's predecessors at AT&T and Bell Laboratories. During its seven months of in its operational being, Telstar 1 transmitted live images of sports, entertainment and news to the world. Later on, satellite based communication opened doors to 2nd generation mobile communication. But before that in 1960, the world's first fully automated telephone was introduced in Sweden with rotary handset mounted within a car. It could only conduct voice communication. The first handheld mobile phone closely similar to today's mobile phones with press buttons was made by Motorola researcher and executive Dr. Martin Cooper on April 3, 1973. This was the new dawn of mobile telephony which marked the beginning of rapid future advancements in mobile technology. The breakthrough in mobile communication came in year 1900 with the rise of 2nd generation telephone services called 2G. The 2G mobile services introduced SMS messaging with first computer generated SMS sent in 1992 in UK. A year later in Finland, the first person-to-person SMS was

delivered using GSM technology². This was the dawn of new era of wireless communication. It literally changed mobile phones from just a device of voice communication to a complete hand-held system to transfer all kinds of data in text, audio or video format.

Evolving forms of e-content of this age has been static images and short length videos along with the text. The prime form of data transferred across a network was text and audio as speed of data transfer was problem all around the world. Wired technologies were also evolving from co-axial cable to fibre optic. As protocols of data transfer and Internet refined, e-content started evolving in the form of static images and short length videos.

Modern Age of ICT and E-content: Advancement of Internet technology

This stage of e-content can be called Modern age as it is the most advance and rapidly growing stage of e-content development with the origin of Internet and advancement of mobile telephony. From year 1990 to 2015 in just about three decades communication world has actually shrink from a desktop computer to a mobile screen. The major milestones of this period have been advancement in Internet technology and 3G mobile communications. The origin of Internet can be credited to the year 1960 when United States government commissioned to build robust, fault-tolerant communication computer network. The primary precursor network for this purpose was the ARPANET, which served as backbone for interconnection of regional, academic and military networks³. In October 2001, NTT DoCoMo Japan pioneered the 3G mobile services. 3G transformed the mobile industry. It enabled wide spread mobile Internet services possible like Internet TV and Radio. With its high speed mobile devices have become faster and more compact.

Evolving forms of e-content of this age has been text and audio images, graphics, animation and videos. It is the most advance stage of e-content being shared over a network with latest technology and hardware support. So, in this age content of all types were in their most advance form. Text based

media has taken back seat replaced by new non-verbal image-based language supported by emoticons, stickers, graphics and shapes. Internet text-based conversation has evolved into new language of Acronyms and net-words. Offline and online videos and other content can be easily and freely shared across a network. Popularity of YouTube which is the most widely accessed online public communication site is the best example of it. With high internet speed live chats and discussion forums through video conferencing have become possible.

E-CONTENT: CONCEPT, TYPES, PARTNERSHIP OF E-LEARNING AND E-CONTENT

After overview of the historical account to develop the actual picture, this is required to discuss concept of e-content and different types and partnership between e-content and e-learning.

Concept of E-content

Though e-content is a new media but is has grown so rapidly in the last few decades that it has literally captured every moment of our lives. Nowadays everything done with the help of internet is being prefixed with "e" like e-commerce, e-governance-democracy-learning etc. People perceive any electronic information available on internet or any web-based technology as e-content.

In this context, let us consider some definitions of e-content; According to Oxford Dictionary⁴ definition e-content is the digital text and images designed for display on web pages. Also, e-content is digital content that can be transmitted over a computer network such as the Internet. As defined by Organisation for Economic Co-operation and Development-content is "data or information that can be displayed, processed, stored and transmitted electronically". At the Initial Stage, there is paradigm shift in the concept of e-content which leads us towards qualitative approach from quantitative approach. This has been appropriately shown by the Figure 2.

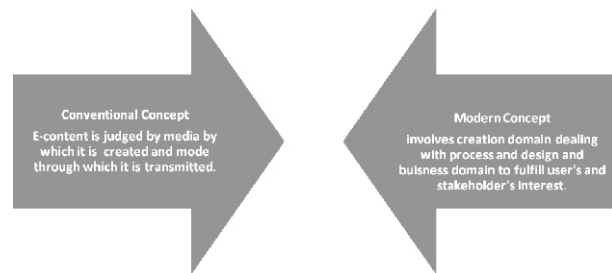


Figure 2: Converging arrows to show Paradigm Shift in Concept of E-content.

Conventional Concept of E-content: A Narrow Approach

Most of the proposed definitions of e-content are based on this single fact. This is the conventional way of defining e-content which considers the most obvious dimension i.e. technology.

In this context, let us consider some conventional definitions of e-content; According to Oxford Dictionary⁴ definition e-content is the digital text and images designed for display on web pages. Also, e-content is digital content that can be transmitted over a computer network such as the Internet. As defined by Organisation for Economic Co-operation and Development e-content is "data or information that can be displayed, processed, stored and transmitted electronically". An interesting example of this common perception about e-content world-wide has becomes evident in United Nation's World Summit Award 2004. In the summit interviews of experts from different countries were taken by Buchholz & Zerfass in 2005, asking them what e-content means in their country. Some of the answers given were, "e-content is all sorts of digital information that's used for all multiple purposes in different fields and areas". Another definition focused on broadcast media, "e-content stands for products or services that are electronically delivered". What we can infer from above definitions is that technological aspect of e-content is the prime basis of defining e-content. It is this narrow outlook under which e-content is judged by media by which it is created and mode through which it is transmitted.

This approach focuses on quantitative aspect of e-content because improved technology and media can help in producing and transmitting huge amount of digital content with greater speed. But in reality today e-content has way more impact on society and its partners namely education, administration, entertainment, media and others, directing us towards a broad outlook to understand and define its.

Modern concept of E-content: Abroad approach

Broad concept of e-content can be understood by Marshall McLuhan's famous saying "The medium is the message"⁶. McLuhan proposed that a medium itself, not the content it carries, should be the focus of study. He said that a medium affects the society in which it plays a role not only by the content delivered over the medium, but also by the characteristics of the medium itself⁷. What McLuhan said regarding importance of medium over message in his interview aired on BBC Radio 4 Series on Jan 27, 2015⁷ is applicable today, also in the context of e-content.

e-content in itself is made up of multiple media and it is delivered to its recipients though some technology, so message that is received at the other end is just not the message but the whole impact of environment created by this message at that moment. For example, there would be a different impact on a receiver of a video documentary of real life experiences than a PowerPoint presentation on the same topic say "female foeticide". It is so because when a message reaches to a recipient with technological components it affects just not the knowledge domain of receiver but the behaviour and attitude domains also. In this light, it becomes necessary to explore e-content with wider scope and define it considering its boarder impact over other media.

As discussed in previous section, apart from technological aspect of e-content, there are other two significant aspects of e-content which are creation domain of e-content dealing with process and design of e-content and business domain dealing with users and other stakeholders related to e-content generation. Both these domains take e-content to

another level of quality distinguishing it from offline and other content available. Under the light of these domains e-content can be characterised as content that can be changed in a moment, delivered to millions of people simultaneously anywhere in the world, modified according to the specific needs of the users, stored on ever changing modern devices and can be reused for generating future content. Now in this contemporary sense in 2005, Buchholz & Zerfass's definition of e-content is the most comprehensive one which is;

"e-content is digital information delivered over network-based electronic devices, i.e., symbols that can be utilized and interpreted by human actors during communication processes, which allow them to share visions and influence each other's knowledge, attitudes or behaviour.

It has subcategory of both digital and electronic content, marked by the involvement of a network, which leads to the constant renewal of content (contrary to the fixed set of content stored on a carrier such as a CD-ROM, or the content broadcast via TV and radio). This constant renewal of content in tie with its dynamic change allows for a qualitative difference, thus making it e-content"⁵. This definition clearly points about quality concerns to be prime issues regarding e-content than just technology used in it. This was the paradigm shift in concept of e-content. It was realized that technology just helps in generating desired content but the quality depends on idea behind its creation and quality of process used in during its creation.

Different Types of E-content

e-content as discussed has become not only indispensable need of education world but also for other fields. It is required for training, entertainment, research and information sharing needs of different varieties of users. Based on differences in desired outcomes of learning and specific needs of users of particular environment there are three major basis of division of e-content which can be further divided into various types. Let us understand types of e-content under each category through Figure 3:-

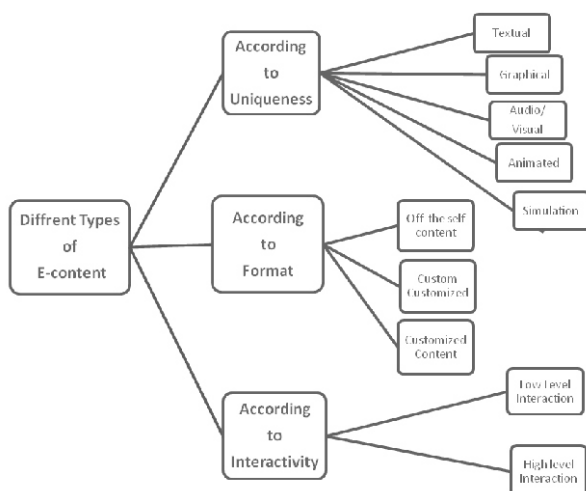


Figure 3. Flow chart to show Different types of E-content.

According to Uniqueness

Uniqueness is the quality which makes any content tailored and shaped according to the specific needs of a user. e-content development may involve reusing of already existing components like audio, video or animation or designer may have to create specific content according to specific needs of the user. Customization is the commonly used term used to define process of development of content according to specified requirements of the users. On the basis of uniqueness e-content can be classified further under following heads:-

- (i) Off-the-Shelf Content: Such content works like a magic in a box, meaning that this content is pulled of the shelf to serve a purpose previously served by similar content. Usually such content contains basic introductions to generic knowledge that applies similarly to different organizations. The cost of reusing such content is very low and requires minimum efforts.
- (ii) Customized Content: When off-the-shelf content is used with minor modifications that help optimize the content to fit organization it can be classified as customized content. Such modifications are usually applied to the fine tunings of the content not the core content. This could be due to difference in languages, different cultures, differences in learner characteristics etc.

(iii) Custom Content: In this category the e-content is designed and created from scratch with full application to a specific organization. Such content is usually based on information specific to this organization or situation and circumstances that are very unique to that very organization.

According to Format

After understanding user needs it becomes necessary to address the format of the content during delivery and specify whether the content will be designed into textual content, audio, video content, graphical or animated content or simulated content. In this Era of education and specifically e-learning course material would usually be a combination of several content formats, all put together to optimize learning results. Different strategies of learning encourage a healthy combination of content formats to simulate different areas of the learner's brain functions. Following are the forms of content as classified under following types:-

- (i) Textual Content: Textual content is the traditional form of content that uses text to deliver information. Generally this form of content is considered less effective and non-desirable, however it varies from user to user. It is best used with other forms of contents to increase their impact. Sometimes textual format is the most effective depending upon the learner's learning situations. In spite of its simplicity it is most generic form of content as it can be easily manipulated requiring no additional purchase/installing of software or hardware.
- (ii) Graphical Content: It is often a very smart way to deliver a message by having some sort of visual aid that matches what the text says. Graphical content is usually some sort of static images and graphs that communicates certain information to the learner. Textual and graphical content are usually closely used together for optimum outcome.
- (iii) Audio/Video Content: Learning Material can very much be communicated using methods of Audio or video, by converting educational messages into such forms. Audio and video can be used in various ways to demonstrate material to learners that is best communicated through moving pictures.

Sometimes the best way to have a piece of information reside in the mind of its receiver is to let the learner see it happen in the form of visuals. One of the limitations of audio and video is their lack of interactivity; both forms seem to involve one way communication between the sender and receiver with no space for feedback from the receiver.

(I) **Animated Content:** People may often confuse animated material with video & audio illustrations. Educational material is converted into animation that depicts certain movements and actions to deliver capsule messages to the learner, Animations also allow user interaction to give the learner a more realistic feel of the content. Animated content secret key lies in the word "interactivity".

(ii) **Simulation:** An advanced form of learning is the process of simulation. The simulation of educational material varies greatly from simple simulations that require straightforward one action interaction versus complex situations that are put into simulation and require a complex of actions. However, this form of learning can be a practical and entertaining way to deliver a message to the learners. Usually, simulations as a form of learning are used to help the learner acquire, enhance or develop certain skills and abilities. It can be said that simulations support learning through "Edutainment", a mixture of both education and entertainment.

According to Interactivity:

The interactivity of content must be assessed according to the level of interaction and the complexity. When two elements mutually influence one another an interaction takes place. In the learning process interaction is a vital factor for retaining more of the material acquired. In the case of instructional interaction the mutual influence occurs between the learner and the learner's environment. Interactive content is designed to create a learning experience for the learner that changes their behaviour to achieve an educational goal. The degree of interactivity is determined according to the amount of knowledge exchanged between the learner and the learning environment.

Such content is divided into two forms according

to the level and complexity of interactivity:

(I) **Low-Level Interaction:** Instructional content with low-level of interactivity may not achieve high level of education. However such type of content is a desirable way to deliver learning material relative to plain textual content. Obviously low interaction as simple as allowing the learner to navigate through the course content with a click of a button does not achieve great impact, but is certainly a good approach to keep the learner hooked into learning process.

(ii) **High-Level Interaction:** With greater levels of interaction the learner may interfere with the learning process by answering questions, interacting with an animation or going through a simulation. Such high level of interaction is bound to create higher levels of educational outputs. Under interaction come items such as Questions, Problem-solving Scenarios, Simulations, Case-Studies, Explorations and Discovery and Educational Games. Above division of e-content has been proposed by 5Learn⁸ in 2012 giving comprehensive and complete picture of various types of e-content.

Partnership of E-Learning and E-content

From above discussion it can be easily deduced that ICT remained foremost reason in the evolution of e-content. Apart from ICT another very strong contributor towards perpetual growth of e-content has been e-learning. Today it has become the ultimate solution to all the teaching-learning situations ranging from pedagogy to heutogy. It has moved far beyond the boundaries of educational institutions becoming the most effectual medium of knowledge exchange among various partners of society namely industries, corporate houses, government departments, science and research etc. So diverse are its applications that apart from teaching it is required for training, instruction, skill acquisition, learning and many more purposes. Since e-learning has revolutionized world of teaching-learning so it has specifically contributed towards advancement of instructional e-content from primitive forms (text and audio) to modern ones (video and animations). e-learning is so versatile and adoptable to

innumerable teaching-learning situations that various terms corresponding to it completely or partially have been conceived. Modern high tech gadgets and high speed internet technology have multiplied its potential manifold making it truly "anytime-anywhere-lifelong-life-wide" medium of learning.

Some of the common terms used synonymously with it are multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer-based training (CBT), computer-assisted instruction or computer-aided instruction (CAI), internet-based training (IBT), web-based training (WBT), online education, online learning etc. Further, it is often used interchangeably with some less similar concepts of virtual campus, online courses, virtual learning, learning management system (LMS), Massive Open Online Courses (MOOC), distance learning, life-long learning etc. which may be part of the e-learning universe but do not sufficiently equal to it. Just by considering so wide array of terms used synonymously with e-learning we can imagine its universal reach and complicated structure. It can crudely be understood as inclusive of all forms of educational technology.

It is, Jay Cross in 2004 who is credited with coining the term e-learning' in 1998. However, the term seems to have been in use as far back as 1997 when Aldo Morri wrote an article for Telephony Online, service: The market for corporate interactive distance learning—now known as 'e-learning,' has boomed along with the growth in the Internet and corporate intranets⁹.

In years to come "e" of e-learning has been buzzword in all fields so much so that now any sector of society using power of information and communication technology puts a prefix before its conventional name like e-governance, e-education or e-democracy. Electronic devices and internet has become so much associated with e-learning that it has become impossible to define it without them. According to Guri-Rosenblit, "e-learning is the use of electronic media for a variety of learning purposes

that range from add-on functions in conventional classrooms to full substitution for the face-to-face meetings by online encounters"¹⁰.

e-learning has revolutionized not only education world but every other field in short period of its origin. It is one area of ICT which has directly affected the shaping up of development of e-content. Partnership of e-learning and e-content is indispensable. With the evolution in the concept of e-learning, e-content also changed as demand of user changed and technology advanced. Let us see how e-learning and e-content suffice each other.

As opined by Paul Henry in 2001 it is important to analyses e-learning on the basis of its essential components. A typical e-learning environment can be identified with three basic key elements which are as follows;

- (1) Content
- (2) Technology and
- (3) Services

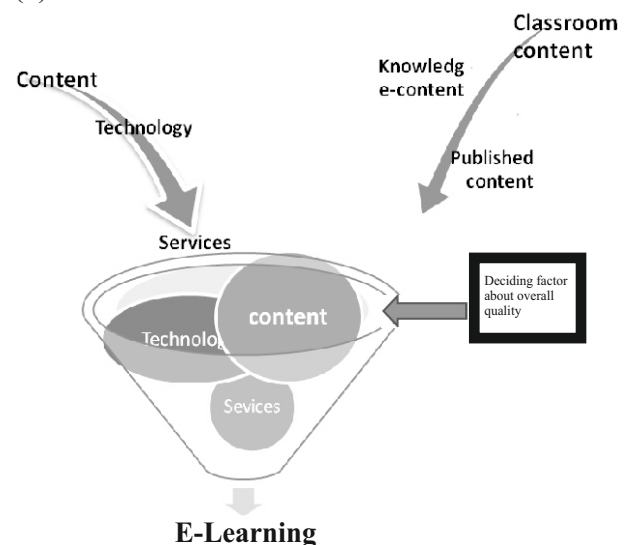


Figure 4: Showing partnership between E-content and E-learning

Figure 4 shows the partnership between e-content and e-learning as the basic three components content, technology and services when come together then e-learning environment is created. Content is the multimedia components namely text, audio, visual, images and animation delivered over a network. Technology is the devices and

telecommunication network used to transmit data and services are modules, programmes and course work designed with the help of various applications and software.

Of these three, content designed for e-learning environment is the deciding factor of quality. Content is the king of e-learning which means impact of e-content is the most on deciding overall quality of e-learning environment. In 2012 Paul Henry states that e-content can majorly fall into three categories as knowledge content, classroom content and published content.

Of these three, content designed for e-learning environment is the most important. Content is the king of e-learning which means impact of e-content is the most on deciding overall quality of e-learning environment. In 2012 Paul Henry states that e-content can majorly fall into three categories as knowledge content, classroom content and published content. All these categories of e-content are available online or offline in the form of courses, modules, events, classroom learning material and other electronic resources¹¹. Impact of well-designed content is great on successful e-learning. To develop quality e-content a strong theoretical grounding is required. e-learning provides that basis in the form of principles of Instructional Design (ID) and theories of Instruction. A content developed taking care of principles and theories of instruction provides qualitative edge to e-learning environment. So we can infer that while e-learning provides theoretical basis to e-content development, e-content in turn provides practical viability to overall e-learning environment. As cited in Eremias and Subhash, 2013, it is worth mentioning here opinion of Jegan and Omwenga et al, about relationship of e-content and e-learning. According to them, content is the heart of learning and medium acts as nerves in that. Although content development plays a key role in e-learning, it is undoubtedly not an easy process. It requires expert knowledge in the subject area, patience in creating the necessary objects that make up quality, interactive courseware, and a high sense of creativity in structuring and sequencing the topics

to make a complete whole. From this we can predict that e-content production enriches the e-learning in a dynamic way. So relationship of e-learning and e-content is mutually symbiotic and supplementary. This partnership between them is essential for improving overall quality of teaching-learning process. And as one develops another automatically advances in form and concept¹².

E-revolution: Development of qualitative E-content

Any product which comes in market initially has prime issues related to its public acceptance in term of performance, user-friendliness, availability and accessibility. e-content with the aid of modern communication technology and devices has achieved a lot. In present scenario e-content is abundantly and freely available on internet through private as well as government channels. Also, e-content what we have today is in its most advance form with text, audio, video, animation and graphics transmitted over a network. So trend with e-content now is that there is more supply than demand and in recent years. This led to increased importance of concerns about quality not the quantity of e-content. This has brought a paradigm shift from vender-centred approach to user-centred approach in e-content development. To address these user-related concerns it becomes necessary to improve process of development of e-content making it more suitable according to the demand of each and every user. By user-friendliness of e-content we mean it has to be self-instructional, interactive, innovative and reusable.

Apart from these basic qualities it should aim to evoke desired behavioural changes in terms of bringing attitude modification and awareness in users. In context of nature of e-content it is apt to mention ideas of Eremias and Subash that e-content should essentially be didactic in nature. The term "didactic" refers to contents such as self-instructional material, audio and video that convey some moral fact or learning. What they said not only applies to education but also to every field. e-content has brought an e-revolution where anyone from

celebrity to common man can share open forums of internet blogging, comments, debates, social awareness videos, pictures and news leading to attitude modification on mass level. Now generating e-content of such standards does not mean just converting any data into digital form. It is actually a systematic process of thinking an innovative idea, converting it into a story line, putting characters into it, making choice of right media components like text, audio, animation and deciding points of interaction to achieve instructional goals. This systematic and scientific approach needed to develop quality content is called instructional design of e-content.

Need of Instructional design

Instructional design is necessary for an effective teaching-learning process. A popular analogy from daily life to understand significance of instructional design for learning is a blueprint of a house which is prepared before it is constructed. Like a blueprint holds all the information regarding place of rooms and other amenities in the house required for comfortable and long dwelling, an instructional design holds information regarding a process of learning which explains flow of information, content analysis, required resources and support activities in a unit of learning. Koper & Fardanesh, 2006 describes instructional design as follows: "instructional design could be defined as the prescribing and forecasting optimal instruction methods for achieving desired changes in knowledge, skills and attitudes of designated students"¹³. In other words, instructional design is a method which the instructor or the designer uses an available resources to meet learners demand for a knowledge transfer. According to Richard Buchanan (2000) a good design can be defined not only to be creative, stylish with extraordinary visual look, but it must consider human engagement in its activities. The designer must appreciate the deep involvement of human characteristics in its design. Educators must think carefully how to design a striking and useful multimedia courseware that takes advantages of current state of art and technology without

compromising learner's needs, motivation and critical thinking skills in the process¹⁴.

Models of Instructional System Design (ISD)

Instructional design models offer users a way to comprehend a problem or situation with more ease. It gives structure and meaning to the instructional problem, allowing the designer and learner with tools to help visualize the problem, to break it down into discrete, manageable units. Based on above discussed approaches there are several models of development of instructional content. They are called models of *Instructional System Design* (ISD). There are well over 100 different models of ISD developed to meet demands of user-specific environment. Among all, *Analysis Development Design Implementation Evaluation* (ADDIE) model is the most widely used model which explains design process exhaustively. Research studies all around the globe confirm positive effect of E-learning systems developed according ADDIE Model on student's learning. It would not be an overstatement that ADDIE is just not a Model of ISD but it is a generic FRAMEWORK of ISD. Therefore most of the current instructional design models are variations of different phases of ADDIE model. Some of the most commonly accepted and widely used models of instructional design are ADDIE Model, ARCS(John Keller), Conditions of Learning (Robert Gagne), Criterion Referenced Instruction(Robert Mager), Dick and Carey, Kirk and Gustafson Model, Kemp Design Model(Morrison, Ross, and Kemp), Organizational Elements Model (OEM), (Roger Kaufman) and Transactional Distance(Michael Moore). Though above mentioned all models have primarily instructional nature but their use depends upon user-end requirement like some are more suitable for learning, some for training needs and some others for various needs of users. All these models have different stages of instructional design but they propose basically three stages of content development namely Development, Implementation and Evaluation. Let's look closely into the most widely used and generic model of instruction i.e., ADDIE which would develop our understanding of other models as well.

ADDIE Model of Instructional System Design

The acronym "ADDIE" stands for Analyze, Design, Develop Implement and Evaluate which are proposed five stages of development of content that can be used to develop any learning situation and e-content. It was developed by Seels and Richey in 1994 of Association for Educational and Communication Technology [AECT], which is a professional organization in the field of educational technology in United States. ADDIE model is a generic model which is used a systematic approach to the instructional design process and serves as the foundation for most Instructional System Design models in use today¹⁵.

Though the model appears linear, it does not have to be followed rigidly in a linear approach the stages of the model are not strictly sequential but each of them may be revisited and revised while any stage is being developed.

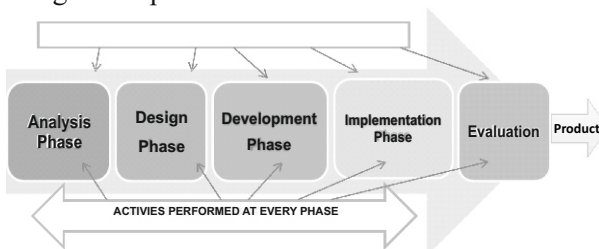


Figure 5: Structural map of ADDIE Instruction design model.

As shown in Figure 5, Let us look closely into what each stage of development process consists of in terms of user requirements defining purpose of that stage, activities performed and key products of that stage.

Analysis phase: The pre-development phase

(i) Purpose of Analysis phase: The analysis phase intensely deals with problem domain of the content development. It identifies the problems and objectives of the project undertaken. It identifies the user's existing knowledge and skills. Some of the questions raised in this phase are, who are the users and what are their characteristics? What is their desired new behaviour? What types of learning constraints are there? What are the delivery options? What are the psychological, pedagogical¹⁶ and social

considerations? What is the timeline for project completion?

(i) Activities performed: Major activities performed during this phase are defining goals of the instruction, conducting Need analysis, identifying knowledge gaps and developing learning objectives.

(ii) Key products of the stage: Outcome products of this stage are need-analysis documents, project plan with estimations of time and cost of the project undertaken.

Design phase

(i) Purpose of Design phase: The design phase deals with learning objectives, assessment instruments, exercises, content, subject matter analysis, and lesson planning and media selection. It should be systematic and specific. Systematic means a logical, orderly method of identifying, developing and evaluating a set of planned strategies targeted for attaining the project's goals. Specific means each element of the instructional design plan must be executed with attention to details.

(ii) Activities performed: Activities involved in this stage are deciding number of content modules, identifying content and media to be used in modules, instruction to be followed, identifying instructional design strategy, selection of appropriate delivery method, developing storyboard, developing media required, deciding number, structure and duration of modules and establishing an evaluation methodology.

(iii) Key products of the stage: The concrete outcomes of this stage are detail design document, story boards, development of user interface, graphics, animation and other media components.

Development phase

(i) Purpose of Development phase: In the development phase, instructional designers and developers assemble content according to the blueprint.

(ii) Activities performed: Designers may revise story boards and graphics according to the suggestions of subject matter experts. Programmers integrate modules with web technologies to make them web

enabled. Testing and debugging of the modules are performed.

(iii) Key products of the stage: Outcomes of this stage are prototype of the project, content usage guides and manuals of procedures and assessment instruments.

Implementation phase

Purpose of Implementation phase: In implementation phase product is run for training facilitators, learners and other users. Training facilitators cover the course curriculum, learning outcomes, method of delivery, and testing procedures. Preparation for learners includes training them on new tools (software or hardware) and student registration.

(I) Activities performed: Major activities performed in this stage are in relation to successful running of the project. Online projects are run on websites and offline projects are delivered and run at user sites with help of programmers and project manager. Users like training facilitators and learners are trained on new tools (software and hardware).

(ii) Key products of the stage: The concrete products of this stage are hands-on equipment, CD-ROMs, software and website.

Evaluation phase

(I) Purpose of Evaluation phase: The evaluation phase consists of two aspects: formative and summative. Formative is present in each stage of the ADDIE process, while summative evaluation is conducted on finished instructional programs or products.

(I) Activities performed: Major activities performed during this stage are collection of evaluation data, assessing project performance and preparing reports of performance results.

(ii) Key products of the stage: Finished products of this stage are program evaluation report and project evaluation report. Once understanding the basic five phases of ADDIE Instructional System Design Model gives us a comprehensive idea of generic process of e-content development¹⁷. The similar processes and activities involved in the five phases of

ADDIE are used as guidelines in other ISD models. It is to understand that with the changing paradigm of educational philosophy from behaviourism to constructivism there aroused a need to have more models of ISDs serving user-specific and situation-specific demands of any system. This only led to development of completely user-specific qualitative e-content tailored according to the minute requirements of the end-users.

Various Types of Instructional System Design Models

According to Gustafson's schema ISD as described in Plotnick Eric's survey¹⁸ models can be classified into three categories on the basis of user's requirement and conditions under which content will be developed and delivered. These three categories make taxonomy of ISD models indicating which model is the most applicable under following three situations: (i) individual classroom instruction; (ii) products for implementation by users other than the developers and (iii) large and complex instructional systems directed at an organization's problems or goals. Following major ISD Models fall under these categories:-

Classroom Orientation ISD Models

Classroom ISD models are of interest primarily to professional teachers who accept that prime role is to teach, and that their students require some form of instruction. Here teacher is not aware of instructional design concepts and uses model as guide map to teach by mastering functions provided by that model. Examples of models¹⁹ most suitable for classroom teaching are:-

- (I) Gerlach and Ely (1980). Teaching and media: A systematic approach.
- (ii) Kemp, Morrison and Ross (1994). Designing effective instruction.
- (iii) Heinich, Molenda, Russell and Smaldino (1996). ASSURE.

Product-Oriented ISD Models

This model assumes that the amount of product to be developed will be several hours or perhaps several days, in length. It is assumed that the time needed for

front-end analysis varies but that a technically sophisticated product will be produced. This is common in educational software development and corporate and business environment. Its important features are small amount or modules of instructions; product will be developed rather than selected or modified from existing resources, emphasis on try-out and revision phases and reusable product. Examples of instructional models:

- (I) Van Patten (1989). What is instructional design?
- (ii) Leshin, Pollock and Reigeluth (1990). Instructional design: Strategies and tactics for improving learning and performance.
- (iii) Bergman and Moore (1990). Managing interactive video/multimedia projects.
- (iv) System-Orientation ISD Models.

System oriented models typically assume that a large amount of instruction, such as an entire course or entire curriculum, will be developed, and that substantial resources will be made available to a team of highly trained developers. Original product may be developed or available resources may be used. The amount of front-end analysis is usually high, as is the amount of tryout and revision. Dissemination is usually quite wide, and typically does not involve the team that did the development. Gustafson & Branch select and discuss six models to represent the variety of ID models most applicable in the systems environment:

- (I) Instructional Development Institute (IDI) (National Special Media Institute, 1971). IDI model.
- (ii) Branson, (1975). Inter-services Procedures for Instructional Systems Development (IPISD).
- (iii) Diamond (1989, 1997). Designing and improving courses and curricula: A practical guide.
- (iv) Smith and Ragan (1993). Instructional design.
- (v) Gentry (1994). Introduction to instructional development process an tedchnique.
- (vi) Dick and Carey²⁰ (1996). The systematic design of instruction.

On the basis of above discussion about all the

aspects of e-content extensively let us now have a look explicitly at the essential requirements of e-content that make it qualitatively user-centred.

KEY CHARACTERISTICS OF QUALITATIVE E-CONTENT

In the above discussion we have discussed the solution to creation domain related concerns of qualitative e-content. Now another dimension to development of quality content is business domain which depends upon user demand. To be user-friendly e-content has be didactive, vivid, interactive, interoperable, reusable and economic. Before establishing key characteristics of qualitative e-content from the viewpoint of each stakeholder, it is important to have an overview of all aspects of e-content. Following flowchart, figure 6 summarizes development of e-content from quantity-orientation to quality-orientation:- Considering qualitative requirements of modern e-content following key characteristics should be there in it:-

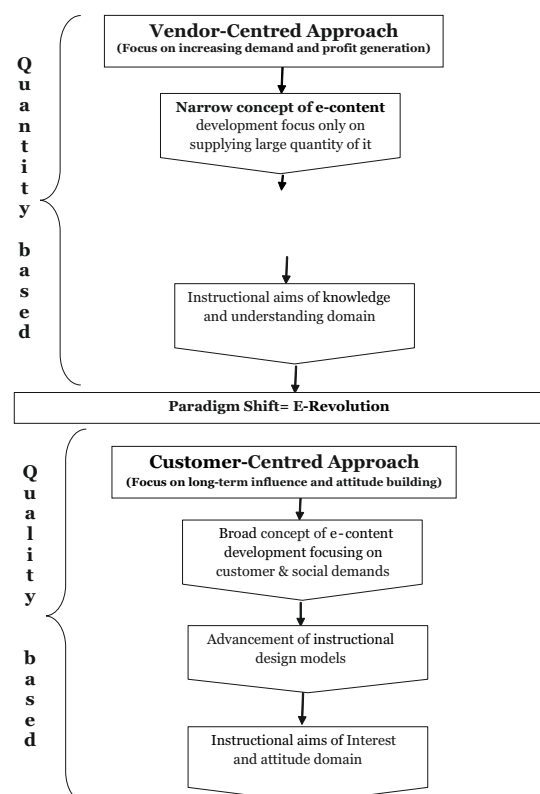


Fig.6: Paradigm Shift -A qualitative approach for the development of E-content.

Appropriate Instructional Design Model

e-content developed must be based on principles of instruction using appropriate Instructional System Design model. An ISD based e-content focuses on user needs and final product is developed with expert advice and developer's programming skills.

Complaint with international E-learning Standards of SCORM and AICC

On line content uses technical standards of development and exchange of online content. These technical standards lay out the conditions of exchange of information between online learning content and Learning Management System(LMS) and thus creates interoperability between modules published using these standards and LMSs also complying to these standards. The two most common technical standards are SCORM and AICC. SCORM stands for "Sharable Content Object Reference Model" and was developed by the United States Department of Defence through the Advanced Distributed Learning initiative, which was established in 1997. SCORM content (modules) and systems (LMSs) are accessible, durable, interoperable, and reusable. The Aviation Industry CBT Committee (AICC) is an international non-profit association of technology-based professionals. When a course is AICC-compliant, it means that it complies with at least one of the nine AICC Guidelines and Recommendations²¹.

Balanced use of multiple media

A correct combination of multiple media should be used for varied teaching approaches-games, quizzes, simulations, video, animation, audio and graphics. Requirement of instructional content must be based on right choice and combination of media used for its development.

Highly interactive and Evaluative

Good e-content must be interactive in terms it should ask for user input and give responses to motivate users. Similarly modern LMSs have tracking and scoring system to keep track of learner's progress.

Multilingual

Since e-content today has become a thing of social affair so it should have universal reach. A good e-content must have feature of existing in multiple languages so that users from different cultures can read content in their language and understand it properly.

CONCLUSION

The complete discussion presented the overview about the development of e-content through advancement of ICT. In second section of paper talked about concept of e-content and paradigm shift bring with time from narrow approach to broad approach along with different types of e-content on the basis of uniqueness, format and interactivity. The key focus is partnership of e-content and e-learning. The relationship is presented with concept map and leads to quality concern in developing e-content and creating e-learning environment, which depends upon instructional system design adopted. ADDIE is first in this line of qualitative approach. In this way a qualitative approach to e-content and e-learning: e-revolution is developed. The last section of paper discussed it with the help of flowchart, which showed paradigm shift from vendor centred to customer centred approach.

After all the deliberations we had under various sections, it clearly understood that e-content, beginning its journey as electronic information used for the purpose of public communication reached to modern e-learning environment. In its primitive form prime concerns of e-content generation and transmission were related to its quantitative and technological aspects. But now with the advancement of Information and communication technology qualitative concerns of e-content generation has taken front seat this leads to revolution in the field of e-learning. To produce qualitative e-content it is important to follow a systematic process of its development. This systematic plan of development of e-content is explained through Instructional System Design Models which are extensive blueprint of

instructional process. The first pioneering ISD model has been ADDIE in this direction which rendered concrete guidelines for future ISD models which have now become around 100 in numbers. These different Models of ISD have further contributed towards development of qualitative e-content by fulfilling user-specific and situation-specific demands of e-content. Thus e-content produced using appropriate Instructional Design Model has qualities of being didactic, vivid, interactive, interoperable, reusable and economic all the same time.

REFERENCES

1. History of Telecommunications.2015.Retrieved from https://en.wikipedia.org/wiki/History_of_telecommunication.
2. Tim Brookes. A brief history of mobile phones. 2012,Retrieved from <http://www.makeuseof.com/tag/history-mobile-phones>.
3. Internet.(n.d.).Retrieved September 25,2015 from <https://en.wikipedia.org/wiki/Internet>.
4. e-content(n.d.) in *Oxford Dictionaries* Retrieved from <http://www.oxforddictionaries.com/definition/english/e-content>.
5. Peter Bruck, Andrea Buchholz, ZegerKarssen, &AnsgarZerfass.*Springer-Verlag Berlin Heidelberg*.2005. Retrieved from https://en.wikipedia.org/wiki/Communications_satellite.
6. The Medium is the Message.(n.d.). July 5,2015 Retrieved from https://en.wikipedia.org/wiki/The_medium_is_the_message.
7. BBC Radio 4 Series. (Jan 27, 2015). "The Medium is the Message",Retrieved from <https://www.youtube.com/watch?v=Ko6J9v1C9zE>.
8. 5Learn.Types of content.2012. Retrieved from <http://5learn.co/types-content>.
9. Defining e-learning.2010.Retrieved from <http://www.nwlink.com/donclark/hrd/elearnin/define.html>.
10. Albert Sangrà, DimitriosVlachopoulos, & NatiCabrera.*IRRODL:The International Review of Research in Open and distributed Learnings*. Vol 13, No 2. 2012.Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/1161/2146>.
11. Henry Paul, *Education, Training* **43**. 4, 249-255, 2001.MCB University Press. ISSN 0040-0912 retrieved from www.qou.edu/arabic/.../eLearningResearchs/eLearningTechnology.pdf.
12. Omrani Soghra, Fardanesh Hashem, HemmatiNima, HemmatiNaser. (2012) *Turkish Online Journal of Distance Education-TOJDE July 2012 ISSN 1302-6488, 13, 3 Article 23* Retrieved from <http://files.eric.ed.gov/fulltext/EJ997826.pdf>.
13. Lizeron Eremias & R. Subash, *International Journal of Teacher Educational Research (IJTER)*,2,1 January2013.ISSN: 2319-4642.
14. Qais Faryadi.2007.Retrieved from <http://files.eric.ed.gov/fulltext/ED495711.pdf>.
15. ADDIE Model. (n.d.). Wikipedia, the free dictionary. Retrieved 14 September, 2015 from https://en.wikipedia.org/wiki/ADDIE_Model.
16. Anurag Saxena, Pedagogical Designs for Generation of Contents for the Community. Community Development Theme, 2011, Indira Gandhi National Open University publications. New Delhi. p. 1-3.
17. Ike Shibley, Amaral, Katie E. Shank, John D. Shibley, R. Lisa (2011).. *Journal of College Science Teaching*, 40 ,6,80-85, Jul 2011,retrieved from ERIC.ERIC Number: Ej963648.
18. Plotnick Eric, *In Survey of Instructional Development Models*, Third Edition, Gustafson & Branch.1997. Retrieved from <http://www.ericdigests.org/1998-1/survey.htm>.
19. Instructional Design Models(n.d.) Retrieved from <http://www.about-elearning.com/instructional-design-models.html>.

20. W. Dick, , L. Carey, , & J. O. Carey, 2005, *The Systematic Design of Instruction* (6th ed.), New York: Allyn and Bacon. ISBN 0205412742.
21. Just what are SCORM and AICC? 2015. Retrieved from <http://www.proedit.com/just-what-are-scorm-and-aicc>.

MOBILE APP: A POTENTIAL TOOL FOR ENHANCING RESEARCH IMPACT IN FAR FLUNG AREAS AND RURAL SECTOR

Atul¹, Pranshuta¹, Chander Mohan² and
Rashmi Sharma²

The exponential rise of technological innovations in the past two decades has influenced every facet of human civilization. In synchronization with the era of digital revolution, Government of India has initiated a flagship program with a vision to transform India into a digitally empowered society and knowledge economy. This vision of digital reforms can also embrace the domains of planning and implementation of projects, particularly relevant to Science and Technology. Department of Science and Technology through its special initiative is funding projects in the geographical areas that needs specific scientific & technological interventions. One such program is for Cold Desert Region (CODER) of Western Himalaya encompassing Himachal Pradesh and Jammu & Kashmir. The prevalence of cell phones even in remote locations and myriad of mobile apps along with ease of their use has led to development of a mobile app named as CODER_Network app. Its primary objective is to build strong linkages amongst stakeholders including researchers, field workers, monitoring team, funding agency and subject experts mostly hailing from academic institutions. Such a network would not only help in accelerating communication but also enable the monitoring team to evaluate various project activities in real time and provide effective mentoring and handholding. These efforts of government and academia collectively may optimistically magnify the output of Digital India campaign.

INTRODUCTION

Not too long ago, and up to mid 1900s, the primary means to communicate and acquire knowledge were limited to reading and writing. However, in the modern world or the present era, advent and spread of technology has provided diverse communication tools, techniques and resources that enable connectivity in a virtual environment at any point of time. The World Development Report, published by the World Bank in 2016, not only was based on but also had a focus on Digital dividends that explored the impact of digitization on development¹. This report claimed that in developing countries the internet users have grown three times in number in last 10 years. Majority of people in developing countries own

¹Directorate of Extension Education, CSK HP Agricultural University Palampur, Himachal Pradesh, E-mail:prof.atul@gmail.com, ²Science for Equity, Empowerment and Development (SEED) Division, Department of Science and Technology, New Delhi-110016, E-mail:chander.m@nic.in

mobile phones even though they do not have access to some basic amenities like better sanitation facilities or electricity.

In light of Digital revolution, India has started the Digital India Program² with a prospect of paralleling the country with 21st century literacy and economic development. This program has taken initiative to provide basic digital infrastructure and e-services to the masses. Government of India is focusing on providing services in areas of agriculture, finance, business, power, digital literacy, women empowerment, and so on.

This idea of digital revolution can also be extended to the area of education particularly Research and Development (R&D) besides socio economic development through Science and Technology (S&T) interventions. Although under the realm of Digital India several dedicated services have been launched like *Kisan Suvidha* and *Garv*

Grameen Vidyutikaran mobile apps, but application of R&D in rural sector and in remote locations has largely remained overlooked.

RURAL DEVELOPMENT AND RESEARCH

Sustainable rural development requires a wide array of efforts ranging from effective and extensive policy framework, strengthening of existing agriculture and industrial sector at village level, refinement of existing infrastructure, empowerment of regional educational institutions, etc³. However, mere provision of better services and infrastructure cannot uplift the rural sector as deep understanding of design, development and delivery of these inputs is equally important. This highlights the intervention of educational institutions located in the vicinity in imparting knowledge and skills to the rural masses to achieve the desired results. These institutions help in communicating knowledge to the end users in addition to identifying challenges in their immediate surroundings and finding appropriate solutions. Such agencies can also be utilized to pinpoint and then plug loopholes in the development process at rural level and thus cater to the needs of local community. The ease to access information has already enabled the experts and researchers in the educational institutions to remain up-to-date about the global problems and potential solutions. However, these solutions are mostly ineffective when applied at ground level due to lack of connect with the ecosystem these are being developed for⁴.

Some of the issues, flagged above, are being addressed by Department of Science and Technology (DST), Government of India (GoI) through its Science for Equity, Empowerment and Development (SEED) Division in order to support, stabilize and sustain growth in rural sector⁵. SEED solicits active participation from practicing S&T community and academic institutions to identify the challenges obtaining in a specific area/agro-climatic zone, particularly pertaining to grassroots level and provide potential solutions.

RESEARCH IN COLD DESERTS

Even though DST is providing funds for working in rural sector, there is a comparative lack of R&D to

remote areas. Cold Desert Region (CODER) in Western Himalayas of India is one such region. It ranges from Leh and Kargil district in Jammu & Kashmir State (province) to Lahaul-Spiti and Kinnaur district of Himachal Pradesh. This high altitude region is characterized by extremely harsh climate conditions with low precipitation, short period of summers and very long periods of freezing winter conditions⁶. These peculiar characteristics make it a unique ecosystem that is accessible for a very short period. Usually the period for which this Cold Desert Region remain active & accessible lasts from 4 to 6 months. The research practices that implement in other rural area may not work for these unique ecosystems. Such conditions put an automatic timeline for overall research and development activities that are to be carried out in this area.

NEED IDENTIFICATION

An effective research identifies the requirement of local community, it also involves creating a competent methodology to fulfill those requirements along with well-organized demonstration of knowledge to the local communities. The multiple constraints of Cold Desert Region have unfavorably affected the R&D governed by local and national institutions. This sometimes leads to failure of educational institutions to communicate effectively with the local community and motivate them to adopt/adapt S&T interventions for their betterment leading to disappointment of all stakeholders. The challenge lies in the fact that the local people remain isolated and overall development becomes sluggish during about eight months of extreme/harsh conditions. Even the researchers and field workers, who over a period have adjusted to work in the Cold Desert Region, remain disconnected from rest of the world with almost no assistance available to them. The more educated and digital savvy people can use the broadband internet connection and communicate to the outside world using emails for their queries. However, the broadband connection is also not ubiquitous, economical and easily comprehensible to everyone. Globally less than 20 per cent of the

population has access to broadband connection¹. Use of technology may enhance the research productivity in cold desert region but only if it is easily accessible to them.

EVOLUTION OF MOBILE APPLICATION

A broadband connection may not be favorable in Cold Desert Region (CODER) but mobile phones are used more effectively and regularly. Not less than 7 out of 10 persons use mobile phones in the developing country¹. The prevalence of mobile phones and their ease of use allowed the development of a mobile app named as CODER Network app by Monitoring & Evaluation team operational under the CODER Network project of DST at CSK HP Agricultural University, Palampur, Himachal Pradesh. As majority of the mobile phones support android operating system, the app is developed on android technology.

The prime objective to create this app is to allow effective linkages among researchers, field workers, monitoring team, funding agency and experts of various educational institutions that are working in and out of the cold desert region under CODER program (Fig. 1).

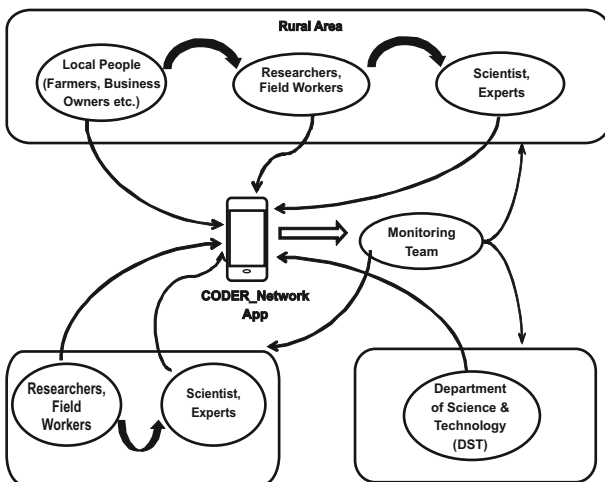


Fig. 1. Diagram showing network created by CODER_Network app among various entities at rural, regional and national level.

This linkage not only helps in accelerating communication but also enables the monitoring team to evaluate various project activities and provide

them much needed and timely assistance. Various features of the app were created to enable easy handling and quick execution of instructions given by users (Fig.2a-j).

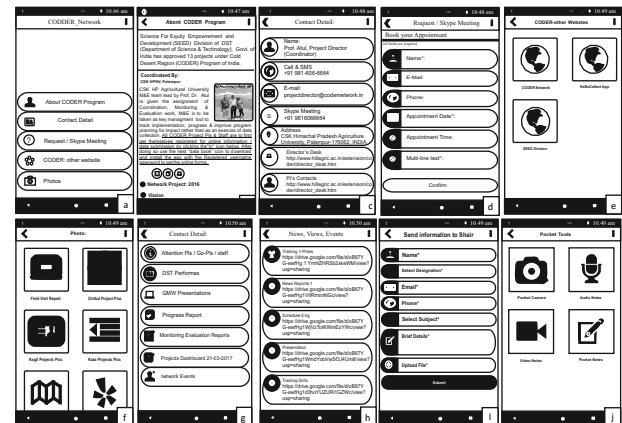


Fig. 2. (a-j). Various features of CODER_Network App.

CODER_NETWORK APP FEATURES AND ITS ADVANTAGES

Availability and Memory usage: This app can be easily downloaded from Play Store and requires only 50.76 MB space which is like a drop in the ocean as most of the android mobile phones have at least 1GB RAM now-a-days.

General Information Board: The common information about CODER program is displayed in the app so that the users are aware of different projects going on in the Cold Desert Region, which are given budgetary support by SEED Division (Fig.2b). This act as a pool of information on various research aspects that are specific to this region. One of the features of the app displays contact information of the Project Director including official email id and mobile number so that users can contact her/him (Fig.2c).

Fix Appointments: Another feature allows the user to fix a Skype meeting with Project Director, CODER Network Project (Fig. 2d). The user will send the suitable time and date of meeting from the app which will deliver a message acknowledging receipt of the request. The Project Director will send

the confirmation of the appointment time and date by email given by user at the time of making the request.

Intra-Connectivity: One of the important features in the app enables the user to connect with various CODER program related websites like those of DST, SEED Division official web page, CODER Network official web page, etc. (Fig. 2e). This provides access to all these web pages at any time without the need of browsing for the same separately.

Information Sharing: This interactive feature allows sharing of project specific documents like field photos, application format, guidelines, projects progress reports, meeting presentations, archived events and upcoming events, etc. with other users in view mode (Fig. 2f-h). App allows information to be viewed by a set of people who are enabled with appropriate rights through authentication mode. Thus, the risk of passing confidential information into wrong hands becomes extremely difficult leading to a secure environment.

Field Connectivity: The app allows the users to connect with CODER Network monitoring team from the field and send information in the form of documents or photographs of the sites (Fig. 2i), thus saving the time of field worker to identify and address problems or issues with the help of expert.

Handy Tools: These tools allow the users to write down important details in the field with the help of notes feature. The app also facilitates those who can communicate better through vocal than through text creation of audio note. Video notes can also be prepared through camera to record the field-based activities (Fig. 2j).

Offline Data Collection: In rural area, the issues of interrupted electricity supply and low income might aggravate the problem of scarce internet services⁷. Most of the app features require mobile data connection, but sometimes when there is limited or no data, connectivity, another feature of the app creates a link to offline data collection

forms. User friendly forms enable data collection under various projects to capture information about proposed trials/experiments / demonstrations, expenditure details, beneficiaries registration, daily work report of staff and feedback/response of trainees/beneficiaries. Prior authentication, username and password is required to attain these forms and network connectivity is necessary for uploading the forms. Once these forms are uploaded on mobile, these can be filled without network connectivity and the app will automatically send the filled forms whenever or wherever the network is available. This will enable the user to create a link even in the offline mode.

FUTURE PROSPECTS: UPGRADATION OF THE MOBILE APPLICATION

CODER Network app offers many services, which enable various users to collect data from field and send the same to various entities. Though all the above features are suitable for preliminary phase of projects, as the need for meaningful information develops with the enhancement in technology, it becomes imperative to generate significant and relevant information in the shortest time possible. Integration of features like real-time data analysis, report generation and authenticated downloading of generated reports in the CODER Network app can strengthen it further, thus providing a more wholesome and independent environment. This, in turn, will lead to a complete, robust and secure channel for data collection, sharing, analysis and presentation in future.

CONCLUSION

Better communication and timely sharing of information with a mobile app can give a significant boost to quality of research in Cold Desert Region of India. This is a unique tool, which has been developed for any research and development program, that can also facilitate researchers and field workers to concentrate more on the field and less on sending of documents or data by emails, speed post, etc. The time thus saved, can be used more judiciously for training and skill development of

local community and enhancing their engagement in development initiatives. The tool helps creating a network of researchers, experts, evaluators and funding agency to contact each other and share their knowledge and experiences to identify and solve immediate problems. Though CODER Network app is still in its pilot phase, it offers a great opportunity for enhancing R&D in Cold Desert Region. In addition, this app can also be customized for other agro-climatic zone/location and thus enhance the visibility of R&D being undertaken at field level. Besides the rapid pace of Digital India Program and its resolution to provide digital infrastructure to the whole country may have a catalytic effect on the success of such initiatives. These joint efforts of Government and educational institutions collaborating thus may favorably magnify the output of Digital India Movement.

The current scenario of the country reveals a paradigm shift from traditional methods to modern technologies. There is tremendous scope for innovation and upgradation in the digital domain. Thus it is necessary to acknowledge the fact that there is a need for improvisation and improvement not only in the mindset but also skills to enhance the acceptance and integration in day-to-day life. These simple, handy yet efficient mobile app tools can be the stepping-stone towards digital progress. This in turn will help in reaping more benefits from the Digital Era that will lead to across the broad development of the country.

REFERENCES

1. World Bank Group ,2016. World Development Report 2016: Digital Dividends. Washington, DC: World Bank. © World Bank, <https://openknowledge.worldbank.org/handle/10986/23347> License: CC BY 3.0 IGO.
2. Digital India: Power To Empower, 2017. <http://digitalindia.gov.in>
3. S. Biriescu, C. Babaita, *Procedia - Social and Behavioral Sciences*, **124**, 77–86, 2014.
4. A.Waugaman, 2016, p. 16, *From Principle to Practice: Implementing the Principles for Digital Development*. Washington, DC: The Principles for Digital Development Working Group.
5. Science for Equity Empowerment and Development (SEED), 2017.<http://dst.gov.in/scientific-programmes/st-and-socio-economic-development/science-equity-empowerment-and-development-seed>.
6. Cold Desert Cultural Landscape of India, 2015. <http://whc.unesco.org/en/tentativelists/6055>.
7. A. Thakur, C. Hota. *International Conference on Advances in Computing, Communications and Informatics (ICACCI)*, Mysore, pp. 1335-1340, 2013. doi: 10.1109/ICACCI.2013.6637371.

NANO FOOD FORTIFICATION

T. Kathiravan. Moses J.A. and C. Anandharamakrishnan*

The use of natural food sources as functional foods for health is gaining public interest. Incorporation of food ingredients and micronutrients into existing food formulations present many challenges due to food stability, bioavailability concerns, high concentration requirements meet specific health applications and unpleasant sensory attribute associated with most nutrients. Conversion of coarse particles of active compounds to nanoparticles or nanosuspensions can be an efficient approach in handling challenges associated in bioactive and nutrient delivery systems.

INTRODUCTION

In both developed and developing countries, nanotechnology is described as the new industrial revolution, involving large investments. Research on nanotechnology and nanomaterials are also substantial. Materials scientists and engineers have made significant developments in the improvement of methods of synthesis of nanomaterial solids¹. It is an essential modern scientific field that is also continuously developing as a broad area of research in food processing, food preservation, packaging and in development of functional foods. Major nano based applications in the food industries are nanoparticles, nanocomposites, nanoemulsions, nanosensors, nanopatterned matter and nanostructured material. Nano based approaches in food manufacturers, agricultural producers, and consumers could gain a more competitive position. Further, the delivery of bioactive compounds, fortification for nutritional aspects, as well as development of functional food are possible through the nano approach.

APPLICATION AND BENEFITS OF NANO STRUCTURED FOOD MATERIALS

Among several applications of nanotechnology in food systems are nanodispersions and nanocapsules for nanoparticulate delivery system, nanolaminates, nanocomposites for food packaging

systems and nanosensors for food safety and biosecurity applications². Nanotechnology also find applications in food and dairy processing. Applications through food additives ('nano inside') (Fig. 1) and food packaging ('nano outside') concepts. Food additives in the nano size can be used to improve texture, flavor and nutrients and even detect pathogens. Nano food packaging involves extending food shelf life, providing edible, nano wrappers which can envelope foods, prevent gas and moisture exchange, contain nano-sensors and antimicrobial activators ('smart packaging') to detect food spoilage and to release nano-anti-microbes that can to extend food product shelf life³.

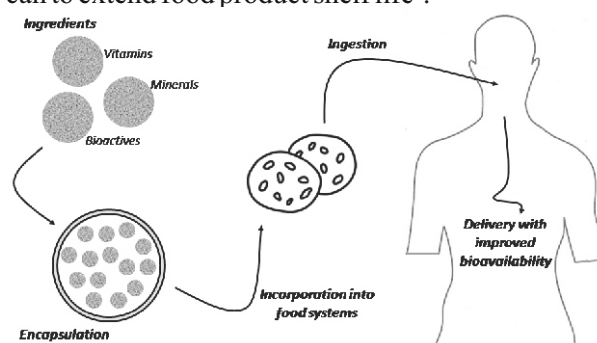


Fig.1. Schematic diagram representing the approach involved in nano based food fortification.

The antioxidant activity of green tea powder can be improved by lowering the size of the powder to around 1000 nm, thereby improving digestion and absorption by increasing the activity of an oxygen-eliminating enzyme⁴. It is also possible to develop

Indian Institute of Food Processing Technology (IIFPT), Ministry of Food Processing Industries, Govt. of India, Pudukkottai Road, Thanjavur - 613005, E-mail: director@iifpt.edu.in

smart delivery systems by engineering the properties of nanostructured shells around droplets. Such interfacial engineering technology would involve food-grade ingredients (such as proteins, polysaccharides, phospholipids, vitamins, antimicrobials, antioxidants, flavorings, colorants, and preservatives) and process operations (such as homogenization and mixing) that are already widely used in the manufacture of food emulsions (Fig. 2). Nanofibers with diameters from 10 to 1000 nm, make them ideal for serving as a platform for bacterial cultures as well as structural matrices for artificial foods. However, nanofibers are usually not composed of food grade substances, they have relatively limited applications in the food industry⁵. With progress in the production of nanofibers from food biopolymers these trends are changing.

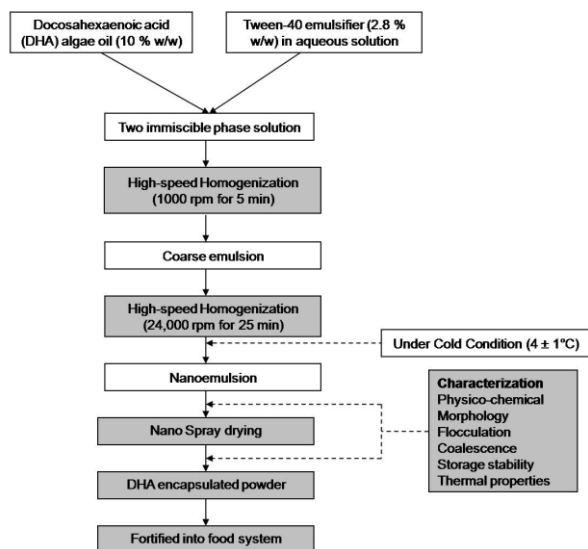


Fig.2. Preparation procedure of Docosahexaenoic acid (DHA) encapsulated nanoparticles by emulsion method¹⁵.

For example whey proteins are valuable by-products of the cheese industry. It is used widely in a variety of foods, primarily for their superior gelling and emulsification properties. In addition to its high nutritive value, it has important functional characteristics including heat induced and cold-set gelation, as well the potential to assemble into various nano and microscaled structures. Whey

proteins get fibrillated into long semi-flexible filaments with micro level lengths and nano diameters when heated in under acidic (pH~2.0) solutions of low ionic strength. Flexible whey protein nanofibrils can entangle and yield viscous dispersions. The fibrils may also gel at low protein concentrations. The assembly of whey proteins into fibrils, microgels and soluble aggregates have received considerable attention by the food, nutraceutical and pharmaceutical industries⁶.

IMPORTANCE OF FOOD FORTIFICATION

Food fortification refers to the addition of micronutrients to processed foods. In many cases, this concept has led to relatively rapid improvements in the micronutrient status of a population; importantly, at a very reasonable cost. This approach is appropriate especially if advantage can be taken of existing technology and local distribution networks. Since the benefits are potentially large, food fortification can be a cost-effective public health intervention. Fortified foods need to be consumed in adequate amount by a larger proportion of the targeted.

Fortification is the process of adding nutrients or non-nutrient bioactive components to edible products such as foods, food constituents or supplements. It can be used to correct or prevent widespread nutrient deficiencies and associated deficiencies. Food fortification can be considered as a public health strategy to enhance the nutrient intake of a population. Over the past century, fortification has been effective in reducing the risk of nutrient deficiency diseases such as iron deficiency anemia, beriberi, goiter, pellagra, and rickets. Although early fortification programs were designed to eliminate deficiency diseases, at present, fortification programs focus on low dietary intakes and rapid absorption of micronutrients.

FOOD 'FORTIFICATION' THROUGH NANO TECHNOLOGY

Of late, there is a keen interest to fortify processed food and dairy products with nanoencapsulated nutrients or bioactive compounds. This also includes by nano-modification of foods for

improved mouth feel. Fortified foods are also claimed for their nutritional benefits; for example, medically beneficial nano-capsules incorporated into chocolate chip cookies or hot chips have been marketed as health promoting and 'artery cleansing' in particular³. Nanotechnology can be used to modify the quantity of fats and sugars in junk foods and also reduce its absorption levels by the body. This is possible by using nanoparticles to prevent the body from digesting or absorbing such food constituents. It is also possible to make vitamin and fibre-fortified, fat and sugar-blocked junk foods as health promoting and weight-reducing products³. Nanoencapsulation of drugs involves forming bioactive compounds of diameters ranging from 1 to 1000 nm⁷. The term nanoparticle is a collective name for both nanospheres and nanocapsules. In recent years, therapeutic drug delivery through nanoparticles is also receiving considerable attention. Several approaches have been used to create nanoscale delivery systems for better improved absorption (Table 1).

Table 1: Examples of different approaches for nanoscale food fortification and delivery¹⁴.

| S.No | Nanoscale delivery systems | Preparation approach |
|------|--|---|
| 1. | Micelles, microemulsions liposomes | Spontaneous self-assembly (bottom-up), spontaneous self-assembly of phospholipid bilayers in combination with physicochemical or mechanical treatments (combined) |
| 2. | Nanoemulsions, emulsions and solid lipid nanoparticles | Mechanical homogenization of oil and water phases (top-down) spontaneous emulsification of surfactant-oil-water mixtures (bottom-up) |
| 3. | Biopolymer nanoparticles | Mechanical fragmentation of larger particles (top-down) Antisolvent precipitation (bottom-up) |
| 4. | Microgels | Mechanical formation by extrusion, molding, or fragmentation (top-down) spontaneous formation by phase separation, followed by disruption and gelation (combined) |

THE NEED FOR MICRONUTRIENT FORTIFICATION

Over the last few years, interest in developing approaches to solve micronutrient malnutrition has increased. One major reason for this is the realization that micronutrient malnutrition contributes substantially to the global burden of disease. In 2000, the World Health Report⁸ identified iodine, iron, vitamin A and zinc deficiencies as issues among the world's most serious health risk factors. In addition to obvious clinical manifestations, micronutrient malnutrition is also responsible for a wide range of non-specific physiological impairments leading to reduced resistance to infections, metabolic disorders, and delayed or impaired physical and psychomotor development⁹. According to World Health Organization (WHO) mortality data, around 0.8 million deaths (1.5% of the total) are known to be attributed to iron deficiency every year, and a similar number to vitamin A deficiency. In terms of the loss of healthy life expressed in disability-adjusted life years (DALYs), iron-deficiency anaemia results in 25 million DALYs lost (or 2.4% of the global total), vitamin A deficiency to 18 million DALYs lost (or 1.8% of the global total) and iodine deficiency to 2.5 million DALYs lost (or 0.2% of the global total).

The burden of micronutrient deficiencies in India is high. Iron, vitamin-A and iodine deficiency disorders are particularly significant. Around 70% children aged between 6-59 months are anaemic. Also, 55% women and 24% men in the country are anaemic. Although there are state wise variations, high prevalence of anaemia does not have exceptions¹⁰. In addition, the intake of the foods rich in essential nutrients is low. India has a national program that provides vitamin-A supplementation (2,00,000 IU every 6 months) to children aged between 12-59 months through the Integrated Child Services (ICDS) scheme. National Family Health Survey (NFHS) reports that the coverage of target population is low, with just 25% children below 5 years of age who had received vitamin-A supplements six months before the survey. Coverage of iron supplementation is also extremely low with

just about 5% of 6-59 month old children receiving iron supplements from ICDS as per the NFHS-3 report¹⁰.

TRENDS IN NANOFOOD FORTIFICATION

The limitations during fortification of most micronutrients are changes in organoleptic characteristics, degradations of fortified vitamins and the low bioavailability of fortified active compounds. Nanotechnology has been hyped as the next revolution concept in the agriculture and food industry. The application of nanotechnology to the food sector could create innovation in macro-level characteristics of food, including texture, taste, other sensory attributes, processability, and storage stability. Nanoscale bioactive compounds can also improve water solubility, thermal stability, and oral bioavailability owing to increased surface area compared to macro scale compounds^{11,12}. Considering an example, the most commonly used iron supplements for iron deficiency and associated anemia is iron sulphate (FeSO_4). However, its use causes undesirable sensory changes, improper absorption in the gastrointestinal tract and poor stability of the fortified compound.

To overcome this problem researchers¹³ have combined whey protein nanofibrils with iron nanoparticles that can be readily absorbed by the body. To produce these nanoparticles, researchers created iron nanoparticles by mixed ferric chloride (FeCl_3) directly with whey protein nanofibrils in the same acid medium, creating iron nanoparticles. The size of the particle found to be in the range of 20 nm, that could immediately bind to whey protein nanofibrils surfaces offering improved stability. Generally iron nanoparticles cannot be easily mixed into foods or drinks because of unstable nature and they tend to quickly clump together and form aggregates. In addition fortified supplements were tested in rats and results revealed that the enzymes in the rat stomachs could completely digest whey protein nanofibrils. Acid conditions in the stomach dissolve iron nanoparticles into iron ions which can then be quickly absorbed into the blood system and

can be used to produce new red blood cells. Iron-coated whey protein nanofibrils can be administered either in powder or liquid forms and the new compound can be easily added to different types of food system without affecting their taste/smell/color. During the iron supplements, the undigested protein fibres did not accumulate in the body and results in potential tissue anomalies. On examining the organs and tissues of rats, the researchers did not find nanoparticles or nanofibrils accumulation or any associated organ changes. Such advancements in iron supplementation has enormous potential for successfully combating iron deficiency in an economic and efficient way.

CONCLUSIONS

Fortification is a successful delivery system to resolve nutrient inadequacy and associated deficiencies. Recent developments have shown that fortification of active compounds can not only prevent of deficiencies but also improve human health. However, its long-term effects remain unknown. Fortification adds to the nutrient intake of nearly everyone in a population. Nanotechnology has already found several applications in fortification or encapsulation of food and dairy ingredients. Although few successful nano food products are already available in the market, their remarkable potential will attract more and more competitors in this field. It has shown greater scopes of improving the effectiveness of bioactive compounds and delivery mechanisms so as to improve human health. However, regulatory issues on nano foods are still being developed and there is a lot of research gap in nanotechnology based applications for the food industry.

REFERENCES

1. R.Namita, *Int. J. Adv. Eng. Tech*, **7**, 1806-1811, 2015.
2. H. J.C. Weiss and F. Shahid, *Food Tech*, **60**, 30-36, 2006.
3. G. Miller, Global Research cited from <http://www.globalresearch.ca/index.php?context=va&aid=10755>, 2008.

4. T. Shibata, Method for producing green tea in micro fine powder. United States Patent US6416803B1, 2002.
5. J. Weiss, T. Paul and D. J. McClements, *J Food sci*, **71**, 107-116, 2006.
6. L. Donato, C. Schmitt, L. Bovetto and M. Rouvet, *Int Dairy J*, **19**, 295-306, 2009.
7. J. Ji, D. Torrealba, A. Ruyra and N. Roher, *Biology*, **4**, 664-696, 2015.
8. Codex Alimentarius Commission. Procedural manual. 12th ed. Rome, Food and Agriculture Organization of the United Nations, 2001.
9. L. Allen, B. de Benoist, O. Dary, and R. Hurrell, World Health Organization, 2006.
10. National Family and Health Survey (NFHS-3), India: International Institute for Population Sciences (IIPS) and Macro International. 2007.
11. A. Nel, T. Xia, L. Madler, N. Li, *Sci*. **311**, 622-7, 2006.
12. D. J. McClements, E. A. Decker, Y. Park and J. Weiss, *Crit. Rev. Food Sci. Nutr.* **49**, 577-606 2009.
13. Y. Shen, L. Posavec, S. Bolisetty, F. M. Hilty, G. Nyström, J. Kohlbrecher, M. Hilbe, A. Rossi, J. Baumgartner, M. B. Zimmermann and R. Mezzenga, *Nat. Nanotechnol.*, 2017. DOI: 10.1038/nnano.2017.58.
14. Q. M. Afroz, S. Swaminathan, K. Punita, ; K. P. Ahmed, U. Sudhir and M. Umesh Kumar, *Pak. J. Food Sci*, **22**, 23-31, 2012.
15. P. Karthik and C. Anandharamakrishnan, *RCS Advances*, **6**, 3501-3513 2016.

SUSTAINABLE SUGARCANE INITIATIVE (SSI) - THE CHOICEST METHOD OF SUGARCANE CULTIVATION IN INDIA

G. Mani, D.Thirusendura Selvi and S. Utharasu

Sugarcane, a very important source of sugar, bagasse and ethanol is a cash crop of commercial importance and high significance. The sugar industry provides major employment to the rural youth in India. Since the production and productivity of sugarcane is in decreasing trend in many states, it becomes essential to increase its production and productivity. Sustainable Sugarcane Initiative (SSI) is one such latest methodology with “more with less” principle that aims to improve the cane productivity and reduces the cost of cultivation thus addressing the sugar sector to a large extent.

INTRODUCTION

Sugarcane is grown commercially in the tropics and sub-tropics and is known to be one of the oldest cultivated plants in the world. Sugarcane was unknown in the new world until Columbus introduced it on his second voyage in 1493. Sugarcane is cultivated in more than 20 million hectares in tropical and sub-tropical regions of the world, producing upto 1.3 billion metric tonnes of crushable stems. It has served as a source of sugar since hundreds of years, represents an important renewable bio-fuel source, which could turn into a global commodity and important energy source. It is generally used to produce sugar, accounting for almost two thirds of the world's production and has lately gained increased attention because of ethanol which is derived from cane. Recently, there has been increased interest in using bagasse for processes such as paper production, as a dietary fiber in bread, as a wood substitute in the production of wood composite, and in the synthesis of carbon fibres. In India, there are 35 million farmers growing sugarcane and another 50 million depend on employment generated by the 571 sugar factories and other related industries using sugar. In Uttar Pradesh, Maharashtra and Tamil Nadu, sugarcane plays a major role in the state economy¹. During the last 10 years, sugarcane production in India has been

fluctuating between 233 million tonnes and 355 million tonnes. Similarly, the productivity at the farm level is as low as 40 t/ha¹. With such low yields and fluctuations in production, and due to occupying India having the second largest area under sugarcane cultivation in the world next to Brazil, the industry is in for big trouble¹. The problem is going to further enhance due to variability of rainfall influenced by climate change. Thus, unless sugarcane farmers are provided with options of high yields with much less water, India will find it difficult to meet its growing demand for sugar. Under such situation, development of new technology involving less input to produce more will be the viable option.

Sugarcane in India is grown in two distinct agro-climatic regions – the Tropical (largely comprising Maharashtra, Karnataka, Gujarat and Tamil Nadu) and the Sub-tropical (Uttar Pradesh, Punjab, Haryana and Bihar). Among the states, Uttar Pradesh occupies half (2.25 m ha) of the total area followed by Maharashtra (1.04 m ha). Though Uttar Pradesh dominates in production with 134 MT followed by Maharashtra with 79 MT, Tamil Nadu leads with 105 t/ha leads in terms of productivity followed by Karnataka (88 t/ha) and Andhra Pradesh (82 t/ha).

POPULAR SUGARCANE VARIETIES GROWN

The following table lists the sugarcane varieties that are popular or gaining good recognition in

Agricultural Research Station, Tamil Nadu Agricultural University, Vaigaidam- 625 562, Theni District, Tamil Nadu, E mail: maniseedtech@gmail.com

Tropical and Sub-tropical India during different periods of time.

| Sub-tropical zone | |
|--------------------------|---|
| 1920's | Co 205, Co 210, Co 213, Co 214, Co 224, Co 281, Co 290 |
| 1930's | Co 205, Co 213, Co 223, Co 244, Co 281, Co 285, Co 290, Co 312, Co 313 |
| 1940's | Co 213, Co 312, Co 313, Co 331, Co 356, Co 453 |
| 1950's | Co 312, Co 313, Co 453, Co 951 |
| 1960's | Co 312, Co 975, Co 1107, Co 1148 |
| 1970's | Co 312, Co 1148, Co 1158 |
| 1980's | Co 1148, Co 1158, Co 7717, Co 7314 |
| 1990's | Co 1148, Co 89003 |
| 2000's | Co 89003, Co 98014, Co 0238, Co 0118 |
| Tropical zone | |
| 1920's | Co 213 |
| 1930's | Co 213, Co 243, Co 281, Co 290, Co 313 |
| 1940's | Co 213, Co 419 |
| 1950's | Co 419, Co 449, Co 527 |
| 1960's | Co 419, Co 527, Co 658, Co 740, Co 853, Co 975, Co 997 |
| 1970's | Co 419, Co 527, Co 658, Co 740, Co 975, Co 997, Co 853, Co 62175, Co 6304, Co 6806, Co 6415 |
| 1980's | Co 419, Co 740, Co 975, Co 62175, Co 6304, Co 6907, Co 7219 |
| 1990's | Co 740, Co 62175, Co 6304, Co 7219, Co 7704, Co 7527, Co 7508, Co 7504, Co 8011, Co 8014, Co 8021, Co 8208, Co 8362, Co 8371, Co 8338, Co 85004, Co 86032, Co 85019, Co 86249, Co 97009 |
| 2000's | Co 86032, Co 99004, Co 94012, Co 2001-13, Co 2001-15 |

Enhancing sugarcane productivity is important both for the farmers and the sugar industry. The critical steps to achieve this process are planting good quality seed material for establishing healthy and good plant stand in the field and good agronomic and crop management practices for higher yields. In the conventional method of planting cane setts, there is lot of wastage of cane and there is variability in the vigour and growth of plants in the sugarcane fields resulting in lesser yields and productivity.

The reasons for such low productivity are:

The improved varieties released by research organizations perform well in the initial year but lose their vigour and decline in yield in due course.

Water availability is unpredictable. The concern is not only the quantity of water required, but also the lack of proper water management practices. Due to this, water is either wasted or sometimes not available at the right time.

Unpredictable climatic aberrations, improper cultivation practices, negligence in plant protection measures, imbalanced nutrition management and other practices like mono cropping often resulting in low productivity and fetching low price in the market.

In addition, it is also very important to consider the enormous amount of water that goes into the sugarcane production. Approximately 25,000 kg of water is needed to produce 10 kg of sugarcane. But the water table is depleting every year. Cost of cultivation, moreover, is increasing not just for the small farmers but for the large industrial players as well. In future, these challenges will become even more complex with climate change inducing direct and indirect effects on crop, water, pests, diseases and volatility in the international market. The situation therefore, calls for innovative methodologies that can be adopted by farmers to address the issue of enhancing productivity and thereby assure higher income to farmers. Sustainable Sugarcane Initiative (SSI) methodology appropriately fits the requirement. The Sustainable Sugarcane Initiative (SSI) is yet another practical approach to increase sugarcane production which is based on the principles of "more with less" in agriculture. Sustainable sugarcane initiative improves the productivity of water, land and labour, at the same time, while reducing the overall pressure on water resources. Sustainable Sugarcane Initiative (SSI) is also considered as one such methodology that helps to improve the cane productivity and reduce the cost of cultivation, thus addressing the problems of sugar sector to a large extent.

Sustainable Sugarcane Initiative (SSI) based on the principles and practices of System of Rice Intensification (SRI) has been introduced in the sugarcane region among farmers as a solution to the above. Extending or extrapolating the ideas and methods of SRI to sugarcane, SSI involves practices including bud (seed) treatment (with lime and cow urine), seedling bed preparation on plastic cavity trays, single bud transplantation, transplantation of young seedlings (25-35 days), wider spacing (5ft x 2ft), and organic manure application. These practices improve the productivity of land and water, producing more healthy canes with less seeds and with more economic benefits to the farmers, with environmental benefits additionally. Moreover, the mulching of dried sugarcane leaves in the inter-row spaces of sugarcane sets conserves surface moisture and controls weeds reducing the water loss due to them.

MAJOR PRINCIPLES OF SSI

Raising nursery using single budded chips

Transplanting young seedlings of 25-35 days old

Maintaining wide spacing of 5x2 feet in the main field for easy sunlight penetration, profuse tillering and mechanical harvesting

Drip fertigation (sub or sub-surface)

Practicing intercropping with effective utilization of land

METHOD OF RAISING "CHIP BUD SEEDLINGS"

Select freshly harvested sugarcane stalks free from pests/diseases of 10 months old.

Scoop out chip buds with the help of hand operated bud scooping device or with bud chipper.

The buds are to be treated with 1 Kg Urea, 50g Carbendazim and 200 ml Malathion dissolved in 100 litres of water and soaked for 15 minutes and shade dried for 15 minutes to induce quick germination of buds.

The buds can also be treated by biological method by dissolving 2 kg of *Trichoderma viride*

in 100 litres of water and soaking for 15 minutes and shade drying for 15 minutes.

After chemical/biological treatment, buds are to be treated with 1 percent lime solution and placed air tight in gunny bags for 3-4 days.

The gunny bags should be opened on the 4th day and healthy sprouted buds can be selected for raising nursery.

Bud treatment helps in protecting the crop from pest and disease incidence in later growth stages.

Store in perforated polyethylene bags after chemical and biological treatment at low temperature conditions (10°C) or in aerated corrugated paper boxes in case of transit to other places or during delayed sowing.

Plant these pre-treated chip buds in upright position in pro-trays filled with potting mixture containing soil, organic matter and sand in the ratio of 1:1:1 or in composted coir pith media (cocopith media)⁵.

After filling all the trays, place the trays one above the other and finally keep an empty tray upside down at the top. About 100 trays (4 sets each consisting of 25 trays) are to be placed together and wrapped tightly with polythene sheets. Place small weights on the bundles and keep it for 5 to 8 days in the same position to create high temperature and humidity.

Take measures to control termites around the trays by drenching the soil with Chlorpyrifos 50 EC (5ml/l) and ensure that no weeds arise in and around the nursery area.

Care should be taken to avoid water, air or sunlight entering into the trays by tightly overing and keeping the bundles in shade net or preferably inside a room. Create artificial warmth through electric bulbs if the climate is too cold. This is the most crucial phase of the nursery management. Under proper conditions (especially, warm temperature) within 3-5 days, white roots (primordial roots) will come out and shoots will also appear in the next 2-3 days.



Fig. A and B - Extraction of single budded chips Fig. C - Lime packet Fig. D - Lime solution
 Fig. E & F - Treated buds cured in gunny bags for 3-4 days Fig. G - Sprouted chip buds
 Fig. H & I - Planting of sprouted chip buds in pro-trays Fig. J - Pro-trays placed one above another
 Fig. K - Pro-trays covered with polythene sheets Fig. L & M - Transplanting of 25-35 days old
 nursery raised seedlings Fig. N & O - Drip irrigation (surface irrigation)

Either on the 5th or 8th day (based on the climatic conditions), remove the polythene sheet covering the pro-trays and place the pro-trays on the ground to facilitate watering and to execute other nursery management practices.

Based on the moisture content of the potting mixture or cocopith, watering has to be done regularly in the evenings for the next 15-20 days using rose cans to promote shoot induction and to obtain healthy seedlings. After appearance of two leaves, application of water can be increased gradually depending on the moisture level in pro-trays.

During six leaf stage (about 25-30 days old seedlings), grading of the plants has to be done. Arresting the irrigation one day prior to lifting enables easy lifting up of the young seedlings with ball of earth for field planting.

Plants of similar age (height) can be lifted up and placed in one tray. This method of seedling grading based on height enables easy elimination of damaged and dead plants.

TILLAGE

Tillage operations through tractor-drawn implements are most ideal and quick. After one or two initial ploughings, soil must be allowed to weather for a week or two before going in for further tillage operations.

Tillage operations can be carried out using harrows or rotavator. The operations are to be repeated to make the soil free from clods, weeds and crop residues.

After tillage operations, the field should be deep ploughed using a tractor.

If the field is uneven, leveling has to be done using a tractor operated leveler. While leveling, a gentle slope can be maintained to facilitate easy movement of irrigation water.

TRANSPLANTING YOUNG SEEDLINGS

Normally, sugarcane setts are planted directly in the well wetted main field but in the SSI method, it involves raising of plants from single buds in a

nursery and about a month old seedlings (30-35 days old seedlings) are transplanted in the main field. Young seedlings are raised in the nursery using pro-trays in the appropriate potting mixture media. Growing seedlings in the nursery have several benefits. It ensures selection of good seed material, raising of uniform and robust planting stock material, optimum percentage of plant population with very low mortality and saving of water which normally would have been used for irrigating the field sown with setts until their germination and establishment in traditional method. It also helps in gaining about one month of planting season where previous crop is harvested late or the fields are wet due to late rains during North-east monsoon, as it very often happens in coastal areas of Andhra Pradesh and Tamil Nadu.

WIDERSPACING IN THE FIELD

In conventional method, the distances between two rows are maintained at 45-75 cm (1.5-2.5 ft). Normal population expected is 44,000 canes per acre. For that, 16,000 three budded setts or 48,000 two budded setts are required, whereas in SSI, wide spacing of 5x2 feet is maintained in the main field. Therefore, only 4,000 to 5,000 single buds are used to achieve 45,000 to 55,000 millable canes due to more tillering resulted from wider spacing. In addition, there is a great scope for air and sunlight entering into the crop canopy and photosynthetic activity is increased resulting in increase in length and girth of canes.

DRIP IRRIGATION AND FERTIGATION

The productivity of cane under SSI can be enhanced by practicing drip irrigation with fertigation. Based on the soil type, drip irrigation can be scheduled daily or once in three days. Fertigation can be done at ten days interval. The water use efficiency is higher in drip irrigation and can save irrigation water to the tune of 55 per cent (1200 mm).

Nutrient management in sugarcane cultivation is very essential for better crop growth. It is always better to know the required quantity of nutrients through soil testing and enrich the soil accordingly. If it is not feasible, NPK can be applied at the rate of 275 kg, 63 kg and 115 kg per hectare respectively through inorganic or organic sources.

Fertigation schedule for Sugarcane in SSI (Kg/ha)

| Crop stage (days after planting) | Nitrogen | Phosphorus | Potassium |
|--|------------|------------|------------|
| 0-30 | 39.40 | 0.00 | 0.00 |
| 31-60 | 50.60 | 26.25 | 9.00 |
| 61-90 | 56.50 | 20.50 | 14.50 |
| 91-120 | 60.20 | 16.25 | 16.00 |
| 121-180 | 57.80 | 0.00 | 40.50 |
| 181-210 | 10.50 | 0.00 | 35.00 |
| Total | 275 | 63 | 115 |

Recommended dose of fertilizers (RDF)-275:63: 115
NPK once in 10 days.

In intercropping systems, the time of fertilizer application to sugarcane plays a significant role in deciding the efficiency of applied fertilizer and yield of sugarcane. Sugarcane accumulates hardly two to three tonnes/ha of dry matter till the harvest of intercrops and hence utilizes only a small amount (15 to 20 Kg/ha) of soil 'N'. The nitrogen fertilizer applied to sugarcane as basal dose results in excessive foliage growth of intercrops because of luxury consumption of 'N' and as a consequence, growth as well as yield of sugarcane is adversely affected. Thus, a major portion of 'N' for sugarcane should be applied only after the removal of intercrop. The time and dose of fertilizer application to intercrop may be similar to sole cropping and adjusted to the population.

WEEDING AND EARTHING UP

Weeding has to be done at 30, 60 and 90 days after transplanting. Earthing up has to be done on 45th and 90th day after planting for enhancing aeration and root growth.

TILLERING ARCHITECTURE AND SSI

The increase in productivity that results in SSI is mainly because of robust root system and vigorous growth of the plant. The special feature of the system is that the plant has enormous potential for tillering

which has to be tapped properly⁴. Tillering in sugarcane comes from the bottom most six internodes which are highly compressed. The bud from these six internodes in the mother shoot are capable of giving six primary tillers and again these primary tillers in turn, are capable of giving six secondary tillers each ($1+6+6 \times 6 = 43$), theoretically speaking. If tertiary tillers are also produced, the number could be enormous. In practice, however, even if four tillers are produced from the mother shoot and if they give again four tillers each, then the total tillers emerging would be 21 (i.e. $1+4+4 \times 4$). It is extremely important to harness the full potential of tillering in SSI⁶. Tillering is an important area that needs intensive research, since under SSI, tillering forms the foundation for obtaining higher productivity. Loosening of soil at an early stage could improve tillering. Normally, the first earthing up (half earthing up) to loosen the soil and convert ridges into furrows and furrows into ridges, is practiced at around 100 days after sett planting. Since tillering starts at around 60 days, it is worthwhile exploring the possibility of advancing half earthing up by a month or so under SSI method to enhance tillering potential.

SYNCHRONOUS TILLERING IN SSI

Apart from high levels of tillering, synchrony of tillering is a feature of SSI that results in better sugar recovery. The growth phases in sugarcane are conveniently divided into³ the germination phase as a

| | Days after planting | Duration in days |
|--------------------|------------------------|---------------------|
| Germination phase: | 30 | 30 |
| Tillering phase : | upto 120 | 90 |
| Growth phase : | upto 270 | 150 |
| Maturity phase : | Upto 360 | 90 |

whole in SSI is completed in the trays in a shorter period of around 10-12 days compared to around 30 days under conventional system, where sprouting of all the buds in the setts planted does not occur simultaneously. Since the germinants emerge in different periods in over 30 days of time, the millable canes produced could not be very synchronous. This

means that the individual clumps and hence the millable canes that are produced ultimately vary in their age under normal method of cultivation. In the case of SSI, on the other hand, the germinants/sprouts emerge within a short period of time and hence the tillering is very synchronous giving a better sugar recovery to the miller. It appears that the increase in sugar recovery would be to the tune of 0.5% because of synchronous tillering. For a 7500 TCD (Tonnes crushing per day) mill running for 200 days in a year, this works out to an extra sugar production of 7500 tonnes of sugar in crushing season, which is a very attractive proposition³.

WATER MANAGEMENT

Drip irrigation can be practiced effectively in SSI due to wider spacing and raising of single seedlings.

It is always better to provide sufficient quantity of water on time rather than flooding the field with enormous amount of water.

In conventional flooding method, water is always applied more than the biological demand of the crop which may affect the crop growth.

After transplantation, the frequency of the irrigation may differ depending on the soil type, age of the crop, rainfall and moisture availability. For sandy soil, the frequency will be more and for clay soil it will be less.

Give irrigation once in 10 days during tillering stage (36-100 days), once in 7 days during Grand Growth period (101-270 days) and once in 15 days during maturity period (from 271 days till harvest).

Furrow irrigation helps in proper application and saving of water. Alternate furrow irrigation means irrigating the furrows of odd numbers initially followed by irrigating the furrows of even numbers after 7 to 15 days as per the moisture content and age of the crop. This will ensure saving of water upto 50%.

In conventional flooding method, water is always applied more than the biological demand of the crop which may affect the crop growth. In SSI,

Comparison Between Flood Irrigation and Drip Fertigation in SSI

| Particulars | Flood irrigation | Drip fertigation |
|--|------------------|------------------|
| Water Requirement | 2200 mm | 1,000 mm |
| Duration of irrigation | 250 days | 250 days |
| Irrigation interval | 7 days | 1 day |
| Number of irrigation | 36 | 250 |
| Water requirement of single irrigation (lit) | 6.1 lakhs | 0.4 lakhs |
| Yield | 92-05 t/ha | 150-200 t/ha |
| Fertilizer use efficiency | 30% | 60% |
| Benefit Cost ratio | 1.97 | 4.7 |

better water management is a crucial issue. It is always emphasized to provide sufficient moisture, rather than inundating the field with water. In SSI, crop is in wide rows and water can be given in channels along with the row. About 40% of water is saved in this method by following measures like raising of nursery, furrow or alternate furrow irrigation, optimum application of water by reducing periodicity and quantity of water besides saving electric power in pumping.

ENCOURAGING ENVIRONMENTALLY FRIENDLY CULTURAL PRACTICES

In SSI, inorganic practices like application of chemical fertilizers and pesticides are discouraged. Farmers are encouraged to practice measures like incorporation of organic manures, application of bio-fertilizers and use of bio-control measures for plant protection. Integrated approach is encouraged to deal with pest and disease. Gradual reduction of inorganic inputs and adoption of organic methods can be tried by farmers for long term benefits. Inorganic fertilizers should always be applied mixing with farm yard manure. Applying organic manures like Farm yard manure/well-decomposed press mud (about 8-10 tonnes/acre) at the time of field preparation and incorporation of green manure into

the soil enables supply of sufficient quantity of nutrients to plant growth. Application of bio-fertilizers like Azospirillum, Phosphobacteria @ 5 kg/acre would also improve the crop growth. This can be applied in the sides of furrows and incorporated into the soil while earthing up.

INTERCROPPING

Wide spacing in SSI provides interspaces in sugarcane field for intercropping of short duration crops and helps in optimum utilization of land. In addition to effective utilization of land, this practice would reduce the weed growth upto 60% and give extra income to farmers. It acts as live mulch and preserves moisture. Green manures raised as intercrop can improve the soil fertility on incorporation. Crops like wheat, potato, cow pea, french bean, chick pea, water melon, brinjal etc. can be intercropped with sugarcane².

YIELD ATTRIBUTES

As SSI method advocates wider spaced cane cultivation, it provides more light and helps in better growth, with more number of tillers and millable canes contributing to higher yields.

TILLER NUMBER AND MILLABLE CANES PER CLUMP

In the SSI practice, good tillering and growth occurs compared to conventional practice. The minimum tiller number was about 8 per clump and in regions of good growth, the number went as high as 16-18 tillers per clump in SSI practice, however the average number of tillers was about 10 per clump in SSI fields. While in conventional practice, the number of tillers was comparatively much lower in the range of 5-8 tillers per clump with an average of 6 tillers per clump.

The millable canes that contribute to the final yields were also proportionate in SSI adopted fields with a range of 6-14 millable canes and an average of 9 millable canes per clump. While in conventional practice millable canes will be in the range of 4-6 with an average of 5 canes per clump. The millable canes in SSI plots will be almost double the conventional practice. Moreover the tiller number

was maximum (18) per clump compared to that of conventional practice.

INDIVIDUAL CANE WEIGHT

Higher cane girth and good cane height even upto 12 feet is commonly noticed in the SSI fields. Moreover, the individual cane weight in SSI practice is significantly higher compared to the conventional practice. The cane growth is good and the individual cane weight ranges from 1.5 kg to 2.6 kg in SSI practice with an average cane weight of 1.9 kg. (Table 1). In SSI fields when the individual cane weight falls in the range of 2.26 kg to 2.46 kg, higher cane yield is noticed. In conventional practice, the individual cane weight ranges from 1.2 to 1.6 kg with an average of 1.4 kg and this factor affects the cane yield in conventional practice.

CANE YIELD

In SSI adopted fields, the cane yield is highly impressive over that of conventional practice. In SSI practice, yields recorded will be in the range of 48 to 68 tonnes per acre with average of 57.5 tonnes per acre. In SSI practice where higher individual cane weight were recorded, cane yields will be in the range of 65 to 68 tonnes per acre. Yields recorded in SSI practice will be in the range of 48 tonnes per acre wherein late transplanting is done and might be due to other factors such as poor soil fertility conditions. In conventional planting, the yield is in the range of 35 tonnes per acre to 45 tonnes per acre with an average of 40 tonnes per acre. Thus SSI practice tends to achieve an additional yield in the range of about 8-24 tonnes per acre with an average of 16.2 tonnes per acre.

| Parameter | SSI practice | | Conventional practice | |
|-----------------------------|--------------|---------|-----------------------|---------|
| | Range | Average | Range | Average |
| Tillers per clump | 8-18 | 10 | 5-8 | 6 |
| Millable canes per clump | 6-14 | 9 | 4-6 | 5 |
| Individual cane weight (Kg) | 1.5-2.6 | 1.9 | 1.2-1.6 | 1.4 |
| Yield (tonnes/acre) | 46-68 | 57.5 | 35 | 40.1 |

Cane growth and yield in SSI practice and conventional practice

Comparison Between SSI and Conventional Method.

| Particulars | Conventional method | SSI method |
|--|---|--|
| Planting material (setts/buds) | 48,000 buds (16,000 three budded setts) of 3-4 tonnes per acre | 5,000 single budded chips (5,000 buds per acre) |
| Nursery | Sett planting | Raising of seedlings from chip buds |
| Quality of plants | No Grading | Grading is done after nursery |
| Planting | Direct planting of 2-3 budded setts in the main field | Transplanting of 25-35 days old young chip bud seedlings (settlings) |
| Spacing | 1.5 to 2.5 ft between rows | 5 to 9 feet between rows |
| Water requirement | More (flooding of field) 24 hrs/day for 4 days: 8 times in a crop cycle (768 hrs) | Less (maintenance of moisture in the furrows, drip etc) 8 hrs/day for 3 days: 4 times in a crop cycle (96 hrs) |
| Plant mortality | High | Low |
| No. of tillers per plant | Less | More (15-25) |
| No. of millable canes achieved per clump | 4-5 | 9-10 |
| Accessibility to air and sunlight | Low | High |
| Scope for intercrop | Less | More |
| Labour (including irrigation) | 1,190 person days or 1,776 hrs in a crop cycle | 136 person days or 648 hrs in a crop cycle |
| Cost per acre | Rs. 21,244/ | Rs. 7,200/ |

Comparison of cost of cultivation for sugarcane under surface irrigation, sub-surface drip fertigation and SSI under SSDF system.

| Particulars | Conventional method | Sub surface drip fertigation (SSDF) | SSI under SSDF |
|---------------------------------|---------------------|-------------------------------------|---------------------|
| 1. Drip system cost | - | 12,000 | 12,000 |
| 2. Preparatory cultivation | 8,800 | 10,950 | 10,950 |
| 3. Setts and planting | 23,640 | 16,160 | 15,500 |
| 4. Crop maintenance | 8,400 | 8,400 | 8,400 |
| 5. Fertilizer cost | 5,250 | 5,250 | 5,250 |
| 6. Irrigation/ Drip fertigation | 4,200 | 3,000 | 3,000 |
| 7. Weeding | 3,000 | 3,000 | 3,000 |
| 8. Plant protection | 2,470 | 5,060 | 5,060 |
| 9. Herbigation | - | 1,257 | 1,257 |
| 10. Chlorine treatment | - | 600 | 600 |
| 11. Acid treatment | - | 800 | 800 |
| 12. Micro nutrients | 900 | 900 | 900 |
| 13. Harvesting | 42,000 (manual) | 48,750 (mechanical) | 48,750 (mechanical) |
| 14. Yield/ha | 98 tonnes | 175 tonnes | 195 tonnes |
| 15. Economics | | | |
| Gross income @ Rs.1950/ tonnes | 1,91,100 | 3,41,250 | 3,80,250 |
| Cost of cultivation | 98,660 | 1,16,127 | 1,15,467 |
| Net income | 92,440 | 2,25,123 | 2,64,783 |
| B:C ratio | 1.93 | 2.93 | 3.29 |

CONCLUSION

Sugar is produced commercially in 114 countries from two different sources, sugarcane and sugarbeet. Both the crops produce identical refined sugar. Sugarbeet is grown in temperate countries whereas sugarcane in semi-tropical countries like India. Cane sugar accounts for 79.8% of world's crystal sugar production whereas beet sugar accounts for 20.2%. Sugar is an essential commodity and has great demand in India and throughout the world. The necessity to improve its production and productivity through SSI is hence the need of the hour. SSI involves use of less seeds, less water and optimum land utilization to achieve more yields. It is governed by some principles like using single budded chips, raising nursery, wider spacing, sufficient irrigation and intercropping. By practicing these measures, the following benefits can be realized.

- Seed cost can be reduced upto 85%
- Better germination/sprouting percentage
- Reduction in the plant mortality rate in the field
- Easiness to transport young seedlings to longer distances
- Intercultural operations can be carried out easily due to wider spacing
- Increase in the length and weight of each cane
- High number of millable canes is achieved
- Reduction in the duration of the crop
- Increases water use efficiency
- Improvement in accessibility to nutrients with optimum use of fertilizers

- More accessibility to air and sunlight

- Reduction in the cost of cultivation

- Extra income from intercrops

- Easy to propagate new varieties

On the whole, by practicing SSI, farmers can very well increase their productivity by reducing the use of inputs like fertilizers and save the vital resources like water simultaneously. It therefore, enables sugar cane farmers reap greater economical benefits by maintaining ecological sustainability.

REFERENCES

1. Biksham Gujja *et al.*, *Training Manual on Sustainable Sugarcane Initiative*, 4-5, 2009.
2. Vignesh and Selvakumar, *Kisan world*, **33**, 8, 33, 2006.
3. U. S. Natarajan, *First National Seminar on Sustainable Sugarcane Initiative, SSI-A methodology to improve cane productivity held at TNAU, Coimbatore*, 21-23. 2011.
4. A. K. Srivastava *et al.*, Physiological interventions for enhancing sugarcane and sugar productivity, *Published online in Springer link*, 3rd June, 2014, 1-2. 2014.
5. Radha Jain *et al.* *Acta Physiol. Pl.*, **33**, 905-910. 2011.
6. Agsri, *First National Seminar on Sustainable Sugarcane Initiative, SSI-A methodology to improve cane productivity, TNAU, Coimbatore organized by Agsri, SBI and NRMC (NABARD)*, 24th-25th Aug, 2011, 3-8, 2011.

SCIENTIFIC STORY OF OUR LAUGHTER, CRYING AND STRESS

Nivedita Acharjee

Our thoughts, intentions, decisions and actions are dictated by our emotions. Emotions trigger the release of different hormones in human body which affect our mood and these biochemical messengers are responsible to regulate normal functioning of tissues and organs especially the human brain. There exists a scientific interplay between our emotions and the released hormones. Positive and negative emotions are essentially required to be channelized in different situations and age-groups of human life. This can be exercised only if we are well aware of the scientific story behind our emotions. This article primarily focuses the scientific and psychological aspects of three intense emotions- laughter, crying and stress.

INTRODUCTION

Ben Goertzel has defined emotions as "A mental state that does not arise through free will, and is often accompanied by physiological changes". Our emotions indeed serve as a delicate and sophisticated internal guidance system at every moment of our life. When we feel lonely, we need a company as needed by our emotions. When we feel afraid, we need safety as guided by our emotions or when we feel sad, we need to be consoled as demanded by our emotions. Goleman's 1995 book on emotional intelligence presented the importance of our emotions for survival, decision making, predicting behavior, boundary setting, communication, happiness, unity etc. Our brain is the controlling authority of our emotions. Hormones are one of the important factors operating to produce a particular pattern of emotional behavior under different circumstances. We always think that our hormones control our emotions. However, it is the other way round, emotions control our hormones through biochemical changes in our brain. Laughter, anger, crying and stress issues trigger the release of these chemicals or hormones to maintain the balance in our body. The present article aims to summarize some of the hormonal changes associated with these four emotions in addition to some associated scientific facts.

Department of Chemistry, Jalpaiguri Government Engineering College, Jalpaiguri-735102, West Bengal, E-mail : nivedita_acharjee@rediffmail.com

LAUGHTER

Mark Twain once said "The human race has only one really active weapon, and that's laughter". What is laughter? Why do we laugh? Is it healthy for life? Are we happy because we laugh? Or do we laugh when we are happy? Let us discuss some simple answers to these.

Laughter is a complex process of our body which involves complicated activities of our brain. There are different theories to underline the causes of our laughter. According to *relief theory*¹, we need a release of our emotions through our laugh. The *incongruity theory* explains that we laugh when our logic doesn't match with a situation or a joke. This is infact the basic principle of a comedian. When he or she dictates a joke, the audience tries to understand the same. When the latter realize that the inconsistency of the joke doesn't match with their logical expectations, it makes them laugh at the end. *Superior theory* is another theory of laugh. This implies when we consider ourselves superior to someone else and we laugh at their ignorance and mistakes.

It is worth mentioning in this context that age, gender, culture, education, language and knowledge of a person determine the causes and extent of his or her laughter. Small children learn to laugh before they can talk or judge situations properly. We often laugh because someone else is laughing. According

to Robert Provine, psychologist and neuroscientist from the University of Maryland, comedians laugh 46% more than the listeners². It is based on their subconscious thinking that if they laugh, the audience is likely to laugh. This subsequently makes the speaker more comfortable while performing. When we laugh, there is release of a of healthy hormones. Endorphins and interferon-gamma (IFN) are two vital ones within the cocktail. Endorphins³ are released from the pituitary glands. *Endo* means endogenous and *orphin* refers to morphine. These are endogenous opioid peptides, just like morphine secreted in our body without any side effects. Endorphins act as natural pain killers. We feel happy and calm when these are released in our body. However, endorphins remain in our blood for a very few seconds. These also protect us from stress, hypertension and depression, increase our memory and keep us healthy and cheerful. Interferon gamma activates T cells, B cells, immunoglobulin and NK cells in our body. This helps to fight viruses, strengthens our immune system and regulates cell growth.

About 2000 years ago, Physician Galen stated that cheerful women have lesser probability of getting cancer than depressed women. According to a 1989 study⁴, laughter can decrease the serum levels of cortisol, dopac, epinephrine and growth hormone. Cortisol is commonly called the stress hormone. It is released by the adrenal glands whenever we recognize a threat or tension.

When we laugh, we make gestures and sounds and our facial muscles contract. A 2010 study⁵ published in FASEB journal reported that our body responds to repetitive laughter and repetitive exercise in a similar manner.

CRYING

Tears play an important role in our biological and social experiences. In the words of cultural historian, Thomas Dixon, "Tears are intellectual things. They are produced both by thoughts and the lachrymal glands." Shakespeare said "To weep is to make less the depth of grief".

Tears are advanced form of our body excretions.

They can be categorized into three types: (a) Basal tears (b) Reflex tears (c) Emotional tears.

Basal tears⁶ are formed continuously. They are secreted by the lachrymal gland under the upper eyelid. Every time we blink, basal tears are spread over the surface of our eyeballs. It causes eye lubrication and prevents our eyes to completely dry out. Basal tears are composed of water, little mucus (which allows them to adhere to the eye surface), nutrients, glucose, lysozyme (antibacterial enzyme), lipocalin (protein transporter), urea, potassium and sodium. These tears travel to the nose through the tear duct which renders our nose moist and inhibits bacterial infection. Human body produces an average of 5 to 10 ounces of basal tears each day. Basal tears are never referred to as crying. They are merely denoted as the secretions of lachrymal fluid. When these secretions overwhelm the draining capacity of the tear duct, it is called the crying process. Reflex tears and emotional tears are generally considered within the crying process.

Reflex tears⁷ are produced under the influence of a stimulant. When our eyes are hit by wind, sand, insects, rocks, chemicals etc, then the lachrymal gland secretes excess fluid (reflex tears) to wash out the irritant. When we cut onions, the enzyme called lachrymatory-factor synthase⁷ is released which converts the onion amino acids to sulfenic acid. Sulfenic acid is transformed to syn-ropanthethial S-oxide which irritates the lachrymal glands and behaving as an eye-intruder, it triggers the formation of reflex tears. These tears contain 98% water and higher concentration (than basal tears) of antibodies and enzymes to target the microorganisms. Reflex tears are not produced continually like basal tears. Under the irritant attack, the sensory nerves in our cornea send signals to the brain stems which trigger a hormone signal to the lachrymal gland for shedding reflex tears.

Our body has its own processes to remove toxins and excess stress hormones. Emotional tears serve as one of these processes to release stress and tension and wash the toxic chemicals out of our bodies. Human beings are believed to be the only living

creatures to shed emotional tears. However, Charles Darwin has pointed out in "The Expression of the emotions in Man and Animals" that zoo keepers told him about elephants which shed tears in sorrow. Dr. William Frey, biochemist and tear expert, studied⁸ the composition of our tears and concluded that emotional tears contain stress hormones contrary to basal and reflex tears. When crying related emotions get registered into the brain, the cerebrum triggers the release of hormones which travels to the glands behind our eyes (ocular area) and causes emotional tears. Emotional tears mainly contain three chemicals: (a) Leucine enkephalin- A mood elevating and pain decreasing endorphine; (b) Adrenocorticotrophic hormone (ACTH)- a hormone released during stress; and (c) Prolactin- a hormone which regulates milk production in mammals. Emotional tears have 24% higher protein concentration than in reflex tears. According to Journal of Social and Clinical psychology⁹, crying has its own benefits. We feel better after a good cry. Manganese is involved in regulating our moods and depressed people contain higher levels of manganese in their systems. Emotional tears remove concentrated manganese from our body since they have 30 times greater manganese compared to the blood serum.

Research studies¹⁰ have reported that women cry an average of 5.3 times a month, while men cry an average of 1.3 times per month. These findings have been supported biologically since testosterone in men inhibits crying and prolactin hormone is found in higher concentrations in women. Prolactin hormone in body has been correlated with the frequency of emotional tears. Men can discharge their stress by other channels especially through their sweat glands. Men generally sweat more than women and sweat contain most of the similar chemicals as tears.

Too much or frequent crying masks the healing effect of tears and often leads to depression. Crying leads to a feeling of lump in the throat, referred to as global sensation. Some researchers have also reported¹¹ that infants who have experienced

persistent crying episodes are likely to develop high stress hormone levels and low growth hormone levels leading to poor school performance, lack of responsiveness and antisocial behavior.

STRESS

In the words of stress physiologist Hans Selye, "Stress is the nonspecific response of the body to any demand made upon it". We generally associate stress to negative situations. However, if our lives are completely devoid of stress, then we will be incapable to react to the different challenges of life. The optimal positive stress level prevalent in an individual is referred to as eustress while harmful stress is known as distress. Stress is popularly defined as time pressure. An individual feels stressed when sufficient time is not available to perform the scheduled tasks. However, this definition doesn't apply to all. Actually stress denotes a highly individualized experience and is not exclusively time pressure dependent.

John Mason¹² in 1968 pointed out that under stress, an individual has the feeling that he or she does not have a control over a particular situation. Stress can be absolute or relative. Absolute stress refers to the real threat. Natural (e.g. earthquake, floods, landslides etc) or anthropogenic (e.g. bhopal gas tragedy) degradations induce real threat. We naturally adapt some absolute stressors; for example, stress induced by extreme hot, acute cold or a dangerous animal. Sometimes, an individual can interpret an unpredictable and/or uncontrollable situation and experience stress which is relative; like delivering lecture in a public meeting. Human brain conducts the complex thinking process of sensation, perception, apperception, association and memory through different sections. Stress disrupts the functioning of these sections and therefore interferes with our cognitive processes. It leads to hasty decisions and deterioration of judgment.

Stress induces the release of a wide range of hormones. There are two major classes of stress hormones, catecholamines (adrenaline and nor-adrenaline) and the glucocorticoids (cortisol). Whenever a stressful situation arises, brain sends

message to the adrenal glands which release the flight or fight, adrenaline. Our heart starts pounding, our muscles are tense, our breathing gets faster and we start sweating. That is adrenaline. Another hormone norepinephrine is released from the adrenal glands. It keeps us more awake and focused during stress. Therefore, sometimes we suffer from insomnia during stress. Cortisol is another stress steroid hormone produced by the adrenal glands. Cortisol is released in a multistep process. First, amygdala in the brain recognizes a stressful situation. It then sends a message to the hypothalamus to release corticotrophin-releasing hormone (CRH). CRH triggers the release of adrenocorticotrophic hormone (ACTH) from the pituitary gland. This hormone then triggers the adrenal glands to produce cortisol. An optimum level of cortisol helps to maintain our fluid balance and blood pressure. It also aids in the regulation of reproductive drive, proper glucose metabolism, blood pressure regulation, immunity, digestion and growth. However, a higher level of cortisol hampers the immune system, blood pressure and sugar levels. It causes obesity and decreases bone density. Long time stress exposure causes complete impairment of reproductive function and also affects the thyroid gland secretions. Different people have different levels of cortisol secretion. People who secrete more cortisol tend to eat more food rich in carbohydrates compared to the people who secrete less cortisol. A different research¹³ has reported that endorphins play an important role in response to stress and to the functions of adrenocorticotrophin. A study¹⁴ presented at 2007 Society for neuroscience meeting reported that hormone oxytocin has important effects under stressful conditions.

REFERENCES

1. S. Freud, *Jokes and Their Relation to the Unconscious*, Norton, Psychology, 1989.
2. R. Provine, *American Scientist*, "Laughter", Jan-Feb 1996.
3. Release of Endomorphin Hormone and Its effects on our body and moods: A Review, *International Conference on Chemical, Biological and Environmental Sciences*, Bangkok, Dec. 2011.
4. L. S. Berk, S. A. Tan, W. F. Fry, B. J. Napier, J. W. Lee, R. W. Hubbard, J. E. Lewis, W. C. Eby, *Am J Med Sci*, **298**, 390-396, 1989.
5. L. Berk, M. Prowse, G. Bains, J. Batt, J. Petrofsky, N. Daher, H. Danner, L. Ludeman, M. Lahman, S. Tan, D. Berk, *FASEB J*, **24**, 996-, 2010.
6. http://www.dryeyezone.com/encyclopedia/basal_tears.html.
7. <http://www.loc.gov/rr/scitech/mysteries/onion.html>.
8. W. H. Free, *Crying: The Mystery of Tears*, Winston Pr, 1985.
9. L. M. Bylsma, Ad J. J. M. Vingerhoets, J. Rottenberg, *Journal of Social and Clinical Psychology*, **27**, 1165-1187.
10. L. M. Bylsma, M. A. Croon, Ad.J.J.M. Vingerhoets, J. Rottenberg, *Journal of Research in Personality*, **45**, 385-392, 2011.
11. D. Wolke, P. Rizzo, S. Woods, *Pediatrics*, **109**, 1054-1060, 2002.
12. J. W. Mason, *Psychosom Med*, **30**, 576-607, 1968.
13. S. Amir, Z. W. Brown, Z. Amit, *Neuroscience & Biobehavioral Reviews*, **4**, 77-86, 1979.
14. K. L. Bales, A. I. Stone, E. M. Boone, C. S. Carter, Long-term and intergenerational effects of early handling on oxytocin, pair-bonding, and parenting in monogamous prairie voles, poster, location: San Diego Convention Center: Halls B-H, *Society of Neuroscience*, 2007.

CALCIUM AND VITAMIN D THROUGH DIET FOR HEALTHY BONES

Mithun Rudrapal* and Dipak Chetia

Bone health is largely responsible for the overall good health in our life. Poor nutrition affects adversely bone health particularly in deficient conditions. Good nutrition is therefore crucial for maintaining bone health. Calcium and vitamin D are the key nutrients inevitably required to build strong bones. Calcium is necessary to build new bone, and vitamin D helps the body to absorb calcium. They are important at every stage of life, not only to form new bone tissue but also to prevent bone loss. Inadequate intake may lead to reduced bone mass, early bone loss, increased risk of developing osteoporosis, in which bones become so weak and brittle that may ultimately lead to fractures with chronic pain and skeletal deformity. Osteoporosis is a serious bone related health problem which affects predominantly older people over the age of 50. Taking calcium and vitamin D through diet in adequate (required) amount is important and enough in large extent for the strong bones with a faster rate of bone formation and lower rate of bone loss. It is not that calcium requirement in our diet is just important for older people to prevent osteoporosis, but it is equally important for children, teens, and young adults under the age of 30 to get enough calcium to build bone mass which help protect our body from serious bone loss and prevent osteoporosis later in life. It is customary to say that a balanced diet rich in calcium and vitamin D helps strengthen bones for preventing bone disorders or weakened bones at any age. However, other nutrients like magnesium, phosphorus, vitamin K, vitamin C and vitamin B₁₂ also play an important role in bone development. This article discusses how we can take care of our bones through getting right amount of calcium and vitamin D (and some other minerals and vitamins that are essential for bone health) from various dietary sources such as vegetables, herbs, spices, dairy foods and other foods

INTRODUCTION

Healthy bones are essential for a healthy life. In the human body bones perform several important functions such as provide structure, protect vital organs and store calcium. It is generally attributed that bones are the building block of human body. Bone health is largely responsible for the overall good health. However, nutrition affects bone health throughout our lives. Good nutrition is therefore crucial for healthy bones.

Calcium and vitamin D are the key nutrients inevitably required for proper growth and functioning of bones. Calcium plays a vital role in maintaining bone health, while vitamin D is necessary for the body to absorb calcium. Taking calcium and vitamin D through diet in adequate

*Department of Pharmaceutical Sciences, Dibrugarh University, Dibrugarh-786004, Assam, E-mail: rudrapal.m03@gmail.com

(required) amount is important and enough to an appreciable extent for the healthiest bones possible. If our body does not get enough calcium in the diet, stored calcium from bones are utilized for normal cell function, which can lead to weakened bones or osteoporosis. Osteoporosis is a serious bone related health problem which affects predominantly older people over the age of 50. Approximately one in two women (and about one in four men) suffers from this disorder in the world. It is not that calcium requirement in our diet is just important for older people to prevent osteoporosis, but it is equally important for children, teens, and young adults under the age of 30 to get enough calcium to build bone mass which eventually help protect our body from serious bone loss later in life. It is customary to say that a balanced diet rich in calcium and vitamin D

helps strengthen bones for preventing bone disorders or weakened bones at any age.¹⁻⁴

Though calcium and vitamin D are abundantly present in our daily foods, our body gets deprived of these important nutrients because of several reasons such as dietary modification because of changes in life style, lack of awareness about their daily requirements in our diet for positive health benefits etc.. However, other nutrients like magnesium, phosphorus, vitamin K, vitamin C and vitamin V₁₂ also play an important role in bone development. This article discusses how we can take care of our bones through getting right amount of calcium and vitamin D (and some other minerals and vitamins that are essential for bone health) from various dietary sources such as vegetables, herbs, spices, dairy foods and other foods.

CALCIUM AND VITAMIN D: DIETARY SOURCES AND ROLE IN BONE HEALTH

Calcium and vitamin D together play an important role in bone health. Calcium is necessary to build new bone, and vitamin D helps the body to absorb calcium. Thus, full bone-building potential of calcium is achieved only when there is enough vitamin D in our diet. Calcium is essentially a

building block of bone, and it helps maintain bone strength throughout our life time. Approximately 99.5% of body Ca is found in bone, where it serves a key structural role as a component of hydroxyapatite. Most foods contain calcium and vitamin D that help our body function properly. Some common sources of calcium-rich foods include dairy products, vegetables, beans, herbs, spices etc. (Table 1). On the other hand, vitamin D is of two types, viz. vitamin D₂ (ergocalciferol) and vitamin D₃ (cholecalciferol). Our body synthesizes vitamin D (cholecalciferol) when skin is directly exposed to the sunlight. Vitamin D, whether produced in the skin (cholecalciferol) from 7-dehydrocholesterol (7-DHC) or absorbed from the diet (cholecalciferol/ergocalciferol), must be metabolized first to corresponding 25-hydroxy vitamin D (25-OHD, in liver) and then to its corresponding active form 1,25-dihydroxy vitamin D (1,25-(OH)₂D), in kidney). The active forms of vitamin D help our body absorb and utilization of dietary calcium. Dietary sources of vitamin D are limited, so it is difficult to get enough of this important vitamin from food alone.^{1,4,5} There are a very few foods rich in vitamin D as depicted in table 1.

Table 1: Dietary sources of Calcium and Vitamin D.^{6,7}

| Type of food(s) | Source(s) | |
|--|---|---|
| | Calcium | Vitamin D |
| Dairy foods | Milk (whole/skim/), curd, butter milk, cheese, pudding (instant/rice) and ice cream | Milk/fortified milk, cheese, butter and cream |
| Greens and vegetables (cooked/soup/salad) | Broccoli, cabbage, celery, kale, white spinach, beet greens, collard greens, mustard greens, turnip greens, carrots, tomatoes, lettuce, okra (ladies fingers), summer squash, Brussels sprouts, rhubarb, asparagus, bok choy, green | Fortified cereals |
| Beans (canned/boiled/soup/baked/cooked), legumes and grain products Grains/grain products | Green beans, lima beans, black beans, pinto beans (chick peas), red kidney beans, white beans and soy products like soybeans, tofu (including soy milk) | - |
| Grains/grain products | Amaranth (boiled), whole wheat/white bread, whole wheat flour, brown rice, beet grains, fortified whole wheat cereal, corn muffin, waffle/pan cake (made with milk, baked), and custard(baked) | - |

| Type of food(s) | Source(s) | |
|--|---|---|
| Herbs and spices (green leafy salad/soup/juice/drinks) | Basil, parsley, fenugreek, thyme, dill weed, cinnamon, peppermint leaves, garlic, oregano, rosemary and parsley | - |
| Seeds and Nuts | Sesame seeds/ sesame paste (tahini), sunflower seeds, almonds (dry roasted), almond butter, soy nuts, oatmeal etc. | - |
| Meats, sea fish and poultry | Dried fish, Salmon (canned), sablefish (black cod), oysters, clams, shrimp (canned) and haddock | Oily fishes like shrimp, tuna, trout, pilchards, salmon, oyster, egg yolk and organ meats |
| Other foods | Calcium-fortified foods and non-dairy beverages: Cereal foods, and orange juice, soy beverage, rice beverage, orange/grapefruit beverages; Fruits: figs (dried), orange, dates; cheese pizza, macaroni, mushrooms, green tea, blackstrap molasses (black treacle), green leafy salads like romaine hearts, arugula, butter lettuce, watercress, red leaf lettuce etc. | Orange juice, vegetable fat like margarine, and soy beverage |

OTHER NUTRIENTS FOR HEALTHY BONES AND THEIR DIETARY SOURCES

Apart from vitamin D there are a number of other vital nutrients that help our body to absorb and metabolize dietary calcium. The most important of these are magnesium, phosphorus, and vitamin K. However, vitamin C and vitamin B₁₂ also play an important role in bone development. The dietary sources of these important nutrients are detailed here under.

Magnesium works closely with calcium to build and strengthen bones. It helps our body absorb and retain calcium. Magnesium is found in nuts (almonds and cashews), seeds (pumpkin, sesame, flax and sunflower), whole grains, seafood, legumes, tofu, and many vegetables (spinach, summer squash, turnip and mustard greens, broccoli, sea vegetables, cucumbers, green beans, and celery). Phosphorus works with calcium to build bones. Excess intake of phosphorus may lead to toxic signs and also causes

our body to absorb less calcium. Good sources of phosphorus include dairy products, lentils, nuts, whole grains, poultry, pork and fishes (cod, salmon, tuna). Vitamin K helps regulate calcium and form strong bones. Greens or leafy vegetables such as broccoli, Brussels sprouts, dark green lettuce, collard greens and kale are rich in vitamin K. Foods rich in vitamin C may help to prevent bone loss. Good sources include citrus fruit, such as oranges and grapefruit, strawberries, kiwi, mango, Brussels sprouts, and green bell peppers. Vitamin B₁₂ also helps increase bone density. Good sources of B₁₂ include seafood such as salmon, haddock, and canned tuna, as well as milk, yogurt, eggs and cottage cheese.

BONE HEALTH AND OSTEOPOROSIS

Bone is formed from a complex matrix of proteins within which calcium and other minerals like magnesium and phosphorus are abundantly deposited, where calcium and phosphate combines

together to form a crystalline complex, called hydroxyapatite $[\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2]$. Hydroxyapatite contributes hard and rigid structure to bones, which is essential to its function in supporting soft tissues and as a store of calcium for other body functions like regulation of nervous system and heart and muscle contraction etc. The more calcium and minerals deposited in bone (during childhood and adolescence), the stronger the bones develop. This physiological function of new bone formation continues on a daily basis until it reaches peak bone mass just before the age of about 35. Peak bone mass is the stage when our bones are strongest and is usually reached at 30-35 years of age. During this period the rate of bone formation is greater than bone loss (bone resorption), so our bones get stronger. At the age of 35, bone loss occurs at a faster rate than bone formation. Lack of sufficient calcium in the diet during childhood and adolescence significantly affects peak bone mass increasing the rate of bone loss which in turn increases the risk of developing osteoporosis. Osteoporosis is a condition in which low bone mass and deterioration of the bone tissue results in fragile bones (thinning of the bone). In osteoporosis, bones become so weak and brittle that a fall or mild stress like bending over or coughing can cause fractures. Osteoporosis can affect all the bones in the body, but fractures to bones in the wrist, spine and hip are most common. Bone fracture lead to chronic pain and possibly deformity. Women are at a higher risk for osteoporosis than men. While many factors such as physical activity, body shape/body frame and diet play a role in osteoporosis, postmenopausal women (mainly due to lack of estrogen) are often at particular risk. Women have certain female hormones that help preserve the strength of bones and slow down bone loss between the age of 25 and 50. But after menopause, the production of female hormones is decreased and there is a drastic increase in the amount of bone tissue that is lost. So after the age of 50, women lose more bone tissue than do men. This is the primary reason why women are at a greater risk for osteoporosis than men. Men and women who have small body frames

are also at a higher risk of developing osteoporosis. People with a sedentary lifestyle also have a higher risk for osteoporosis when compared to active people⁶⁻⁸.

BUILDING STRONG BONES: PREVENTION OF OSTEOPOROSIS

Calcium and vitamin D together build strong bones and protect it from bone loss. They are important at every stage of life, not only to form new bone tissue but also to prevent bone loss. Inadequate calcium contributes to diminished bone density, early bone loss, increased fractures and development of osteoporosis. A greater bone mass is associated with a lower the rate of bone loss with ageing, and a reduced risk of fracture and osteoporosis. The risk of fracture and osteoporosis in later life are lower in people who develop stronger bones during life. The bone loss is an important determinant with regard to the strength of bones and prevention of osteoporosis. There are number of ways to reduce bone loss to build strong bones in the prevention of osteoporosis program.

- 1) **Physical exercise:** Regular physical activity is essential to building and maintaining strong bones. Any weight bearing exercise is beneficial. This places some load on the bones and reduces bone loss. Activities like walking, jumping, dancing, jogging, stair climbing, skipping rope, racquet sports, hiking and weight lifting appear to be particularly helpful for healthy bones.
- 2) **Recommended daily intake of calcium and Vitamin D:** Getting enough calcium and vitamin D either through diet is an essential part of osteoporosis prevention plan. National nutrition surveys have shown that most people are not getting the calcium they need to grow and maintain healthy bones. However, Magnesium works closely with calcium to build and strengthen bones and prevent osteoporosis. Studies have also indicated that vitamin C and vitamin B₁₂ may play important roles in bone health and the prevention of osteoporosis. Dietary intake of calcium and vitamin depends

on many factors, such as, age, gender, drugs, hormone status, and bone mineral density. The National Osteoporosis Foundation's (NOF) recommended calcium and vitamin D intake according to age, sex and hormone status as described in table 2.

Table 2: Recommended daily intake of calcium and vitamin D^{8,9}

| Infants, children & adolescents | Calcium | Vitamin D |
|--|----------------|------------------|
| 6 months to 1 year | 270 mg | 400 IU* |
| 1 to 3 years | 500 mg | 400 IU* |
| 4 to 8 years | 800 mg | 400 IU* |
| 9 to 18 years | 1,300 mg | 400 IU* |
| Adult women & men | Calcium | Vitamin D |
| 19 to 49 years | 1,000 mg | 400-800 IU |
| 50 years and over | 1,200 mg | 800-1000 IU |
| Pregnant & breast-feeding women | Calcium | Vitamin D |
| 18 years and under | 1,300 mg | 400-800 IU |
| 19 years and over | 1,000 mg | 400-800 IU |
| Postmenopausal women | 1,200-15,00 mg | 500-800 IU |

*Recommendation of the American Academy of Pediatrics; 40 IU= 1 mcg

- 3) **More alkali foods and less acid foods:** Intake of plenty of alkaline foods such as fruits and vegetables balance out or neutralize the acid from the protein (processed meat) and refined cereal grains (white bread, pizza dough, muffins, cookies etc.) in our diet. Acid foods increase calcium loss from the body.
- 4) **Minimizing calcium draining substances in diet:** There are a number of foods and substances that, when consumed in excess, drain calcium from our bones and deplete your body's calcium stores. Salt (Table salt): Eating too much salt can contribute to calcium loss and bone breakdown. Packaged and convenience foods, fast foods, and processed meats must therefore be avoided. Caffeine: Drinking coffee should limit to 2 cups

per day beyond which may lead to calcium loss. Alcohol: Alcohol interferes with the body's ability to absorb calcium. Reduce alcohol consumption can be reduced to a maximum of one drink per day. Soft drinks (phosphoric acid): In order to balance the phosphates in soft drinks, your body draws calcium from your bones, which is then excreted. Water or calcium-fortified orange juice can be opted for instead⁷⁻⁹.

CONCLUSION

To achieve good bone health calcium and vitamin D are the essential nutrients in our diet that can be obtained in adequate quantities from a variety of dietary sources such as vegetables, dairy foods, and other foods as described above to meet our body's requirement at any stage of life. Along with them other important nutrients such as magnesium, phosphorous, vitamin C etc. also play vital role in bone growth and development. Additionally, regular physical exercise and diet restriction (foods that hinder calcium absorption or calcium draining substances) can be adopted for building strong bones during early life and preventing bone loss in later life. Thus, the risk of developing osteoporosis can be prevented. However, in case of insufficient intake of calcium and vitamin D from dietary sources particularly in deficiency conditions they can be administered through fortified foods and/or dietary supplements (e.g., fortified milk, calcium citrate, multi-vitamin or vitamin D supplements etc.) readily available in the market. However, it is not generally recommended to consume these nutrients from commercial dietary supplements unless serious medical cases because our body is able to absorb more calcium from dietary foods than it can from supplements. Moreover, studies have shown that people who get most of their calcium from food have stronger bones than those who obtain it from supplements. Besides, using high-dose calcium supplements may increase the risk of kidney stones and heart diseases. Because of this reason doctors advise that to get as much of our daily calcium needs from foods as possible and use only low-dose supplements to make up any deficiency states.

REFERENCES

1. R. K. Murray, D. K. Granner, P. A. Mayes and V. W. Rodwell, *Harper's Illustrated Biochemistry*, 2003, 26th Edn., The McGraw-Hill Companies, Inc., Asia (India).
2. U. Kini and B. N. Nandeesh, *Radionuclide and Hybrid Bone*, 2012, Springer-Verlag Berlin, Heidelberg.
3. D. Daniel and V. A. Bikle, *Chem Biol*, **21**, 319-329, 2014.
4. R. Rizzoli, S. Boonen, M. L. Brandi, *et al.*, *Bone*, **42**, 246-249, 2008.
5. J. A. Sunycz, *Ther Clin Risk Manag*, **4**, 2008, 827-836, 2008.
6. <http://www.niams.nih.gov> (access date: 02/07/2016).
7. <http://www.webmd.com> (access date: 18/07/2016).
8. <https://medlineplus.gov> (access date: 22/07/2016).
9. <https://medlineplus.gov> (access date: 22/07/2016).

CONSUMPTION OF HEAVY METALS CONTAMINATED VEGETABLES: A THREAT TO HUMAN HEALTH

Anupa Yadav

Accumulation of toxic metals in vegetables due to irrigation of agriculture fields with treated/untreated wastewater becomes a global problem. Heavy metals accumulation in vegetables depend on both types of soil and vegetable. Consumption of heavy metals contaminated vegetables for long time period cause clinical problem in humans and animals too.

INTRODUCTION

Contamination of agricultural field soils with heavy metals has become one of the most significant environmental problems today. Surface water sources get polluted due to anthropogenic activities either directly (effluent discharge from industries) or indirectly (surface run off from polluted lands) and on the other hand scarcity of fresh water for irrigation purpose. Therefore application of polluted river water, industrial waste, some time sewage water is widely used for the irrigation of crops in the urban areas worldwide which ultimately leads to contamination of agro-products. Metal uptake by vegetables /crops/ plants may have adverse impacts on human health through the food chain¹. Therefore, the food chain contamination is the major pathway of trace metal exposure for humans². Consumption of heavy metals contaminated vegetables cause clinical problem in humans and animals too.

SOURCES OF HEAVY METALS IN VEGETABLES

Some of the heavy metals (like Cu, Fe, Ni, Zn, Mn) are essential for the growth and development of the plants when present in trace amount, but at excessive concentration these become toxic. Both natural and human activities, directly or indirectly responsible for increase in heavy metals concentration in the environment. To increase the yield of agro-products and due to cost effectiveness farmers use Department of Industrial Hygiene, Regional Occupational Health Centre (Eastern), (Indian Council of Medical Research), Kolkata-700091, Email- anupayadav08@gmail.com

compost, organic manure, fertilizers, sewage sludge³, treated or untreated industrial /municipal effluent for irrigation purpose⁴ that leads to accumulation of heavy metals in soil. The various anthropogenic activities results in elevation of heavy metals in soil and vegetables are presented in Table 1.

Table 1. Sources of Heavy Metals in agriculture soil and agro-products

| Contamination of Soil/Vegetable | Activities | Heavy Metals | Ref. |
|---------------------------------|--|---------------------------------------|------|
| Soil | Mining | As, Ni, Co, Cu | 5 |
| Soil | Mining and Smelting | Cd, Cu and Zn | 6 |
| Soil and crops | Use of pesticides, fungicides, organic/inorganic fertilizers | Cd, Ni, Mn, Co, Cu | 7 |
| Vegetables | Treated and untreated waste water use for irrigation | Cd, Pb and Ni | 8 |
| Soil | Sewage effluents use for irrigation | Fe, Mn, Cu, Zn, Pb, Cr, Ni, Cd and Co | 9 |

HEAVY METALS UPTAKE BY VEGETABLES

All sources contribute heavy metals to the soil from where these are translocated into different plants parts via root up-take. Accumulation of heavy metals and their uptake by different plant parts

depends on the concentration of available heavy metals in irrigation water/ soil, type of metals and physico-chemical characteristic of soil. The range of known transport mechanisms or specialized proteins embedded in plasma membrane of the plant cell involved in ion uptake and translocation. These embedded proteins include: (1) proton pumps (ATPases that consume energy and generate electrochemical gradients), (2) co- and anti-transporters (proteins that use the electrochemical gradients generated by ATPases to drive the active uptake of ions), and (3) channels (proteins that facilitate the transport of ions into the cell). Each transport mechanism is likely to take up a range of ions. Positive metal ions are attracted towards negative charges (like hydroxyl group and electron pairs of oxygen) present in clay minerals and carboxyl and phenolic groups of organic substances¹⁰, whereas negative metal ions are attracted to positively charged hydrous oxides of Fe and Al. The rate of solubilisation of metals and differences in plant species also affect the availability of metals, this is due to difference in their genotype and transport properties¹¹.

ACCUMULATION OF HEAVY METALS IN VEGETABLES

Heavy metals accumulation in vegetables depends on various parameters like i) Source of contamination, ii) plant species, iii) seasonal variation and iv) Soil pH etc.

i) **Source of contamination:** Vegetables like cucumber, tomato, green pepper, lettuce, parsley, onion, bean, eggplant, peppermint, pumpkin and okra grown in urban area were affected due to municipal, domestic, traffic and some industrial discharges while same varieties of vegetables grown in rural area affected by traffic and industrial activities only. Vegetables which were grown in urban area have higher concentration of heavy metals like Cd, Pb, Cu and Ni than the vegetables of rural area. Heavy metals Concentrations (mg/kg) in vegetables like cucumber, tomato, green pepper, lettuce, parsley, onion, bean, eggplant, peppermint,

pumpkin and okra of urban area ranged from 0.34-0.97 for Cd, 5.3-10.7 for Pb, 32.6-76.5 for Cu and 1.8-13.45 for Ni whereas in rural area vegetables 0.24-0.63 for Cd, 3.00-8.00 for Pb, 22.19-60.40 for Cu and 0.44-4.10 for Ni. Observed difference between level of heavy metals in vegetables of urban and rural areas showed a direct correlation with the sources of metals exposure to the vegetation¹².

- ii) **Plant species:** The tendency of plants to accumulate heavy metals not only depends upon the environmental contamination but also on plant species. Monitored concentration of heavy metals (Cu, Zn, Cd & Pb) in vegetables like spinach and lady's finger grown in Delhi urban area, contaminated through industrial effluents, sewage sludge and traffic emission. It was found that levels of heavy metals (mg/kg) varied 7-50, 51-282, 1.4-9.0 and 1.7-9.2 for Cu, Zn, Cd & Pb respectively in spinach, and in lady's finger it varied from 12-29, 39-156, 0.4-6.0 and 0.8-7.3 for Cu, Zn, Cd & Pb respectively. Accumulation of heavy metals is more in spinach than lady's finger¹³. This difference is ascribed to the physiology and morphology of the plant like variation in root interception of metal ions, variation in entry of the metal ions through mass flow and diffusion and translocation of metal ions from the root to shoot, their accumulation tendency and retention capacity¹⁴. It was also observed that Cu and Cr concentration was higher in leafy vegetables (like palak, amaranthus and cabbage) than non-leafy vegetables (brinjal, lady's finger and tomato)^{15,16}. It may be due to higher transpiration rate of plants to maintain the growth and moisture content of the plant¹⁷.
- iii) **Seasonal variation:** Seasonal variations also have significant effects on heavy metals concentration in vegetables. A Indian study on vegetables contamination by heavy metals showed that concentration of metals (mg/kg) like Cd (4.2), Zn (29), Cr (18) and Mn (125) were higher in summer but for Cu (16.5), Pb (16.0) and Ni (7.5) higher in winter⁴. It might be

possible that decomposition rate of organic matter was higher during the summer season so there is more release of heavy metals in soil solution for uptake by plants¹⁸.

- iv) **Soil pH:** Soil pH had the greatest impact on desorption and bioavailability of heavy metals, because of its strong effects on solubility and speciation of heavy metals both in the soil as a whole and particularly in the soil solution¹⁹. A negative correlation has been observed in numerous studies for transfer of heavy metals to the plants and soil pH^{20,21}. A study on smelter contaminated site showed highest accumulation of Cd in mint (2.22mg/kg) than other vegetable like spinach (0.743mg/kg), lettuce (0.424mg/kg), leek (0.200mg/kg) and cabbage (0.062mg/kg). This was attributed due to acidic nature of the soil²².

HEALTH RISK BY CONSUMPTION OF CONTAMINATED VEGETABLES

Heavy metals intake through the food chain by human population has been widely reported throughout the world. The exposure of human beings to toxic heavy metals increases day by day either directly or indirectly by increasing application of heavy metal contaminated water for irrigation purpose. Absorption of heavy metals in human digestive tract depends on the chemical nature of heavy metals, human age and nutritional status. If diet are deficient in Ca, Fe and Zn, individual absorb more Pb from their food²³. Due to persistent and non-biodegradable nature, these toxic heavy metals are accumulated in human tissues like kidney, bone and liver that results in various health problems. To quantify the health risk value, a target hazards quotient (THQ) is calculated²⁴. It provide indication of the risk due to exposure for both carcinogenic and non-carcinogenic pollutants. It depends upon exposure frequency (the number of days food consumed per year), exposure duration (the life expectancy of the person), quantity of food consumed per day, concentration of metals in the food (oral reference dose), average body weight and an exposure time for non-carcinogens. If value of

THQ > 1.0, then it indicates a potential concern for health.

CONCLUSION

Heavy metals are one of the major ubiquitous toxic pollutants and their removal from polluted water/soil is urgently required to reduce their impact on various food chains and to maintain the concentration of heavy metals within the safe limits. Vegetables are one of the major components of common food habit because they provide essential micro and macronutrients, proteins, antioxidants and vitamins to the human body. Now days due to scarcity of fresh water for irrigation purpose, all vegetables are grown in suburban areas by the use of wastewater experiencing high concentration of heavy metals. Heavy metals contaminated sites are suggested to be used for growing ornamental and timber plants rather than growing vegetables to minimize bio-accumulation/bio-magnification of heavy metals in human beings through various food chain.

REFERENCES

1. F. N. Sadon, A. S. Ibrahim and K.N. Ismail. *Journal of Purity, Utility Reaction and Environment*, **1**, 308-334, 2012.
2. S.Q.Khan, Y.M. Cao, Y.Z. Zheng and Y.G. Huang. *Environmental Pollution*, **152**, 686-692, 2008.
3. R.P. Singh and M. Agrawal. *Chemosphere*, **67**, 2229-2240, 2007.
4. R. K. Sharma, M. Agrawal and F.M.Marshall. *Ecotoxicology and Environmental safety*, **66**, 258-266, 2007.
5. I. Razo, L. Carrizales, J. Castro, F. Diazbarrigs and M.Monroy. *Water, Air and Soil Pollution*, **152**, 129-152, 2004.
6. N. Herawati, S. Susuki, K. Hayasi, I.E. Rivai and H. Koyama, *Bulletin of Environmental Contamination and Toxicology*, **64**, 33-39, 2000.
7. M.B. McBride. *Advances in Environmental research*, **8**, 5-19, 2003.

8. H.A. Khan, I.A. Arif and A.A. Homaidan. *International Journal of Food Properties*, **15**, 6, pp 1212–1219, 2012.
9. R.K. Rattan, S.P. Datta, P.K. Chhonkar, K. Suribabu and A.K. Singh. *Agriculture, Ecosystem and Environment*, 109, 3–4, 310–322, 2005.
10. K. Mengel and E. A. Kirkby. *Principles of plant Nutrition, International Potash Institute Bern, Switzerland*, 347-373, 1982.
11. Z. Kafka and M. Kurus In: *Cheremissionoff Paul N. (Ed) Ecological Issues and Environmental Impact Assessment*, Gulf Publishing Company, Houston, Texas, 175-180, 1997.
12. D. Demirezen and A. Aksoy *Journal of food Quality*, **29**, 252-265, 2006.
13. S. Singh and M. Kumar, *Environmental Monitoring and Assessment*, **120**, 79-91, 2006.
14. C.H. Carlton-Smith and R.D. David. *Proceedings of International Conference on Heavy Metals in the Environment. CEP Consultant Ltd. Edinburg, U.K.*, 3933-3940, 1983.
15. R.K. Sharma and M. Agrawal. *Journal of plant Nutrition*, **29**, 1791-1804; 2006.
16. G. Wang, Y.S. Miao, Y.H. Chen, F.F. Lin, L. Dan and S.F. Gao, *Environmental Pollution*, **144**, 127-135, 2006.
17. F.H. Tani and S. Barrington, *Environmental Pollution*, **138**, 538-547, 2005.
18. S.P. McGrath, A. C. Chang, A. L. Page and E. Wilter, *Environmental review*, **2**, 108-118, 1994.
19. G. Muehlbachova, T. Simon and M. Pechova. *Plant Soil and Environment*, **51**, 26-33, 2005.
20. A. S. Wang, J. S. Angle, R. L. Chaney, T. A. Delorme and R. D. Reeves, *Plant and Soil*, **281**, 325-337, 2006.
21. A.K. Ghosh, M. A. Bhatt and H. P. Agrawal. *Environmental Monitoring and Assessment*, **184**, 1025-1036, 2012.
22. G. A. Kachenko and B. Singh, *Water, Air and Soil Pollution*, **169**, 102-123, 2006.
23. K. R. Mahaffey, *Environmental Health Perspectives*, 89, 75-78, 1990.
24. U. S.EPA, 2002. *United State, Environmental Protection Agency, Region 9, Preliminary remediation goals*. <<http://www.epa.gov/region09/waste/sfind/prg>>

KNOW THY INSTITUTIONS**NATIONAL INSTITUTE FOR RESEARCH IN TRIBAL HEALTH , JABALPUR**

Regional Medical Research Centre for Tribals (RMRCT) started functioning in 1984, at Jabalpur , from three rooms in Medical College with a handful of staff . The centre continued functioning from Medical College till 1990 to address mainly to the study of the health and nutritional problems of the tribal populations, including nutritional disorders, common communicable diseases, environmental health problems, etc. The State Health has utilized the expertise of the scientists in planning, monitoring and evaluation of tribal health and other developmental programs in tribal areas of Madhya Pradesh and Chhattisgarh and also in training health functionaries of the se states. This Centre is also attempting simultaneously to estimate the magnitude of health problems posed by other common diseases such as malaria, tuberculosis, leprosy, diarrhoea, filariasis, venereal diseases, poliomyelitis, measles, etc. Further, the Centre also studies the blood groups, abnormal haemoglobins and other genetic health problems to stratify areas and to suggest control measures including interventions. Socio economic, demographic and cultural profile of the tribal

population gives an insight about how they play an important role in complicating and enhancing the magnitude of the problem. The centre was shifted to the main building of RMRCT in April 2002 and now establishing laboratories for Molecular Genetics, Immunology, Microbiology and Clinical Epidemiology in full swing. RMRCT has been designated as National Institute for Research in Tribal Health (NIRTH) in the year 2015.

Vision

To improve health, nutrition and educational awareness of tribal through basic, applied and operational research to levels that they are no longer considered under privileged communities of the country.

Objectives

To plan, conduct and coordinate research in order to bring out the specific health problems and health needs of the tribal of the country.

To conduct epidemiological studies of communicable and non -communicable diseases among the tribal.

To investigate haemoglobinopathies in tribal and other communities.

To advise and assist the Government in planning, executing, monitoring and evaluation of tribal health programmes and in training of health functionaries

Thrust Areas

1. Haemoglobinopathies and malaria Work on the genetic disorders by mapping the genetic traits/diseases.
2. Work on bio-medical and behavioural aspects of malaria using technology driven laboratories developed by it over the years.

RMRCT, Jabalpur is designated recently as WHO Collaborative Centre for Research on the Health of Indigenous People. RMRCT, Jabalpur works in close coordination with many international organizations in collaborative research or organizing symposia, etc. e.g. Centre for Disease Control, London School of Tropical Medicine, Liverpool School of Tropical Medicine and Hygiene, UNICEF, WHO, DFID, USAID, US Embassy, etc.

RMRCT, Jabalpur jointly with NIMR-Field Station, Jabalpur organises from time to time training workshop for medical officers on malariology. RMRCT, Jabalpur also organizes various national/international symposia, workshops and trainings. Students from various universities such as Rani Durgawati Vishwavidyalaya, Jabalpur, etc. have completed their M.Sc dissertation work under the guidance of scientists of the centre.

Rani Durgawati Vishwavidyalaya, Jabalpur through a memorandum of understanding in 2008 has recognized the centre/ scientists for guiding bio-medical and socio-behavioural health research students for the degree of Ph.D. The centre is also recognized for Ph.D work by Jiwaji University, Gwalior.

Significant achievements of RMRCT, Jabalpur are

Tuberculosis laboratory of the Centre is recently recognized as Intermediate Referral Laboratory (IRL) beside State Referral Laboratory for HIV. The Centre has established the H1N1p testing laboratory and is receiving samples from different parts of Madhya Pradesh. Establishment of a Sick cell clinic at the NSCB Medical College, Jabalpur where regular diagnosis, counseling and treatment is given to the patients mostly from the rural areas. Malaria clinic at the NSCB Medical College for prompt diagnosis. Round the clock malaria clinic at Jagdalpur in Chhattisgarh (CG) to cater to the need of the rural tribal population. On fluorosis, the nutritional supplementation and safe drinking water model of the centre has been accepted by the programme for prevention of the disease.

Establishment of close linkages with the Tribal Welfare Department, Government of India as well as Government of Madhya Pradesh for providing technical assistance/evaluation of programmes and for receiving financial support for the research studies.

Contact :

Director

National Institute for Research in Tribal Health (NIRTH) Formerly: Regional Medical Research Centre for Tribals (RMRCT) (Indian Council of Medical Research) Department of Health Research, Ministry of Health & Family Welfare NIRTH Complex, Nagpur Road P.O. - Garha, Jabalpur - 482 003, Madhya Pradesh, Phone:- +91-761-2370800, 2370818, 2673807, 3204738, Fax:- +91-7612672239,2672835;

E-mail:- director@nirth.res.in

CONFERENCES / MEETINGS / SYMPOSIA / SEMINARS

International Conference on Chemistry for Human Development (ICCHD-2018), 8th-10th January, 2018, Kolkata.

Topics:

Chemistry of Natural Product
Carbohydrate Chemistry
Organic Synthesis
Catalysis
Medical Chemistry
Herbal Drugs

Advanced Bioorganic and Biochemistry
Structural Chemistry
Chemistry and Industry
Organic Materials
Nanoscience and Engineering

Contact :

Prof. Dilip K. Maiti, Dept. of Chemistry, University of Calcutta, 92, A.P.C. Road, Kolkata-700009, E-mail: icchd2018@gmail.com / dkmcchem@caluniv.ac.in / kali.dhara@gmail.com; Fax: +91-33-2351-9755; Phone: 91-9836307419/9433379965/7980617676 (DKM)/9433166973(KPD).

National Conference on Diversity and Utilization of Tropical Plants, 24-25, January, 2018, Gorakhpur.

Topics:

Status of Plant Diversity and Impact of Climate Change
Plant Genetic Resources and Their Conservation
Utilization of Plants for Food and Medicine

Pre and Postharvest Crop Protection
Physiological, Biochemical and Molecular Aspects of Biodiversity and Utilization of Plant Products

Contact :

Prof. V. N. Pandey, Head, Department of Botany, E-mail: conferencebotany.gkpuniv@gmail.com

National Symposium on Contributions of Women in Science in India (NSCWSI-2018), 15th - 16th February, 2018, Kolkata.

Topics:

Scientific Lectures on Researches Being Conducted by Our Women Scientists in the Chemical, Physical Biological, Pharmaceutical, Medical and Both Science and allied Areas

Social and Cultural Issues of Women Scientists in the Present Society

A Tribute to Reputed Indian Women Scientists who Brought Name and Fame to Indian Science.

Contact :

For details please visit: www.scienceandculture-isna.org

73rd Annual Conference of the Association of Physicians in India (APICON 2018), 22nd to 25th February, 2018, Bengaluru, Karnataka.

Topics:

Cardiology
Hypertension
Endocrinology
Diabetes
Neurology
Rheumatology
Genetic
Nephrology
HIV
Interventional Radiology
Pregnancy

Respiratory System
ICU
Gastroenterology
Infections
Hepatology
Haematology
Oncology
Social Issue and Soft Skills
Poisoning & Toxicology
Geriatrics

Contact :

Dr. P Chandrasekhara, Organising Secretary, APICON 2018, No. 16/F, A.P.I. Bhavana, Miller Tank Bed area, Vasantha Nagar, Bengaluru - 560052, Landline : +91 (80) 48535566, Email: secy@apicon2018.org

2nd International Conference on Emerging Trends In Engineering, Science and Technologies (ICETEST-18), 16th - 17th February 2018, Warangal, Telangana.

Topics:

Computer Science and Engineering

Electronics and Communication

Electrical and Electronics

Mechanical Engineering

Civil Engineering

Chemical Engineering

Fundamental and Applied Science

Advanced Databases

Advanced Operating Systems

Animation and Artificial Intelligence

Applications in Medical field:

 Bio Informatics

 DNA testing and sequencing/
 human genome mapping

 Anti-retroviral treatment for AIDS

 Non-invasive laser/robotic surgery
 (laparoscopy)

Compiler Optimization Techniques

Programming Languages.

CAD-CAM.

Computing:

 Bio-inspired Computing

 Reconfigurable Computing

 Energy Aware Computing

 Cloud Computing & its

 nomenclatures

Computer Networks:

 Software Architectures

 Design and management of CN

 Network architecture and design

 Network and Information Security

Data & Information Management:

 Data Encryption

 Data structures

 Data Mining Techniques

 Data Visualization Techniques

 Managing Big Data

 Information Retrieval Techniques

 Information Storage Management

GUI, Distributed and Parallel Processing.

Internet and Web Applications.

Mobile Application Development

Online shopping/ ecommerce/ auctions

Programming Languages.

RFID and barcode applications

Social Network Analysis

Security and Cryptography.

Case studies

Innovative inventions

Contact :

Balaji Institute of Technology & Science Maheswaram (P), Narsampet Mandal, Warangal Dist, Warangal-Narsampet Road, Laknepally, Telangana 506331, +91-9087388603 , info@icetest.in

S & T ACROSS THE WORLD

NEW PROPERTY FOUND IN UNUSUAL CRYSTALLINE MATERIALS

Most metals and semiconductors, from the steel in a knife blade to the silicon in a solar panel, are made up of many tiny crystalline grains. The way these grains meet at their edges can have a major impact on the solid's properties, including mechanical strength, electrical conductivity, thermal properties, flexibility, and so on.

When the boundaries between the grains are of a particular type, called a coherent twin boundary (CTB), this adds useful properties to certain materials, especially at the nanoscale. It increases their strength, making the material much stronger while preserving its ability to be deformed, unlike most other processes that add strength. Now, researchers have discovered a new deformation mechanism of these twin crystal boundaries, which could help engineers figure out how to more precisely use CTBs to tune the properties of some materials.

Contrary to expectations, it turns out that a material's crystal grains can sometimes slide along these CTBs. The new finding is described in a paper published in the journal *Nature Communications*, 2017; 8 (1) by Ming Dao, a principal research scientist in MIT's Department of Materials Science and Engineering; Subra Suresh, the Vannevar Bush Professor Emeritus of Engineering and president-designate of Nanyang Technological University in Singapore; Ju Li, the Battelle Energy Alliance Professor in MIT's Department of Nuclear Science and Engineering; and seven others at MIT and elsewhere.

While each crystal grain is made up of an orderly three-dimensional array of atoms in a lattice structure, CTBs are places where, on the two sides of a boundary, the lattice forms a mirror-image of the structure on the other side. Every atom on either side of the coherent twin boundary is exactly matched by

an atom in a mirror-symmetrical location on the other side. Much research in recent years has shown that lattices that incorporate nanoscale CTBs can have much greater strength than the same material with random grain boundaries, without losing another useful property called ductility, which describes a material's ability to be stretched.

Some previous research suggested that these twin crystal boundaries are incapable of sliding due to the limited number of defects. Indeed, no experimental observations of such sliding have been reported before at room temperature. Now, a combination of theoretical analysis and experimental work reported in the *Nature Communications* paper has shown that in fact, under certain kinds of loads these grains can slide along the boundary. Understanding this property will be important for developing ways to engineer material properties to optimize them for specific applications, Dao says.

"A lot of high-strength nanocrystalline materials [with grains sizes measured in less than 100 nanometers] have low ductility and fatigue properties, and failure grows quite quickly with little stretching," he says. Conversely, in the metals that incorporate CTBs, that "enhances the strength and preserves the good ductility." But understanding how these materials behave when subjected to various mechanical stresses is important in order to be able to harness them for structural uses. For one thing, it means that the way the material deforms is quite uneven: Distortions in the direction of the planes of the CTBs can happen much more readily than in other directions.

The experiment was carried out with copper, but the results should apply to some other metals with similar crystal structures, such as gold, silver, and platinum. These materials are widely used in electronic devices, Dao says. "If you design these materials" with structures in the size range explored in this work, which involves features smaller than a few hundred nanometers across, "you need to be aware of these kinds of deformation modes."

The sliding, once understood, can be used for

significant advantages. For example, researchers could design extremely strong nanostructures based on the known orientation dependence; or by knowing the type and direction of force that's required to initiate the sliding, it might be possible to design a device that could be activated, such as an alarm, in response to a specific level of stress.

"This study confirmed CTB sliding, which was previously considered impossible, and its particular driving conditions," says Zhiwei Shan, a senior co-author and dean of the School of Materials Science and Engineering at Xi'an Jiao Tong University in China. "Many things could become possible when previously unknown activation or enabling conditions are discovered."

"This work has identified through both systematic experiments and analysis the occurrence of an important mechanical characteristic which is found only in certain special types of interfaces and at the nanoscale. Given that this phenomenon can potentially be applicable to a broad range of crystalline materials, one can envision new materials design approaches involving nanostructures to optimize a variety of mechanical and functional characteristics," Suresh says.

"This discovery could fundamentally change our understanding of plastic deformation in nanotwinned metals and should be of broad interest to the material research community," says Huajian Gao, the Walter H. Annenberg Professor of Engineering at Brown University, who was not involved in this work.

Gao adds that "CTBs are key to engineering novel nanotwinned materials with superior mechanical and physical properties such as strength, ductility, toughness, electrical conductivity, and thermal stability. This paper significantly advances our knowledge in this field by revealing large-scale sliding of CTBs."

(Source: <https://www.sciencedaily.com/releases/2017/10/171025141126.htm>)

STUDY UNVEILS CHANGES IN THE BRAIN DURING EXTENDED MISSIONS IN SPACE

It's been 55 years since NASA astronaut John Glenn successfully launched into space to complete three orbits aboard the Friendship 7 Mercury spacecraft, becoming the first American to orbit Earth. The evolution of spaceflight, advancements in science and technologies and the progress of public-private commercial partnerships with companies such as Space X and Blue Horizons have strengthened NASA's goals and the public's confidence to move forward in discovery and human exploration.

More people today are poised to explore space than ever before; those who do will experience the effects of microgravity on the human body. Recognizing the need for data related to those effects, MUSC neuroradiologist Donna Roberts, M.D., conducted a study titled "Effects of Spaceflight on Astronaut Brain Structure as Indicated on MRI," the results of which will be featured in the Nov. 2 issue of the *New England Journal of Medicine*, 377 (18), 2017;

"Exposure to the space environment has permanent effects on humans that we simply do not understand. What astronauts experience in space must be mitigated to produce safer space travel for the public," said Roberts.

While living and working in space can be exciting, space is a hostile environment and presents many physiological and psychological challenges for the men and women of America's space program. For example, NASA astronauts have experienced altered vision and increased pressure inside their heads during spaceflight aboard the International Space Station. These conditions can be serious problems for astronauts, particularly if they occur in low-earth orbit aboard the International Space Station or far from Earth, such as on an exploration mission to Mars.

To describe these symptoms, NASA coined the term visual impairment intracranial pressure syndrome, or VIIP syndrome for short. The cause of VIIP syndrome is thought to be related to the redistribution of body fluid toward the head during long-term microgravity exposure; however, the exact cause is unknown. Given safety concerns and the potential impact to human exploration goals, NASA has made determining the cause of VIIP syndrome and how to resolve its effects a top priority.

Roberts is an associate professor of radiology in the Department of Radiology and Radiological Sciences at MUSC. Before attending medical school at MUSC, she worked at NASA Headquarters in Washington, D.C. Working with NASA's Space Life Sciences Division in the early 1990s, she was already aware of the challenges astronauts faced during long-duration spaceflights. She was concerned about the lack of data describing the adaptation of the human brain to microgravity and proposed to NASA that magnetic resonance imaging (MRI) be used to investigate the anatomy of the brain following spaceflight.

Roberts suspected subtle anatomical changes in the brains of astronauts during spaceflight might be contributing to the development of VIIP syndrome, based on her earlier work. From 2001 to 2004, Roberts led a three-year NASA-funded bed rest study, collaborating with other life sciences researchers at the University of Texas Medical Branch in Galveston. A South Carolina native, Roberts had just completed a two-year neuroradiology fellowship at the University of California at San Francisco.

For this study, she examined the brains and muscular responses of participants who stayed in bed for 90 days, during which time, they were required to keep their heads continuously tilted in a downward position to simulate the effects of microgravity.

Using functional MRI, Roberts evaluated brain neuroplasticity, studying the brain's motor cortex before, during and after long-term bed rest. Results confirmed neuroplasticity in the brain occurred during bed rest, which correlated with functional

outcomes of the subjects.

As Roberts evaluated the brain scans, she saw something unusual. She noted a "crowding" occurrence at the vertex, or top of the brain, with narrowing of the gyri and sulci, the bumps and depressions in the brain that give it its folded appearance. This crowding was worse for participants who were on longer bed rest in the study.

Roberts also saw evidence of brain shifting and a narrowing of the space between the top of the brain and the inner table of the skull. She questioned if the same thing might be happening to the astronauts during spaceflight.

In further studies, Roberts acquired brain MRI scans and related data from NASA's Lifetime Surveillance of Astronaut Health program for two groups of astronauts: 18 astronauts who had been in space for short periods of time aboard the U.S. Space Shuttle and 16 astronauts who had been in space for longer periods of time, typically three months, aboard the International Space Station. Roberts and her team then compared the brain images of the two groups of astronauts.

Roberts and study investigators evaluated the cerebrospinal fluid (CSF) spaces at the top of the brain and CSF-filled structures, called ventricles, located at the center of the brain. In addition, the team paired the preflight and postflight MRI cine clips from high-resolution 3-D imaging of 12 astronauts from long-duration flights and six astronauts from short-duration flights and looked for any displacement in brain structure.

Study results confirmed a narrowing of the brain's central sulcus, a groove in the cortex near the top of the brain that separates the parietal and frontal lobes, in 94 percent of the astronauts who participated in long-duration flights and 18.8 percent of the astronauts on short-duration flights. Cine clips also showed an upward shift of the brain and narrowing of the CSF spaces at the top of the brain among the long-duration flight astronauts but not in the short-duration flight astronauts.

Her findings concluded that significant changes in brain structure occur during long-duration space

flight. More importantly, the parts of the brain that are most affected -- the frontal and parietal lobes -- control movement of the body and higher executive function. The longer an astronaut stayed in space, the worse the symptoms of VIIP syndrome would be.

Roberts compared these findings with a similar medical syndrome experienced by women called idiopathic intracranial hypertension (IIH), which affects young, overweight women who present with symptoms similar to VIIP syndrome: blurry vision and high intracranial pressure with no known cause. A common treatment for IIH is to perform a lumbar puncture, whereby CSF is drained using a needle placed in the lower back -- a procedure performed by a neuroradiologist such as Roberts. Presently, there is no protocol to perform a lumbar puncture in a microgravity environment.

To further understand the results of the study, Roberts and the team plan to compare repeated postflight imaging of the brains of astronauts to determine if the changes are permanent or if they will return to baseline following some time back on Earth. With NASA's Mars expedition mission set to launch in 2033, there's an urgency for researchers such as Roberts to collect more data about astronauts and understand the basics of human space physiology.

A journey to Mars can take three to six months, at best. In order to reduce travel time between Earth and Mars, the two planets need to be aligned favorably, which occurs approximately every two years.

During this two-year time period, crew members would remain on Mars, carrying out exploration activities. The gravity on Mars is approximately one-third that of Earth. Considering travel to and from Mars, along with the time on the surface, the Martian expedition crew would be exposed to reduced gravity for at least three years, according to Roberts. What would that do to the human body? Could a human even survive that long in a reduced gravity environment?

NASA astronaut Scott Kelly spent 340 days living and working aboard the International Space Station, and astronaut Peggy Whitson recently

completed a 288-day mission in space. To date, the longest continuous time in space was 438 days, a record held by Russian cosmonaut Valery Polyakov.

"We know these long-duration flights take a big toll on the astronauts and cosmonauts; however, we don't know if the adverse effects on the body continue to progress or if they stabilize after some time in space," Roberts said. "These are the questions that we are interested in addressing, especially what happens to the human brain and brain function?"

Study co-author and Department of Radiology and Radiological Science colleague Michael Antonucci, M.D., agreed. "This study is exciting in many ways, particularly as it lies at the intersection of two fascinating frontiers of human exploration -- space and the brain."

"We have known for years that microgravity affects the body in numerous ways," he continued.

"However, this study represents the most comprehensive assessment of the impact of prolonged space travel on the brain. The changes we have seen may explain unusual symptoms experienced by returning space station astronauts and help identify key issues in the planning of longer-duration space exploration, including missions to Mars."

Roberts hopes to continue to collect long-term follow-up data on the astronauts already being studied. In addition, she is participating in a new bed rest study in Cologne, Germany, collaborating with Racheal Seidler, Ph.D., of the University of Florida and the German Space Agency. The study simulates astronauts living aboard the International Space Station, while being exposed to higher levels of carbon dioxide. Carbon dioxide scrubbers aboard the International Space Station clean and filter the air systems throughout the spacecraft, but some CO₂ remains. Roberts will evaluate the blood flow to the brain, brain structure and other changes among study subjects.

With her team's hard work and dedication, Roberts hopes to establish MUSC as the go-to institution for further studies in clinical neuroimaging related to space exploration.

HUMAN BONES: STALAGMITE REVEALS AGE AS 13,000

A prehistoric human skeleton found on the Yucatán Peninsula is at least 13,000 years old and most likely dates from a glacial period at the end of the most recent ice age, the late Pleistocene. A German-Mexican team of researchers led by Prof. Dr Wolfgang Stinnesbeck and Arturo González González has now dated the fossil skeleton based on a stalagmite that grew on the hip bone. "The bones from the Chan Hol Cave near the city of Tulum discovered five years ago represent one of the oldest finds of human bones on the American continent and are evidence of an unexpectedly early settlement in Southern Mexico," says Prof. Stinnesbeck, who is an earth scientist at Heidelberg University. The research findings have now been published in PLOS ONE.

The early settlement of the Americas is a subject of controversial debate. A longstanding hypothesis claimed that the first migration took place 12,600 years ago through an ice-free corridor between retreating North American glaciers, via the ice-age Bering Land Bridge between Siberia and Alaska. In recent years, however, this theory is being increasingly called into question by new finds from North and South America. They indicate that people arrived there earlier, explains Prof. Stinnesbeck. However, these finds were mostly artifacts or open hearths, their age being dated by using the sediment they contained. It has been extremely rare so far to find human bones older than 10,000 anywhere in the Americas.

The water-filled caves near Tulum on Yucatán – a peninsula separating the Gulf of Mexico from the Caribbean Sea – offer a rich area for finds. Seven prehistoric human skeletons have already been documented in the intricate cave system near the coast in the eastern part of the peninsula, some of them previously dated by other researchers. The caves along Yucatán's Caribbean coast were not flooded until the worldwide rise in sea level after

the ice age. They contain archaeological, palaeontological and climatic information hidden there from the time before the flooding, which is extremely well preserved, according to Wolfgang Stinnesbeck.

It was, however, difficult to exactly determine the age of the human skeletal material using conventional radiocarbon dating, because the collagen in the bones had been completely washed out due to the long period spent in water. Prof. Stinnesbeck and his German-Mexican team of earth scientists and archaeologists therefore chose another method. By dating a stalagmite that had grown on the hip bone, they were able to narrow down the age of the human bones from the Chan Hol Cave.

The analysis of the uranium-thorium isotopes gave the skeleton a minimum age of 11,300 years. However, the climatic and precipitation data stored in the stalagmite showed a clearly higher age. It is measurable in terms of oxygen and carbon isotope ratios and was compared to "environmental archive" data from other parts of the earth. Aged at least 13,000, the Chan Hol Cave inhabitant presumably dates from the Younger Dryas. "It represents one of the oldest human skeletons from America. Our data underline the great importance of the Tulum cave finds for the debate about the settling of the continent," says Prof. Stinnesbeck.

According to the Heidelberg earth scientist, the enormous urbanisation and growth of tourism in this region threaten the palaeontological and archaeological archives preserved in the caves. Shortly after the discovery of the human skeleton in February 2012 the site of the find was looted; unknown divers stole all the bones lying around on the ground of the cave. Only a few photos and small fragments of bones bear witness today to the original find situation. The hip bone investigated by the German-Mexican researcher team only escaped being stolen through the protection provided by the rock-hard lime-sinter of the stalagmite.

(Source: <http://www.research-in-germany.org/en/research-landscape/news/2017/08/2017-08-31>)



भारतीय विज्ञान कांग्रेस संस्था

14, डॉ० बिरेश गुहा स्ट्रीट, कोलकाता - 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

दूरभाष/Telephone : (033) 2287-4530, 2281-5323

फैक्स/Fax : 91-33-2287-2551

वेबसाइट/ Website : <http://sciencecongress.nic.in>

ई-मेल/E-mail : iscacal@vsnl.net

es.sciencecongress@nic.in

सदस्यता की शर्तें और सदस्यों की विशेषाधिकार/Terms of Membership and Privileges of Members :

संस्था की सदस्यता उन सभी लोगों के लिए खुली हैं, जो स्नातक या उसके समान स्तर पर शैक्षणिक योग्यता अर्जन कर चुके हैं, और जिन्हें भारत में विज्ञान की तरक्की में रुचि हैं।

Membership of the Association is open to person with Graduate or equivalent Academic Qualifications and interested in the advancement of Science in India.

1. **वार्षिक सदस्य** : जो व्यक्ति नये रूप से वार्षिक सदस्यता ग्रहण करना चाहता है उसे वार्षिक सदस्यता शुल्क ₹ 200/- के साथ भर्ती शुल्क ₹ 50/-* (विदेशियों के लिए** U.S. \$ 70) मात्र देने पड़ेंगे। वार्षिक सदस्यता शुल्क प्रत्येक वर्ष के 01 अप्रैल को देय हो जाएगा। जो भी 15 जुलाई के भीतर अपनी सदस्यता शुल्क नहीं अदा कर पाएगा वह उस साल के लिए अपनी वोट देने की क्षमता से वंचित हो जाएगा और/या वह उस वर्ष के लिए संस्था के कार्यालय को भी नियंत्रण नहीं कर पाएगा। वार्षिक सदस्य अपनी सदस्यता दोबारा अगले साल 15 जुलाई के भीतर बिना शुल्क दिए पुनः अपनी सदस्यता प्राप्त कर सकता है।

सदस्यगण अपना पेपर कांग्रेस सत्र के समय पेश कर सकते हैं। उन्हें वार्षिक विज्ञान कांग्रेस सत्र की कार्यविवरण की एक प्रति बिना मूल्य में प्राप्त हो सकती है। इसके साथ वे संस्था के रोजनामचा "एवरीमैन्स साइंस" की प्रति भी बिना मूल्य उस साल के लिए प्राप्त कर सकते हैं। सदस्यता के नवीकरण के लिए कृपया ISCA वेबसाइट से फार्म डाउनलोड करें।

1. **Annual Member** : A person willing to be enrolled as new Annual Member has to pay an annual subscription of ₹ 200/- along with an admission fee of ₹ 50/-* (for foreign ** U.S.\$ 70) only. The annual subscription of a Member shall become due on the 1st April of each year. Anyone who fails to pay the subscription on or before the 15th July in any year shall lose the right of voting and/or holding any office of the Association for that year. A member failing to pay the annual subscription by the end of March of the following year shall cease to be a Member. Annual members can renew their Membership without paying the admission fee in the next year by remitting subscriptions in time i.e. within 15th July. Members may contribute papers for presentation at the Science Congress. They will receive, free of cost, reprints of the Proceedings of the Session of any one section of their interest and also the bi-monthly journal of the Association Everymans Science for that year only. For Renewal of Membership please download the form from ISCA website.

2. **सत्र सदस्य** : यदि कुछ कारणों से वार्षिक सदस्य अपनी सदस्यता उस वर्ष के 15 जुलाई के अंदर दोहराना भूल जाएँ, तो उनकी सदस्यता, सत्र सदस्यता के रूप में बिना वोट डालने की क्षमता में सीमित कर दिया जाएगा। सत्र सदस्यको ₹ 200/- (विदेशियों के लिए \$ 50) अदा करना पड़ेगा। एक सत्र सदस्य को लेख/पोस्टर प्रस्तुतीकरण का अधिकार प्राप्त होगा जिस कांग्रेस सत्र का वह सदस्य है। एक सत्र सदस्य वोट प्रक्रिया में भाग लेने के योग्य नहीं हैं। सत्र सदस्य को विभागों के व्यवसाय बैठकों और साधारण बैठकों में भाग लेने की योग्यता प्राप्त नहीं है।
2. **Sessional Member** : If for some reasons, Annual Members fail to renew their Membership by remitting subscription prior to 15th July each year, their Membership for the year would be restricted to Sessional Membership without voting right. Sessional Member has to pay ₹ 200/- (for foreign \$50). A Sessional Member shall have the right to present paper / poster at the session of the congress of which he/she is a member. A Sessional Member shall not be eligible to participate in the voting process. A Sessional member shall not be eligible to participate in the Business meetings of the Sections and the General Body.
3. **छात्र सदस्य** : जो व्यक्ति स्नातक स्तर से नीचे पढ़ाई कर रहा है, उसे वार्षिक सदस्यता शुल्क ₹ 100/- मात्र देने पड़ेंगे अपना नाम छात्र सदस्य के रूप में लिखवाने के लिए, बशर्ते उसके आवेदन पत्र पर उसके प्राचार्य/विभागाध्यक्ष/संस्थान के प्रधान के हस्ताक्षर हों। एक छात्र सदस्य को यह अधिकार दिया जाएगा, कि वह अपना पेपर कांग्रेस सत्र के समय पेश कर सकें, बशर्ते वह पेपर वह किसी वार्षिक सदस्य या संस्था के कोई अवैतनिक सदस्य के साथ पेश करें। उसे वोट करने का या कार्यालय को नियंत्रण करने का अधिकार प्राप्त नहीं होगा। छात्र सदस्य को विभागों के व्यवसायबैठकों में भाग लेने की योग्यता प्राप्त नहीं है।
3. **Student Member** : A person studying at the under - graduate level may be enrolled as a Student Member by paying an annual subscription of ₹ 100/- **only provided his/her application is duly certified by the Principal/Head of the Institution/Department.** A student member shall have the right to submit papers for presentation at the Session of the Congress of which he / she is a member, provided such papers be communicated through a Member, or an Honorary Member of the Association. He/She shall not have the right to vote or to hold any office. A student member shall not be eligible to participate in the Business Meetings of the Sections and the General Body.
4. **आजीवन सदस्य** : एक सदस्य अपने भविष्य की सारी वार्षिक सदस्यता शुल्क एक बार में ₹ 2,000/- (विदेशियों के लिए U.S.\$ 500) मात्र अदा करके पा सकता है। एक व्यक्ति जो 10 साल या उससे अधिक नियमित रूप से सदस्यता प्राप्त कर चुका है, उसे उसकी संयुक्त सदस्यता शुल्क के ऊपर प्रतिवर्ष ₹ 50/- की छूट दी जाएगी, बशर्ते कि उसकी संयुक्त शुल्क ₹ 1,200/- से नीचे न हों (विदेशियों के लिए U.S.\$ 12.50 और U.S.\$ 300 क्रमशः)। एक आजीवन सदस्य को उसके पूरे जीवन काल में सदस्यता की सारे विशेषाधिकार प्राप्त होंगे।
4. **Life Member** : A Member may compound all future annual subscriptions by paying a single sum of ₹ 2,000/- (for foreign** U.S.\$ 500) only. Any person who has been continuously a member for 10 years or more, shall be allowed a reduction in the compounding fee of ₹ 50/- for every year of such membership, provided that the compounding fee shall not be less than ₹ 1,200/- (for foreign** U.S.\$ 12.50 and U.S.\$ 300 respectively). A life Member shall have all the privileges of a member during his/her lifetime.
5. **संस्थान सदस्य** : एक संस्थान जो ₹ 5,000/- सदस्यता शुल्क के रूप में दे वही संस्था के संस्थान सदस्य उस वित्तीय वर्ष के लिए बन सकता है, (विदेशियों के लिए U.S.\$ 2,500)। इसमें वह विज्ञान कांग्रेस के वार्षिक सत्र में अपने एक व्यक्ति का नाम नामांकित कर सकता है, जो उनका प्रतिनिधि हों। एक संस्थान सदस्य को वार्षिक विज्ञान कांग्रेस

सत्र की कार्यविवरण की एक पूर्ण प्रति बिना मूल्य में प्राप्त हो सकती है। इसके साथ वे संस्था के रोज़नामचा "एवरीमैन्स साइंस" की प्रति भी बिना मूल्य प्राप्त कर सकते हैं।

5. **Institutional Member** : An Institution paying a subscription of ₹ 5,000/- (for foreign** U.S.\$ 2,500) only, can become an Institutional Member of the Association for that financial year. It shall be eligible to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional Member shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also a copy each of the Associations journal Everymans Science.
6. दाता : कोई भी व्यक्ति जो एक साथ ₹ 10,000/- (विदेशियों के लिए U.S. \$ 5,000) मात्र दें, वह संस्था के दाता बन सकते हैं। एक व्यक्तिगत दाता को वह सारे अधिकार और विशेषाधिकार मिलेंगे जो एक सदस्य को उसके पूर्ण जीवन काल में प्राप्त होते हैं।

एक संस्थान जो एक साथ ₹ 50,000/- (विदेशियों के लिए U.S. \$ 25,000) मात्र दें, सदा के लिए इस संस्था के संस्थान दाता बन सकते हैं, जिसे वह एक व्यक्ति को नामांकित करके उसे अपने संस्थान के प्रतिनिधि के रूप में विज्ञान कांग्रेस के वार्षिक सत्र में भेज सकते हैं। एक संस्थान/व्यक्तिगत दाता वार्षिक विज्ञान कांग्रेस के कार्यविवरण और संस्था के रोज़नामचा "एवरीमैन्स साइंस" की प्रति भी बिना मूल्य प्राप्त कर सकते हैं।

6. **Donor** : Any person paying a lump sum of ₹ 10,000/- (for foreign ** U.S.\$ 5,000) only, can become an Individual Donor of the Association. An **INDIVIDUAL DONOR** shall have all the rights and privileges of a member during his/her lifetime.

An Institution paying a lump of ₹ 50,000/- (for foreign ** U.S.\$ 25,000) only, can become an **INSTITUTIONAL DONOR** of the Association forever, which shall have the right to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional/ Individual Donor shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also the Associations journal Everymans Science.

* भर्ती शुल्क ₹ 50/- सिर्फ एक नये वार्षिक सदस्य के लिए ज़रूरी है। यह सत्र सदस्य/आजीवन सदस्य/ संस्थान सदस्य/छात्र सदस्य/दाता के लिए ज़रूरी नहीं है।

* Admission fee of ₹ 50/- is needed only for becoming a new Annual Member and not for Sessional Member/Life Member/Institutional Member/Student Member/Donor.

** (एक विदेशी सदस्य का अर्थ है, जो भारतवर्ष के बाहर का नागरिक हों।)

** (A Foreign Member means one who is normally Resident outside India).

(अ) **पेपर पेश करना** : एक पूर्ण पेपर की प्रति उसके साथ तीन सारांश की प्रति जो 100 शब्दों से ज्यादा न हों और जिसमें कोई आरेख या फार्मूला न हों, वह प्रत्येक वर्ष 15 सितम्बर के अंदर अनुभागीय अध्यक्ष तक पहुँच जाना चाहिए।

(A) **Presentation of Papers** : A copy of complete paper accompanied by an abstract in triplicate not exceeding one hundred words and not containing any diagram or formula, must reach the Sectional President latest by September 15, each year.

(ब) सभी वर्गों के सदस्य जो विज्ञान कांग्रेस सत्र में भाग लेने के पश्चात लौटते समय के टिकट में रियायत प्राप्त कर सकता है, बशर्ते कि उनकी यात्रा के खर्च का थोड़ा भी भाग सरकार (केन्द्रीय या राज्य),

कोई कानूनी सत्ता या कोई विश्वविद्यालय या कोई नगरपालिका न उठाएँ और उनकी कुल कमाई या परिलब्धियां ₹ 5,000/- (प्रति माह पाँच हजार रुपए) से अधिक नहीं हैं। कृपया ISCA वेबसाइट से रेलवे रियायत फार्म डाउनलोड करें।

- (B) Members of all categories are entitled to **Railway Concession** of return ticket by the same route with such conditions as may be laid down by the Railway Board for travel to attend the Science Congress Session provided that their travelling expenses are not borne, even partly, by the Government (Central or State), Statutory Authority or an University or a City Corporation and their total earning of or emoluments drawn do not exceed ₹ 5,000/- (Rupees Five Thousand per month). Please download the Railway Concession form from ISCA Website.
- (स) संस्था के पुस्तकालय में सभी वर्गों के सदस्य को पढ़ने की सुविधा सुबह 10.00 बजे से शाम को 5.30 बजे तक सभी काम के दिनों में (शनिवार और रविवार) को छोड़कर प्राप्त होगी।
- (C) Members of all categories are entitled to reading facilities between 10.00 a.m. to 5.30 p.m. on all weekdays (except Saturdays & Sundays) in the library of the Association.
- (ड) समय समय पर संस्था द्वारा तय की गई मूल्य दरों पर विश्रामगृह, सभागार आदि सुविधाओं की प्राप्ति भी सभी वर्गों के सदस्य कर सकते हैं।
- (D) Members of all categories may avail Guest House facilities, Lecture Hall hiring at the rates fixed by the Association from time to time.
- (ई) भविष्य में भारतीय विज्ञान कांग्रेस संस्था द्वारा आयोजित परिसंवाद, सम्मेलन और वार्षिक कांग्रेस में सभी वर्गों के सदस्यों द्वारा भाग लेने के लिए अपनी-अपनी सदस्यता पत्र को लाना जरूरी होगा।
- (E) Members of all categories should bring the Membership Card always for attending any Seminar, Conference and Annual Congress organized by ISCA in future.

ध्यान दें : (1) सभी बैंक ड्राफ्ट The Indian Science Congress Association के नाम से ही लिखा जाएँ, और जो कोलकाता के किसी भी शाखा में देय हों। सदस्यों से यह निवेदन किया जा रहा है, कि वे अपनी सदस्यता संख्या का उल्लेख भारतीय विज्ञान कांग्रेस संस्था के कार्यालय के साथ पत्राचार के वक्त अवश्य करें।

(2) भारतीय विज्ञान कांग्रेस संस्था द्वारा मनीऑर्डर, आई. पी. ओ., ई. सी. एस. या चेक से भुगतान ग्रहण नहीं किया जाएगा। कोई भी सदस्यता निर्धारित सदस्यता फार्म (आवेदन-पत्र नई सदस्यता/सदस्यता की नवीकरण के लिए) में विधिवत बिना भरने से नहीं लिया जाएगा।

(3) नकदी केवल ISCA मुख्यालय में हाथ से लिया जाएगा। कृपया डाक द्वारा लिफाफे के भीतर नकदी नहीं भेजें।

Note : (1) All Bank Drafts should be drawn in favour of *The Indian Science Congress Association* Payable at any branch in Kolkata. Members are requested to mention their Membership No. while making any correspondence to ISCA office.

(2) No money order, I.P.O., ECS or cheque will be accepted by ISCA. No Membership will be taken without duly filled in prescribed Membership Form (Application Form for New Membership/ Application for Renewal of Membership).

(3) Cash will only be taken by hand at ISCA Hqrs. Pl. do not send the Cash by Post within the envelope.



भारतीय विज्ञान कांग्रेस संस्था

14, डॉ० बिरेश गुहा स्ट्रीट, कोलकाता - 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

दूरभाष/Telephone : (033) 2287-4530, 2281-5323

फैक्स/Fax : 91-33-2287-2551

वेबसाइट/Website : <http://sciencecongress.nic.in>

ई-मेल/E-mail : iscacal@vsnl.net

es.sciencecongress@nic.in

सदस्यता के लिए नया आवेदन पत्र / Application Form For New Membership

सेवा में/To

महासचिव (सदस्यता कार्य)/ The General Secretary (Membership Affairs)

भारतीय विज्ञान कांग्रेस संस्था/The Indian Science Congress Association

14, डॉ० बिरेश गुहा स्ट्रीट/14, Dr. Biresh Guha Street,

कोलकाता - 700 017/Kolkata - 700 017

महोदय/Dear Sir,

मैं भारतीय विज्ञान कांग्रेस संस्था का आजीवन सदस्य/वार्षिक सदस्य/सत्र सदस्य/छात्र सदस्य/संस्थान सदस्य/व्यक्तिगत दाता/संस्थागत दाता अपना नाम लिखवाना चाहता/चाहती हूँ।

I like to be enrolled as a Life Member/Annual Member/Sessional Member/Student Member/Institutional Member/Individual Donor/Institutional Donor of The Indian Science Congress Association. (Pl. Tick)

मैं इसके साथ ----- सदस्यता शुल्क के रूप में नक़द ₹ -----/बैंक ड्राफ्ट संख्या ----- दिनांकित ----- प्रचालक बैंक ----- 01 अप्रैल 20--- से 31 मार्च 20--- तक भेज रहा/रही हूँ।

I am sending herewith an amount of ₹ in payment of my subscription by Cash/Bank Draft No. dated issuing bank from the year 1st April 20 to 31st March 20.

मैं निम्नलिखित विभाग में रुचि रखता/रखती हूँ (कृपया किसी एक में निशान लगाएँ)/ I am interested in the following section (Please tick any one).

विभाग/Sections

1. कृषि और वानिकी विज्ञान/Agriculture and Forestry Sciences
2. पशु, पशुचिकित्सा और मत्स्य विज्ञान/Animal, Veterinary and Fishery Sciences
3. मानवशास्त्रीय और व्यवहारपरक विज्ञान (जिसमें सम्मिलित हैं, पुरातत्व-विज्ञान, मनोविज्ञान, शैक्षिक विज्ञान और सेना विज्ञान)/Anthropological and Behavioural Sciences (including Archaeology, Psychology, Education and Military Sciences)
4. रसायन विज्ञान/Chemical Sciences

5. भू-पद्धति विज्ञान/Earth System Sciences
6. अभियन्ता विज्ञान/Engineering Sciences
7. पर्यावरण विज्ञान/Environmental Sciences
8. सूचना और संचारण विज्ञान और प्रौद्योगिकी (जिसमें कंप्यूटर विज्ञान भी सम्मिलित है)/Information and Communication Science & Technology (including Computer Sciences)
9. भौतिक विज्ञान/Materials Science
10. गणित विज्ञान (जिसमें सांख्यिकीय सम्मिलित है)/Mathematical Sciences (including Statistics)
11. चिकित्सा शास्त्र (जिसमें शरीर विज्ञान भी सम्मिलित है)/Medical Sciences (including Physiology)
12. नया जीवविज्ञान (जिसमें जीव रसायन, जीव भौतिकी और आणविक जीवविज्ञान और जीव-प्रौद्योगिकी भी सम्मिलित है)/New Biology (including Bio-Chemistry, Biophysics & Molecular Biology and Biotechnology)
13. भौतिकीय विज्ञान/Physical Sciences
14. वनस्पति विज्ञान/Plant Sciences

(कृपया टंकित करें या ब्लॉक अक्षरों में भरें/Please type or fill up in Block Letters)

नाम/Name (ब्लॉक अक्षरों में/in Block Letters) :

श्री/सुश्री/श्री/श्रीमती/डॉ॰/प्रो॰/Mr./Ms./Shri/Shrimati/Dr./Prof (कृपया टिक करें)/(Please tick)

कुलनाम/Surname

प्रथम नाम/First Name

मध्य नाम/Middle Name

शैक्षणिक योग्यता/Academic Qualifications :

(अंतिम शैक्षणिक योग्यता प्रमाण-पत्र अंक-सूची का स्वतः सत्यापित जिराक्स प्रति संलग्न करना है / Self attested xerox copy of last educational certificate/marksheet must be attached)

पदनाम/Designation

सम्पर्क का पता/Address of communication :

(राज्य, शहर/नगर और पिन कोड सहित/including state, city/town and pin code)

दूरभाष संख्या/मोबाईल संख्या और ई-मेल/Phone No./Mobile Number & E-mail :

आधार नंबर (अनिवार्य) / Aadhaar Number (Mandatory) :

स्थायी पता/Permanent Address :

दिनांक/Date :

भवदीय/Yours Faithfully

हस्ताक्षर/Signature

ध्यान दें : (i) सभी बैंक ड्राफ्ट The Indian Science Congress Association के नाम से ही लिखा जाएँ और जो कोलकाता के किसी भी शाखा में देय हों।

- Note :** (i) All Bank Drafts should be drawn in favour of *The Indian Science Congress Association* Payable at any branch in Kolkata.
- (ii) सभी सदस्यता और सदस्यता के नवीकरण के लिए आवेदन-पत्र आवेदकों को अपने खुद के पते उपलब्ध कराके करने चाहिए न कि देखभाल के पते प्रस्तुत करने चाहिए।
- (ii) All Application Forms for Membership and the renewal of Membership must be submitted by providing the address of the applicants themselves only and not any care of address.
- (iii) भर्ती शुल्क ₹ 50/- सिर्फ एक नये वार्षिक सदस्य के लिए ज़रूरी है। यह सदस्य/आजीवन सदस्य/संस्थान सदस्य/छात्र सदस्य/दाता के लिए ज़रूरी नहीं है।
- (iii) Admission fee of ₹ 50/- is needed only for becoming a new Annual Member and not for Sessional Member/Life Member/Institutional Member/Student Member/Donor.
- (iv) सदस्यों से यह निवेदन किया जा रहा है कि वे अपनी सदस्यता संख्या का उल्लेख भारतीय विज्ञान कांग्रेस संस्था के कार्यालय के साथ पत्राचार के समय अवश्य करें।
- (iv) Members are requested to mention their Membership No. while making any correspondence to ISCA office.
- (v) भारतीय विज्ञान कांग्रेस संस्था द्वारा मनीऑर्डर, आई. पी. ओ., ई. सी. एस. या चेक से भुगतान ग्रहण नहीं किया जाएगा।
- (v) No Money order, I.P.O., ECS or Cheque will be accepted by ISCA.
- (vi) कोई भी सदस्यता निर्धारित सदस्यता फार्म (आवेदन-पत्र नई सदस्यता/सदस्यता की नवीकरण के लिए) में विधिवत बिना भरने से नहीं लिया जाएगा।
- (vi) No Membership will be taken without duly filled in prescribed Membership Form (Application Form for New Membership/Application For Renewal of Membership)
- (vii) नकदी केवल ISCA मुख्यालय में हाथ से लिया जाएगा। कृपया डाक द्वारा लिफाफे के भीतर नकदी नहीं भेजें।
- (vii) Cash will only be taken by hand at ISCA Hqrs. Pl. do not send the cash by Post within the envelope.