

**SCIENTOONIC TELL-TALE
OF
GENOME AND DNA**

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Authors

Madhusudan W. Pandit

Pradeep K. Srivastava

Lajji Singh



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Preface

Scientific and technological advances are probably one of the single most important factors that are metamorphosing our life pattern, whether we want it or not. We are affected in many ways, directly or indirectly, to the extent that these factors have become a part of our lives. It is, therefore, not at all surprising that science is invading our lives to the root. Communication of scientific facts, in their true perspective, to the common man, will not only help him to acquaint with the scientific jargon, but also make him understand how best we can make use of such facts in our day-to-day life. Recent advances in scientific research demand proactive efforts from the scientists, so that complex ideas reach the people effectively and in a timely manner. This book is one of such efforts with an entirely novel approach in communication.

The foundation of this book, without our realization, was laid down when Dr. Pradeep K. Srivastava, a Scientist working at Central Drug Research Institute (CDRI), Lucknow, visited Centre for Cellular and Molecular Biology (CCMB). The purpose of his visit was to interact with several scientists, share their excitement, and collect some material for scientoons. Most of the scientoons, which are included in this book, were created during his stay in Hyderabad. Scientoons are a product of the expression of how the science is perceived, or sometimes even misunderstood by society, of course, in a lighter vein. These scientoons were created over a few months covering varied subjects. They are essentially a depiction of the present concerns brought forward by the recent explosion of knowledge, especially the knowledge about human genome and related areas. This collection of scientoons has addressed areas such as DNA, DNA fingerprinting, human genome, conservation of wildlife, etc. Creation of scientoons was neither focused on any specific single topic nor were they created in a particular sequence. It was later perceived as an integrated narration, the stories of inventions and contributions elaborating the topics, which were chosen for scientoons.

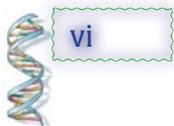
The creation of scientoons has origins in our day-to-day life, our social structure, cultural backgrounds, regional and religious biases, dogmatic beliefs, educational background, but foremost being its primary scientific paradigm. Scientoons in

this book not only have intimate relationship with science and scientists but also with institutes where the science is practiced.

Various media in their own way try their best to make the common man aware of what is happening in this scientific world. Therefore, today, the public is certainly more aware than before of the happenings in science. However, these efforts are not adequate. There is a need to reach to the common public so that the excitement in science is shared by them without getting bogged down with its technical jargon and sometimes even drudgery. We, therefore, decided that we should elaborate the scientific aspect of the scientoons and take an opportunity to provide information, which would not only help the readers in appreciating the spirit and the humor in scientoons but also enrich their knowledge of scientific advances that are taking place around us. Each scientoon is therefore, associated with a text, which narrates the serious part of the science or its applications. This approach has led to the present form of the book. However, it has also led to certain inevitables such as repetitions at a few places that we could not avoid because of the overlapping nature of topics . At some places, this was intentional in the sense that the write-up associated with each scientoon, we felt, should be independent to a certain extent and should be more or less complete within itself. We have tried to classify these scientoons under various groups depending upon the broad subject areas, although it is somewhat arbitrary. Prologues at the beginning of every group of scientoons are expected to serve the purpose of the orientation of the reader to particular topics covered in that part. Although the text is kept mostly to essentials, we have taken some liberty to extend its scope keeping in view the readers with wider interests and heterogeneous background. We must also mention that we have deliberately underplayed the technical jargons, technical terms, and concepts in order to make the book more acceptable to general readership.

This book is an endeavour to reduce the gap between the excitement of some of the scientific advances in science of the present time and the curious readers who want to know more about science.

Madhusudan W. Pandit
Pradeep K. Srivastava
Lalji Singh



About Sciuntoons

Sciuntoonics is a new branch of science that deals with effective science communication, using a novel class of science cartoons called 'Sciuntoons'. Sciuntoons are the cartoons based on scientific concepts, discoveries, results and their applications. They are loaded with sense of humour and deal with ideas originating from science subjects and associated social interactions, sometimes even with constructive sarcasm with an objective of helping the readers to understand science and its impact on society in a simple and interesting way.

The term 'Sciuntoon' was coined by one of us (Pradeep K. Srivastava) when he delivered a lecture on the Development of Drugs and Pharmaceutical Industry in Developing Countries in Asian Conference held on May 26, 1988, at the National University of Singapore, Singapore. In fact, research paper on 'Sciuntoons' was accepted for presentation in the 32nd IUPAC-World Congress at Stockholm in Sweden held during 2–7 August 1989. But the bureaucratic machinery in Delhi could not process his papers till the Conference was over, and unfortunately he could not make a personal presentation. However, IUPAC published his paper in the abstract form, which was followed by several queries about Sciuntoons. Later, the concept was widely accepted around the world.

Sciuntoons have been widely covered both by electronic and print media. In fact, a permanent gallery of Sciuntoons depicting research and development achievements has been established: the CSIR institutions, at Lucknow, India. Sciuntoons are covered by several communication channels like BBC London, National TV channels, Educational Media Research Center (EMRC), Hyderabad, sponsored by UGC Network, etc. There are instances where science cartoons were used as one of the communication tools (e.g., Cooper Toons). Charles Fisher Cooper, in 1970s, provided cartoons for *Saturday Evening Post*, *Physics Today*, *Chemtech*, etc. Science and scientific knowledge is growing with a great pace to such an extent that common man is lost in this ocean of advances in science and clouds of its complexities. They are always intrigued and inhibited to confront these advances. Therefore more concerted efforts are required to communicate serious, intricate and scientifically-jargoned ideas in a way that the

common man will not only understand them but also enjoy reading about them. Scientoons have certainly made a niche in the world of communication tools for their existence and have opened new door for a common man to enable him to reach to the science. Scientoons are going to stay as long as they can live with what Mark Twain said – “He told the truth, mainly”.

Acknowledgements

- We gratefully acknowledge our professional colleagues and friends, who were the source of information as well as inspiration and provided help in many ways in realizing this book.
- We are grateful to the Director, CCMB, Hyderabad, for making available to us some of the resource material such as reports and publications, the information from which was used while writing this book.
- Some of the scientoons that appear in this book have been earlier published in the Annual Reports of the CCMB and Jigyasa, the Hindi Annual Magazine brought out by the CCMB. We thank the editors for giving us permission to include those scientoons in this book.
- Several websites on Internet have also provided us with significant information. Thanking their creators individually is neither possible nor practical; we gratefully acknowledge all of them.
- We gratefully acknowledge Jagdish and Kamla Mittal Museum of Indian Art, Hyderabad, for its kind permission to reproduce peacock painting from its collection. We acknowledge T. Ramakrishna for editorial assistance, G. Giridharan and B. Nageswara Rao for reprographics and D. Lavanya for secretarial help.
- Our special thanks are due to Dr. P. M. Bhargava, the Founder Director of CCMB, whose valuable suggestions helped us to improve the manuscript in terms of the quality of its contents and presentation.

Madhusudan W. Pandit
Pradeep K. Srivastava
Lajji Singh

Abbreviations

A, G, C, T	Adenine, Guanine, Cytosine, Thymine
AIDS	Acquired Immuno Deficiency Syndrome
ART	Assisted Reproductive Technologies
BBC	British Broadcasting Corporation
BRCA1	Gene 1 for Breast Cancer
BRCA2	Gene 2 for Breast Cancer
CAG	Trinucleotide made up of nucleotides Cytosine, Adenine and Guanine
CBI	Central Bureau of Investigation
CCMB	Centre for Cellular and Molecular Biology
CDFD	Centre for DNA Fingerprinting and Diagnostics
CDRI	Central Drug Research Institute
DNA	Deoxyribonucleic Acid
ESA	Endangered Species Act
GATT	General Agreement on Tariffs and Trade
HIV	Human Immuno-Virus
ICU	Intensive Care Unit
IICT	Indian Institute of Chemical Technology
IUPAC	International Union of Pure and Applied Chemistry
mtDNA	Mitochondrial DNA
PCR	Polymerase Chain Reaction
RBC	Red Blood Cell
RNA	Ribonucleic Acid
SCNT	Somatic Cell Nuclear Transfer
STR	Short Tandem Repeats
UGC	University Grants Commission
USA	United States of America
UK	United Kingdom
VNTR	Variable Number of Tandem Repeats
WLPA	Wildlife Protection Act

Authors



Dr. Madhusudan W. Pandit

He obtained his Ph.D. from the University of Pune in 1970. He has worked as a professional scientist at various institutions such as NCL, Pune; RRL, IICT and CCMB, Hyderabad. After his retirement in 1993, he worked as a consultant at NAL, Bangalore. As a consultant, he helped in establishing the Centre for DNA Fingerprinting and Diagnostics (CDFD), an autonomous Centre of the Dept. of Biotechnology, Govt. of India. At present, he is working as a consultant to the CCMB on the Project "Laboratory for the Conservation of Endangered Species (LaCONES)". Apart from his professional achievements, he is proficient in music as well as theatre. The plays directed by him have won national awards. He is a poet in his own right and

has published a collection of poems (Swapna Pashan). He has also developed magic as a hobby and is a member of the International Brotherhood of Magicians, USA, and the Society of American Magicians, USA.

Dr. Pradeep K. Srivastava

He obtained his Ph.D. from Kanpur University in 1980. He formally introduced the first series of scientoons in an Asian conference held at the National University of Singapore, Singapore, in 1988. Since then, he has delivered more than 350 lectures in India and abroad. He has given several programs on television and radio. He also received several international as well as national awards, which include 'Outstanding Young Person of the World', given by Junior Chamber International (USA) annually to 10 selected persons from 110 countries. Presently, he is working as a senior scientist at CDRI, Lucknow. He is known as the "Scientoon man" in the campus as well as outside, and has achieved quite a feat by fusing complex scientific concepts with dollops of humour, which is received very well by the audiences. His endeavour to draw Scientoons began way back in 1988.



Dr. Lalji Singh

After obtaining M.Sc. and Ph.D. from Banaras Hindu University, he spent about 13 years in the Institute of Animal Genetics, University of Edinburgh (1974–1987) before joining the CCMB. Since July 1998, he is the Director, Centre for Cellular and Molecular Biology (CCMB), Hyderabad. He is internationally known for his contribution in the areas of molecular basis of sex determination, which has now become the basis of our understanding of sex reversal in humans. As a follow-up of this work, he developed an indigenous probe for DNA fingerprinting. He was responsible for setting up a separate autonomous centre, the Centre for DNA Fingerprinting and Diagnostics (CDFD) at Hyderabad, which is funded by the Department of

Biotechnology, Govt. of India, for which he was the Officer on Special Duty for first 3½ years. Because of his efforts, the evidence-based on DNA fingerprinting is now being accepted in the Indian Court of Law.

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Human Genome Project and Consequences

Chapter 1



DOE
**Human
Genome Program**



Chapter I

Human Genome Project and Consequences

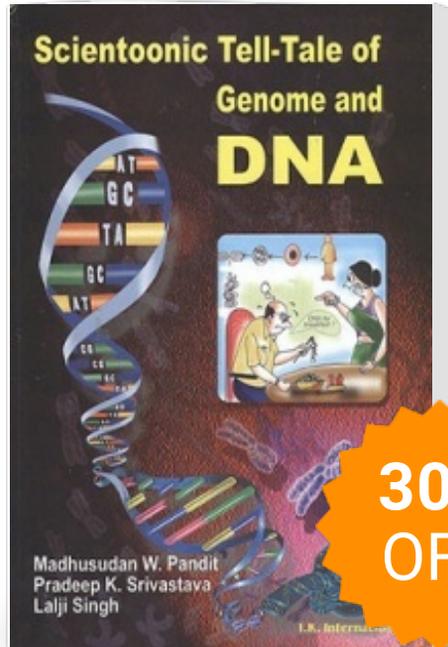
1.0 Prologue

All living organisms require the information coded in their genes for their reproduction, development and survival. A complete set of genes needed to produce an individual human being is called human genome. Human genome has now been completely sequenced. The whole scientific community was thrilled with this outstanding achievement. We are now confronted with the challenge of deciphering the information generated by the Human Genome Project. On one hand, there is bounded universe in terms of what is encoded in the human genome, but on the other hand it was daunting and humbling to learn about how little we know about our genome. It is a story of 6.4 billion letters that tells us who we are. Dr. Michael Dexter, Director of the Wellcome Trust—an organization which partly funded the British part of the efforts—said that “Mapping of human genome has been compared with putting the man on the moon, but I believe, it is more than that”.

It is remarkable that all living organisms on this planet are made up of only four letters (A, G, C and T), which are capable of generating tremendous biodiversity. For example, there are six billion people in the world today, but one cannot find two individuals with identical physical appearance except identical twins. Think of the microbial biodiversity, plant biodiversity and animal biodiversity, they are all combinations of only four letters. This is the beauty of nature’s careful selection of the genetic material and a marvel of its experimentation that is reflected in evolution. It will take



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Author : Madhusudan W
Pandit, Pradeep K
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