ISSN : 0973-6212

Special Edition on Sir U. N. Brahmachari

150th Birth Anniversary

AJHMC

Academic Journal of Hooghly Mohsin College

Volume : 12 | No. : 1 & 2 | June 2025

Peer-Reviewed | Multidisciplinary | Multilingual Journal

Academic Journal of Hooghly Mohsin College

ISSN : 0973-6212

Published by Hooghly Mohsin College

Chinsurah, Hooghly, West Bengal

Editorial Board

About the Journal

The journal is a peer reviewed multidisciplinary and multilingual in-house journal with ISSN. The journal invites original research based articles/papers on literature, science, economics, commerce, management, and related subjects. Write up on contemporary issues are preferred. Thrust areas for a particular issue are also selected to have a focused edition. To encourage the students of the institute "Students' Corner" of the journal is exclusively reserved for students' writings. Views expressed in the articles/papers are of the authors, the editorial board is no way responsible for this.

Published by : Principal, Hooghly Mohsin College, Government of West Bengal, Chinsurah
Editorial Office : Hooghly Mohsin College, P.O. Chinsurah, Dist.
Hooghly, PIN-712101, West Bengal
FAX: 033-2681-0544
E-mail: unbarticle@gmail.com
hooghlymohsincollege@gmail.com

Printed at **'Barno Bitan'** (7044339567) Chinsurah, Dist-Hooghly, West Bengal

Hooghly Mohsin College

Estd. 1836

AJHMC

Academic Journal of

Hooghly Mohsin College

ISSN : 0973-6212

Website : www.hooghlymohsincollege.ac.in

Date : 7th June, 2025

Volume : 12, Issue : 1 & 2

CONTENTS

- PEER REVIEW BOARD MEMBERS 3
- Note from the Editor-in-Chief 4
- Note from Editor 5
- Molecular Typing of Leishmania Genome: A Review 6
  — *Nibedeeta Rani Sarraf, Madhumita Manna*
- স্যার উপেন্দ্রনাথ ব্রহ্মচারী : মৃত্যুঞ্জয়ী বিজ্ঞানসাধক 10
  — *ড. অদিতি ব্যানার্জী*
- Sir Upendranath Brahmachari and His Urea Stibamine The Glorius Science and History Revisited 18
  — *Rajarshi Ghosh*
- Urea Stibamine to Modern Chemotherapeutics Against Kala-Azar: The Legacy of Upendranath Brahmachari and the On-going Journey of Drug Development 23
  — *Dr. Amit Roy*
- A tribute to Sir U N Brahmachari: An Unsung Hero of Indian Medical Research 29
  — *Krishna Roy*
- Structural Journey of the Kala-Azar Drug Urea Stibamine (Brahmachari): A Comprehensive Quantum Chemical Study 34
  — *Snehasis Banerjee*
- Of Bugs and Hope: Contribution of the Proteges of Hooghly Mohsin College in the Medical Sciences 42
  — *Dr. Ashis Kumar Basu, Sambuddha Bhattacharjee*

- পত্রপত্রিকার দর্পণে স্যার উপেন্দ্রনাথ ব্রহ্মচারী 47
  — ড. দেবায়ন চৌধুরী
- উপেন্দ্রনাথ ব্রহ্মচারীর ইউরিয়া স্টিবামিন: ঔপনিবেশিক ভারতে চিকিৎসা বিজ্ঞানের এক যুগান্তকারী উদ্ভাবন 52
  — ড. অতনু সাহা, ড. পিয়ালী ঘোষ
- *Caraka Saṃhitā* and its Relevance in Public Health Sector: A Study 56
  — Dr. Sanchita Kundu, Dr. Shreyasee Majumdar
- বাঙালির বিজ্ঞান সাধনার প্রথমপর্ব ও উপেন্দ্রনাথ ব্রহ্মচারী 61
  — ড. অনন্য ভট্টাচার্য
- EOQ Model for Deteriorating Drugs with Fuzzy Demand, Deterioration and Backlogging under Carbon Tax Policy 65
  — Soumita Kundu
- **सुश्रुतः – शल्यचिकित्सायाः पितामहः तस्य सिद्धान्ताश्च** 73
  — Prosenjit Dutta
- Socio-Economic Determinants of Anaemia Among Indian Women: Some Insights from NFHS-5 In Legacy of the Social Perspective of Sir U.N. Brahmachari 83
  — Tanusree Mishra
- Title: Dr. U.N. Brahmachari: Nationalism, Self-Reliance, and Medical Autonomy 87
  — Piku Das Gupta

PEER REVIEW BOARD MEMBERS

1. Dr. Asok K. Mukherjee, Professor of Chemistry (Retired), The University of Burdwan
2. Dr. Subhashis Sahu, Head & Associate Professor, Dept of Physiology, University of Kalyani
3. Dr. Jayita Dutta, Associate Professor, Department of Bengali, Hooghly Mohsin College
4. Dr. Piyali Ghosh, Associate Professor, Department of Chemistry, Nabagram Hiralal Paul College
5. Dr. Aditi Patra Nee Ray, Associate Professor, Department of Philosophy, Hooghly Mohsin College
6. Dr. Asis Kumar Pandit, Associate Professor, Department of Physiology, Hooghly Mohsin College
7. Dr. Kumkum Chattopadhyay, Associate Professor (Retd), Department of Political Science, Bethune College
8. Smt. Piku Dasgupta, Associate Professor, PG dept of Political Science, Hooghly Mohsin College
9. Dr. Sudip Chakravortti, Assistant Professor, Department of Sanskrit, Sidho Kanho Birsa University
10. Dr. Subha Bose(Banerjee), Assistant Professor, Post Graduate Department of Physiology, Hooghly Mohsin College
11. Dr. Debojit Das, Assistant Professor, Department of Sanskrit, Sivanath Sastri College (South City morning)
12. Dr. Tridib Chakraborty, Assistant Professor, Post Graduate Department of Physiology, Hooghly Mohsin College
13. Dr. Arpita Bose, Assistant Professor, Department of History, Hooghly Mohsin College
14. Dr. Atanu Saha, Assistant Professor, Post Graduate Department of Physiology, Hooghly Mohsin College
15. Dr. Aditi Banerjee, Assistant Professor, Department of Bengali, Hooghly Mohsin College
16. Dr. Subhajyoti Pal, Assistant Professor, Department of Mathematics, Jhargram Raj College

Note from the Editor-in-Chief

In this new issue of the Academic Journal of Hooghly Mohsin College, methodical analysis of those contributions of Sir U.N. Brahmachari in the fields medical sciences that are everlasting and a refinement of the concept medicine evolved through incessant researches for protection of human lives as well as biotic elements in our ecosystem has been studied by the authors.

The purpose of this journal is to organise in pages what Sir U.N. Brahmachari bestowed to our society in a coherent fashion so that readers can learn to devise and analyse the works done by this great physician of our motherland despite many facing many obstacles.

A major portion of this journal deal with different aspects of Sir U N Brahmachari's strategic skills in the fields of medical sciences during the first half of twentieth century India under the British rule. There are successions of examples which reveal varieties of his research works. An example of invention of Urea Stibamine saving many lives of poor community people may be cited here.

It may be mentioned here that this seminary has observed the 150th Birth Anniversary of Sir U N. Brahmachari in solemnity and grandeur and the aim of this celebration has also been discussed in this journal

Another special feature of this journal that the respected authors have tried to cover the areas of Sir U N. Brahmachari as a person, physician, philanthropist, and creator of philosophy of Physiology extensively.

Through diverse topics, suitable examples have been put down in this journal for the betterment of social lives as far as health and hygiene are concerned.

I convey my deepest thanks to everyone attached to the publication of this academic journal in a unique perspective for the cause of our society and safeguard of our ecosystem through Sir U.N. Brahmachari.

My best regards to Sir U N. Brahmachari. I dedicate this issue as a tribute to the greatest son of our motherland from all the stakeholders of this college.

Dr.Purushottam Pramanik

Principal & Editor in Chief

Note from Editor

It is with immense pleasure and pride that we present the 12th volume of the *Academic Journal of Hooghly Mohsin College (AJHMC)*. After a considerable hiatus, this renewed publication not only continues our rich academic tradition but also pays tribute to one of the most revered figures in the history of our institution.

This special edition is dedicated to the 150th birth anniversary of **Sir Upendranath Brahmachari**, whose pioneering contributions to medical science and education have left an indelible impact at both national and international levels. As a distinguished alumnus of Hooghly Mohsin College and a towering intellectual, Sir Brahmachari's legacy continues to inspire generations of scholars and researchers.

Through this edition, we strive to uphold the spirit of academic inquiry and excellence that he so profoundly embodied. The articles featured in this volume reflect the diverse and dynamic research pursuits of our faculty and students, reaffirming our commitment to fostering a culture of critical thinking and scholarly engagement.

We extend our heartfelt gratitude to the Department of Higher Education, Government of West Bengal for their generous support and funding. Our sincere thanks also go to all contributors, reviewers, the editorial team, and faculty members whose tireless efforts have brought this volume to fruition.

May this issue stand as a worthy homage to Sir U. N. Brahmachari and serve as a meaningful contribution to our academic legacy.

Dr. Atanu Saha
Editor

Volume : 12 No. 1 & 2
June, 2025

Molecular Typing of Leishmania Genome: A Review

Nibedeeta Rani Sarraf[1], *[*]*Madhumita Manna*[2]

[1]*Department of Zoology, Bidhannagar College, Kolkata, India.*
[2]*Education Directorate, Dept. of Higher Education, Govt. of West Bengal, Bikash Bhavan, Kolkata, India.*
[*]*Corresponding author: madhumita.manna09@gmail.com*

Received : 29:05:2025 Accepted : 31:05:2025 Published : 07:06:2025

Abstract : Leishmaniasis, a neglected tropical disease caused by the *Leishmania* parasite, poses significant health challenges worldwide. Molecular typing of the *Leishmania* genome has revolutionized our understanding of the parasite's biology, epidemiology, and evolution. Understanding genetic variability is crucial for addressing clinical manifestations and drug resistance. Molecular characterization techniques, such as MLEE, MLMT, RAPD, RFLP, MLST, and Whole-Genome Sequencing (WGS), provide reliable results for species identification and strain characterization. This review explores in brief, the molecular typing techniques, from traditional methods like Multilocus Enzyme Electrophoresis (MLEE) to cutting-edge approaches like WGS. These techniques have enabled researchers to characterize *Leishmania* species, understand genetic variability, and identify potential targets for diagnosis and treatment. The application of molecular typing has significant implications for disease control, vaccine development, and therapeutic interventions. Researchers can develop more effective strategies to combat this deadly disease by exploring the genetic diversity of *Leishmania* parasites. This review highlights the importance of molecular typing in advancing our understanding of *Leishmania* biology and its potential to inform public health policy and disease management. Ultimately, molecular typing of the *Leishmania* genome holds promise for improving the diagnosis, treatment, and prevention of leishmaniasis, reducing its burden on affected communities worldwide.

1. Introduction

Leishmania is a genus of trypanosomatids that causes the disease known as Leishmaniasis. These parasites are transmitted by sand flies belonging to the genus Phlebotomus in the Old World and Lutzomyia in the New World [1]. Their main hosts are vertebrates, with *Leishmania* species frequently infecting hyraxes, canids, rodents, and humans. Leishmaniases encompass a range of diseases, with the primary forms being Cutaneous Leishmaniasis (CL), Mucocutaneous Leishmaniasis (MCL), and Visceral Leishmaniasis (VL) or Kala-azar (KA). VL represents the most severe manifestation of the disease, characterized by symptoms such as hepatosplenomegaly, anemia, edema, abdominal swelling, and liver cirrhosis, which can be fatal if not treated. In contrast, CL, the most commonly occurring form, leads to skin lesions that can appear on any part of the body. MCL may arise from the spread of parasites from the skin to the nasooropharyngeal mucosa, resulting in nasal bleeding and potentially causing severe ulcerative damage to the nasooropharyngeal mucosa if untreated. Post Kala-azar Dermal Leishmaniasis (PKDL) also presents as skin lesions, particularly on the face, which can develop during or after treatment for VL [12]. One intermediate form of the disease where the concurrent manifestation of PKDL in individuals suffering from active VL is referred to as para-kala-azar dermal leishmaniasis (para-KDL) [16]. The disease manifests in various forms, with varying degrees of severity and impact on public health. Hence, understanding the genetic diversity and molecular characteristics of *Leishmania* parasites is crucial for developing effective diagnostic tools, therapeutic strategies, and control measures.

2. The Burden of Leishmaniasis

Leishmaniasis affects millions of people worldwide, with an estimated 1.5 million new cases reported annually. The disease is prevalent in 98 countries, with the majority of cases occurring in the Indian subcontinent, East Africa, and South America. KA, is the most severe form of the disease, with a mortality rate of nearly 100% if left untreated. KA has become endemic in eastern India, particularly in the states of Bihar, Jharkhand, West Bengal, and Uttar Pradesh [8], [18]. The management of Leishmaniasis typically depends on accurate diagnosis, identification of the pathogens responsible for the disease, treatment of infected individuals, vector control, and, in certain instances, management strategies.

3. Leishmania genome

Kinetoplast DNA (kDNA)

kDNA is a unique mitochondrial DNA structure in *Leishmania* and other trypanosomatids, comprising: 1. Maxi circles (~20 kb): Encode rRNA genes and structural proteins for mitochondrial respiration. 2. Mini circles (~0.8 kb): Encode guide RNAs (gRNAs) for editing maxi circle-encoded mitochondrial genes. kDNA constitutes 10-20% of total DNA and features a complex organization exclusive to trypanosomatids [4].

Nuclear Genome

The *Leishmania* genome is composed of 34-36 chromosomes, ranging in size from 0.3 to 3.5 Mb. The genome is rich in genes, with approximately 8,000-10,000 protein-coding genes. *Leishmania* genes are often organized in polycistronic transcription units, where multiple genes are transcribed together as a single unit [4].

Types of Molecular Characterizations of The Parasites

A. Over the years, various molecular typing techniques have been employed to characterize *Leishmania* parasites. Early studies used techniques such as multilocus enzyme electrophoresis (MLEE) and isoenzyme analysis. Both techniques analyze enzymes or isozymes to identify genetic variation and are used for the genetic characterization of organisms, including *Leishmania* parasites [9], [10].

MLEE involves analyzing the electrophoretic mobility of enzymes to identify genetic variation and isozyme analysis involved studying the different forms of enzymes to identify genetic variation. For example, the existence of three visceralizing species in East Africa—*L. donovani, L. infantum, and L. archibaldi*—was not supported by analysis using a variety of molecular markers [9]. Additionally, *L. killicki* was not confirmed as a separate species, and strains with different genetic backgrounds were assigned to the *L. donovani* zymodeme MON-37. The majority of *L. infantum* parasites that cause visceral leishmaniasis in the Mediterranean and South America share the same zymodeme, MON-1, which limits the discriminatory efficacy of MLEE for classes below the species level. Other important drawbacks of MLEE are that it requires bulk cultures of parasites, it is labour intensive and time-consuming, and it can only be performed in specialized laboratories [11].

Despite these limitations, MLEE and isozyme analysis have contributed significantly to our understanding of *Leishmania* genetics and epidemiology. These methods provided valuable insights into the genetic diversity of *Leishmania* parasites and helped establish the foundation for modern molecular typing approaches.

B. The present state of *Leishmania* research is characterized by a growing understanding of the genetic diversity and molecular characteristics of *Leishmania* parasites. The advent of PCR-based techniques includes the recently developed multilocus sequence typing (MLST) and multilocus microsatellite typing (MLMT) [3],[13] as well as the amplification and subsequent restriction fragment length polymorphism (RFLP) or DNA sequence analysis of multicopy targets or multigene families, including coding and non-coding regions and PCR-fingerprinting techniques e.g Random Amplified Polymorphic DNA (RAPD) [14]. These approaches have enabled researchers to identify genetic variants, reconstruct phylogenetic relationships, and investigate the population structure of *Leishmania* parasites. Recent studies have also employed next -generation sequencing (NGS) technologies to explore the genomic diversity of *Leishmania* parasites by performing whole-genome sequencing (WGS) [2].

Here are some PCR-based techniques used in *Leishmania* research:

Random Amplified Polymorphic DNA (RAPD): RAPD involves using arbitrary primers to amplify DNA sequences and identify genetic variation among *Leishmania* parasites and helps in species identification [5].

PCR-Restriction Fragment Length Polymorphism (PCR-RFLP): PCR-RFLP involves amplifying specific DNA sequences and digesting them with restriction enzymes to identify genetic variation. As far as we know, the PCR-RFLP analysis of the internal transcribed spacer 1 (ITS1) is the most commonly utilized method for the direct identification and detection of *Leishmania* species in the Old World. By using a single restriction enzyme, HaeIII, to digest the ITS1 PCR product, it is possible to differentiate all clinically significant *Leishmania* species [6].

Multilocus microsatellite typing (MLMT): Microsatellite analysis involves amplifying and analyzing repetitive DNA sequences to study the genetic diversity and population dynamics of *Leishmania* parasites [13].

Multilocus Sequence Typing (MLST): The term was specifically adopted for a system which is initially developed for bacteria [17]. Recently, preliminary efforts have been made to establish an MLST system for *Leishmania*, although a publicly accessible database has not yet been developed. The *L. donovani* complex has been examined using two sets of five loci corresponding to genes that encode enzymes analyzed through MLEE [11],[19].

One grouping includes asat, gpi, nh1, nh2, and pgd, while the other comprises icd, me, mpi, g6pdh, and fh. Altogether, these ten targets have the potential to create a comprehensive MLST system suitable for the *L. donovani* complex. MLST involves sequencing multiple genetic loci to characterize *Leishmania* parasites and understand their genetic diversity. It also acts as a powerful tool to study the intraspecies variation (Unpublished data).

e) Next-generation sequencing (NGS) technologies have further transformed the field of *Leishmania* research. NGS has enabled researchers to explore the genomic diversity of *Leishmania* parasites, identify genetic variants associated with disease phenotypes, and investigate the molecular mechanisms underlying *Leishmania* pathogenesis [2], [15]. NGS has become a promising and effective method for investigating drug resistance factors and biomarkers in *Leishmania* research. Genome-wide SNP typing through NGS is a robust technique for distinguishing between parasite strains within natural populations and has demonstrated superior results compared to traditional methods [3]. Through NGS tool we can elucidate rative genomic analysis, by conducting WGS. This approach involves comparing the genomes of different *Leishmania* species to identify genetic differences and similarities. A study that compared the genomes of *L. infantum, L. braziliensis,* and *L. major,* revealing conserved synteny and identifying genes with differential distribution between species [14].

Future Prospects

The future of *Leishmania* research holds much promise, with ongoing advances in genomics, transcriptomics, and bioinformatics. The application of NGS technologies and machine learning algorithms is expected to reveal new insights into the molecular mechanisms underlying *Leishmania* pathogenesis, drug resistance, and vaccine development [2]. Furthermore, the integration of genomic data with epidemiological and clinical information will facilitate the development of personalized medicine approaches and targeted interventions [3], [11].

6. Importance of Molecular Typing

Molecular characterization of *Leishmania* parasites has become an essential tool in understanding the genetic diversity and population structure of the parasites [17]. Molecular typing techniques have enabled researchers to identify distinct species and strains, investigate phylogenetic relationships, and explore the genetic basis of disease phenotypes [2]. This information is critical for developing effective diagnostic tools, therapeutic strategies, and can identify genetic markers associated with drug resistance, enabling targeted interventions to control disease.

7. Conclusion

In conclusion, molecular typing of the *Leishmania* genome has undergone significant advancements over the years, from traditional techniques to cutting-edge NGS technologies. This review aims to summarize the prospects of *Leishmania* genome typing, highlighting the potential of molecular approaches to inform disease control strategies, epidemiological surveillance and improve our understanding of this complex parasite.

Acknowledgments

We sincerely acknowledge the Department of Biotechnology (DBT), New Delhi. We are thankful to Dr. Anjan Kumar Das, NRS Medical College & Hospital, Kolkata, Dr. Syamal Roy, Indian Association for Cultivation of Science, Kolkata, the Director and Dr. Partha Saha, Saha Institute of Nuclear Physics, Kolkata, the Principal, Barasat Govt. College, Barasat and the Director, Indian Institute of Chemical Biology, Kolkata.

References

[1] Alvar J, Velez ID, Bern C, Herrero M, Desjeux P, Cano J, Jannin J, den Boer M. (2012). Leishmaniasis worldwide and global estimates of its incidence. PLoS ONE, 7:e35671

[2] Downing et al. (2011). Whole genome sequencing of Leishmania parasites: a comparative analysis. PLOS Neglected Tropical Diseases, 5(10), e1333.

[3] Imamura et al. (2016). Molecular typing of Leishmania donovani isolates from Indian subcontinent. Infection, Genetics and Evolution, 40, 281-289.
[4] Khanra, S., Sarraf, N.R., Lahiry, S. et al. (2017). Nucleus 60, 227–235.
[5] Khanra S, Bandopadhyay SK, Chakraborty P, Datta S, Mondal D, Chatterjee M, et al. (2011). Characterization of the recent clinical isolates of Indian Kala-azar patients by RAPD-PCR method. J Parasit Dis.;35:116–22. 34.
[6] Khanra S, Datta S, Mondal D, Saha P, Bandopadhyay SK, Roy S, et al.(2012). RFLPs of ITS, ITS1 and hsp70 amplicons and sequencing of ITS1 of recent clinical isolates of Kala-azar from India and Bangladesh confirms the association of L. tropica with the disease. Acta Trop. ;124:229–34.

[7] Lukes, J., et al (2007). Evolutionary and geographical history of the Leishmania donovani complex with a revision of current taxonomy. Proceedings of the National Academy of Sciences, USA 104, 9375–9380.

[8] Mann, K. (2021). The structure of homeomorphism and diffeomorphism groups. Notices Amer. 514 Math. Soc, 68, 482-492

[9] Manna M, Majumder HK, Sundar S, Bhaduri AN (2005) The molecular characterization of clinical isolates from Indian Kalaazar patients by MLEE and RAPD-PCR. Med Sci Monit 11:220–227.

[10] Manna M, Khanra S. (2016). Molecular identification of an old clinical isolate of Indian Kala-azar. J Parasit Dis.
[11] Mauricio, I. L., Yeo, M., Baghaei, M., Doto, D., Pratlong, F., Zemanova, E., Dedet, J. P., Lukes, J. and Miles, M. A. (2006). Towards multilocus sequence typing of the Leishmania donovani complex: resolving genotypes and haplotypes for five polymorphic metabolic enzymes (ASAT, GPI, NH1, NH2, PGD). International Journal for Parasitology 36, 757–769.
[12] Murray HW, Berman JD, Davies CR, Saravia NG. Advances in leishmaniasis. (2005).Lancet, 66:1561 –77
[13] Ochsenreither, M., Presber, W., & Schönian, G. (2006). Multilocus microsatellite typing as a new tool for discrimination of Leishmania infantum MON-1 537 strains. Journal of clinical microbiology, 44(2), 495 -503.

[14] Peacock CS, Seeger K, Harris D, Murphy L, et al. (2007). Comparative genomic analysis of three Leishmania species that cause diverse human disease. Nat Genet. Jul;39(7):839-47.

[15] Sarraf NR, Mukhopadhyay S, Banerjee A, Das AK, Roy S, Chakrabarti S, Manna M, Saha P. (2021). Genome wide comparison of Leishmania donovani strains from Indian visceral leishmaniasis and para-kala-azar dermal leishmaniasis patients. Acta Trop.223:106086.

[16] Schönian, G., Mauricio, I., Gramiccia, M., Canavate, C., Boelaert, M. and Dujardin, J. C. (2008). Leishmaniases in the Mediterranean in the era of molecular epidemiology. Trends in Parasitology 24, 135–142.

[17] Schönian G, Kuhls K, Mauricio IL. (2011). Molecular approaches for a better understanding of the epidemiology and population genetics of Leishmania. Parasitology. ;138:405–425.

[18] WHO Leishmaniasis (2022).

[19] Zemanova, E., Jirku, M., Mauricio, I. L., Horak, A., Miles, M. A. and Lukes, J. (2007). The Leishmania donovani complex: genotypes of five metabolic enzymes (ICD, ME, MPI, G6PDH, and FH), new targets formultilocus sequence typing. International Journal for Parasitology 37, 149–160.

Volume : 12 No. 1 & 2
June, 2025

স্যার উপেন্দ্রনাথ ব্রহ্মচারী : মৃত্যুঞ্জয়ী বিজ্ঞানসাধক

ড. অদিতি ব্যানার্জী
সহকারী অধ্যাপক, বাংলা বিভাগ, হুগলি মহসিন কলেজ
aditibanerjee29@gmail.com

Received : 08:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

মানবসভ্যতার আদিপর্ব থেকেই মানুষের সংগ্রাম যে বিরুদ্ধ শক্তিগুলির সঙ্গে তার মধ্যে প্রধান হল ব্যাধি। ব্যাধি মানবমনে যুগপৎ উদ্রেক করেছে আতঙ্ক এবং প্রশ্ন। ব্যাধির প্রতিকারের চেষ্টা তার চিরকালীন। মানবেতিহাসের প্রথমপর্বে মানুষ অনুমান করত রোগের কারণ দেবতার রোষ বা প্রেতের প্রভাব। ফলে তখন রোগ নিরাময়ের 'উপায়' ছিল নানা উপচারে, নানা ক্রিয়াকলাপে রোগসৃষ্টিকারী শক্তিগুলিকে তুষ্ট করা। কিন্তু কালক্রমে জানা যায় রোগের জন্য কোনো প্রেত বা দেবতা দায়ী নন। গ্রিক চিকিৎসক হিপোক্রেটিস উল্লেখ করেন প্রকৃতির মধ্যেই আছে রোগ-উৎপত্তির বীজ। অজ্ঞাত রোগব্যাধির উৎপত্তি এবং প্রতিকার বিষয়ে মানুষের অনুসন্ধিৎসা তাকে এগিয়ে নিয়ে যায় গবেষণার অভিমুখে। চিকিৎসাশাস্ত্রের সঙ্গে গবেষণার নিবিড় যোগ সাধিত হয়। অনেক ব্যাধিরই যথোপযুক্ত চিকিৎসাপদ্ধতি এছাড়া আবিষ্কার সম্ভব ছিল না। যেমন কালাজ্বর। এক নিরাময়হীন আতঙ্কের নাম। রোগলক্ষণ দীর্ঘদিন জ্বর, দুর্বলতা, ওজনহ্রাস, যকৃৎ ও প্লীহার বৃদ্ধি, চামড়ায় কালো ছোপ। আক্রান্ত রোগীর বাঁচার সম্ভাবনা প্রায় বিরল। মৃত্যুহার ৯৮ শতাংশের বেশি। আক্রান্তের নিরিখে সংখ্যাতত্ত্বের বিচারে অবশ্যই মহামারী। অজানা এই জ্বরের নামকরণ কালাজ্বর হবার সম্ভাব্য কারণ একদিকে ত্বকের কালো হয়ে ওঠা, অন্যদিকে ঘনিয়ে ওঠা মৃত্যুর করাল ছায়া। প্লেগ যেমন মারীর ইতিহাসে কুখ্যাত হয়ে আছে 'ব্ল্যাক ডেথ' হিসেবে, তেমনই অবশ্যম্ভাবী মৃত্যুর দ্যোতক এই জ্বরব্যাধি। 'কাল' স্বরূপ। রোগের উৎপত্তি এবং তার নিরাময়ের উপায় দুটোই অজানা। রোগ মানচিত্রের ইতিহাসে ভারতবর্ষ ছাড়াও এর প্রকোপের পদচিহ্ন মেলে চিন, ভূমধ্যসাগরীয় অঞ্চল, ইউরোপের গ্রিস, স্পেন, ফ্রান্স, ইতালি ইত্যাদি দেশে। ভারতবর্ষে এই অজানা জ্বরে আক্রান্ত মূলত বাংলা, আসাম, বিহার, ওড়িশা, মাদ্রাজের জনগোষ্ঠী। বিশেষত আসামের কুলিবস্তিতে এই রোগের প্রাদুর্ভাবের অর্থ রীতিমত মড়ক লাগা। হাহাকার, হতাশা, রোগযন্ত্রণা, মৃত্যু। সেখানে স্নিগ্ধ শুশ্রূষার স্পর্শ যেন এক অলীক কল্পনা। সেই অলীক কল্পনাকেই বাস্তবায়িত করল 'ইউরিয়া স্টিবামাইন'। মৃত্যুর মরুতে মৃত্যুঞ্জয়ী মরুদ্যান। আবিষ্কারক উপেন্দ্রনাথ ব্রহ্মচারী। প্রখ্যাত বাঙালি চিকিৎসক ও গবেষক।

উপেন্দ্রনাথের জন্ম ১৮৭৫ খ্রিস্টাব্দের ৭ জুন, মতান্তরে ১৮৭৩ খ্রিস্টাব্দের ১৯ ডিসেম্বর। সরকারি নথিপত্রের হিসেবে অবশ্য ১৮৭৫ সালটিকেই মান্য করা হয়। জন্মস্থান বিহারের জামালপুর, মতান্তরে বর্ধমানের পূর্বস্থলী। পিতা নীলমণি ব্রহ্মচারীসদাশয় ব্যক্তি, কৃতবিদ্য চিকিৎসক। কর্মসূত্রে পূর্ব রেলওয়ের চিকিৎসক হবার সুবাদে বসবাস জামালপুরে। অঞ্চলের সাম্মানিক ম্যাজিস্ট্রেট। মাতা শ্রীমতী সৌরভ সুন্দরী দেবী। নীলমণি-সৌরভ সুন্দরীর চার সন্তান- শরৎচন্দ্র, উপেন্দ্রনাথ, শ্যামাচরণ, ভবতারণ। পারিবারিক ঐতিহ্যসূত্রে বংশপরম্পরায় উপেন্দ্রনাথের পরিবার শ্রীচৈতন্যদেবের দীক্ষাগুরু কেশব ভারতীর (সন্ন্যাসপূর্ব নাম রামভদ্র) জ্যেষ্ঠভ্রাতা বলভদ্রের পুত্র গোপাল ভারতী ব্রহ্মচারী ঠাকুরের বংশধর। এই বংশের আদি বাসস্থান বর্ধমানের পূর্বস্থলীর নিকটে সরডাঙা গ্রামে। উপেন্দ্রনাথের প্রজন্ম গোপাল ভারতীর বংশের নবম পুরুষ। ভরদ্বাজ গোত্রীয় ব্রাহ্মণ। আদিতে মুখোপাধ্যায়।

দীক্ষিত পুরুষের উপাধি অনুসারে পদবি ব্রহ্মচারী।

বাল্যকাল থেকেই উপেন্দ্রনাথ অত্যন্ত মেধাবী। প্রখর স্মৃতিশক্তির অধিকারী। প্রথম শিক্ষায়তন জামালপুর ইস্টার্ন রেলওয়ে বয়েজ স্কুল। উচ্চশিক্ষার জন্য ভর্তি হন তদানীন্তন হুগলি কলেজে, যেটি বর্তমানে হুগলি মহসিন কলেজ হিসেবে বিখ্যাত। ১৮৮৯-৯৩ খ্রিস্টাব্দ পর্যন্ত হুগলি কলেজের উজ্জ্বল ছাত্র। এখান থেকেই ১৮৯১ খ্রিস্টাব্দে এফ.এ এবং ১৮৯৩ খ্রিস্টাব্দে গণিত ও রসায়নে সাম্মানিকসহ উত্তীর্ণ হন। উপেন্দ্রনাথের সন্তান ফণীন্দ্রনাথ ইন্ডিয়ান ন্যাশনাল সায়েন্স একাডেমির প্রকাশিত স্মৃতিনিবন্ধ সিরিজে তাঁর পিতার দুটি বিষয়ে সাম্মানিক প্রাপ্তির উল্লেখ করেছেন। গণিত সাম্মানিকে প্রথম শ্রেণিতে উত্তীর্ণ হবার জন্য তিনি 'থয়েটস' পদকলাভ করেন।গণিতের পাশেআগ্রহের কেন্দ্র ছিল রসায়ন। এদিকে পিতার আকাঙ্ক্ষা তাঁর তীক্ষ্ণধী দ্বিতীয় পুত্রকে চিকিৎসক রূপে দেখা। ফলে রসায়ন ও চিকিৎসাবিদ্যা অধ্যয়নের মেলবন্ধন। উত্তর-জীবনে বিজ্ঞানের এই দুই শাখাতেই কৃতিত্ব অর্জন।রসায়নশাস্ত্রে স্নাতকোত্তরে পাঠগ্রহণ প্রেসিডেন্সি কলেজে। সেখানে স্যার আলেকজান্ডার পেডলার এবং আচার্য প্রফুল্লচন্দ্র রায়ের মত শিক্ষকের সান্নিধ্যলাভ। ১৮৯৪ খ্রিস্টাব্দে রসায়নে প্রথম শ্রেণিতে প্রথম। কলকাতা বিশ্ববিদ্যালয় থেকে স্বর্ণপদকলাভ। রসায়নশাস্ত্রে উপেন্দ্রনাথের এই আগ্রহ ভবিষ্যতে তাঁরগবেষণার পাথেয় হবে। পিতার নির্দেশিত পথে চিকিৎসাশাস্ত্রেও তিনি অত্যন্ত সাফল্য অর্জন করেন। কলকাতা মেডিক্যাল কলেজে চিকিৎসাশাস্ত্রের পাঠগ্রহণ করেন। ১৮৯৯ খ্রিস্টাব্দে লাভ করেন এল.এম.এফ ডিগ্রি। তার পরের বছর অর্থাৎ ১৯০০ খ্রিস্টাব্দে এম.বি পরীক্ষায় উত্তীর্ণ হন। মেডিসিন এবং সার্জারি দুই ক্ষেত্রেই অর্জন করেন প্রথম স্থান। সেই কৃতিত্বের জন্য লাভ করেন 'গুডেভ' ও 'ম্যাকলিওড' পদক। তারপরকলকাতা বিশ্ববিদ্যালয় থেকে ১৯০২ খ্রিস্টাব্দেএম.ডি ডিগ্রিলাভ। ১৯০৪ খ্রিস্টাব্দে লাভ করেন পিএইচডি ডিগ্রি। বিষয় শারীরবিদ্যা। মানবশরীরে লোহিতকণিকা হ্রাস পাওয়ার কারণ অনুসন্ধান। গবেষণা সন্দর্ভের নাম 'স্টাডিস ইন হিমোলিসিস'। এই গবেষণা সন্দর্ভের এতই চাহিদা ছিল যে ১৯০৯ এ কলিকাতা বিশ্ববিদ্যালয় থেকে প্রথম সংস্করণ বেরোনোর চারবছর পরেই ১৯১৩ তে দ্বিতীয় সংস্করণ মুদ্রিত হয়। বিশ শতকের প্রথমভাগে উপেন্দ্রনাথ ছাড়া সম্ভবত সমগ্র ভারতবর্ষে কেউ সেই সময় মেডিসিনের ওপর ডক্টরেট ডিগ্রি লাভ করেননি। উচ্চতর অধ্যয়নের সমান্তরালেই এগিয়ে চলে তাঁর পেশাগত ও ব্যক্তিগত জীবন। ১৮৯৮ খ্রিস্টাব্দে কলকাতার জোড়াবাগান এলাকার বিখ্যাত চিকিৎসক রামলাল ব্যানার্জীর কন্যা ননীবালা দেবীর সঙ্গে বিবাহবন্ধনে বাঁধা পড়েন। উত্তর-জীবনে এই দম্পতি দুই পুত্র (ফণীন্দ্রনাথ, নির্মলকুমার) ও দুই কন্যা সন্তানের (ঊষা ও শোভা) জনক-জননী হন। একই সঙ্গে যথেষ্ট বৈচিত্র্যময় তাঁর কর্মজীবন। পেশার সূত্রে প্রথমে ১৮৯৯ তে যোগদান করেন প্রাদেশিক চিকিৎসা বিভাগে (প্রভিন্সিয়াল মেডিকেল সার্ভিস)। ১৯০১ খ্রিস্টাব্দে ঢাকা মেডিক্যাল স্কুলে প্যাথোলজি এবং মেটিরিয়া মেডিকার শিক্ষক পদে নিযুক্ত হন। ১৯০৫ এ চিকিৎসক-শিক্ষক হিসেবে যোগদান করেন কলকাতার ক্যাম্পবেল মেডিকেল স্কুলে (যেটি বর্তমানে পরিচিত নীলরতন সরকার মেডিকেল কলেজ ও হাসপাতাল হিসেবে। শিক্ষকতা এবং চিকিৎসা দুই ক্ষেত্রেই তিনি প্রভূত খ্যাতি অর্জন করেন। শিক্ষকতায় অসাধারণ দক্ষতার জন্য তাঁকে বলা হয় 'দি লিভিং ডিকশনারি অব মেডিসিন'। এই প্রতিষ্ঠানে সুদীর্ঘ ১৮ বছর যুক্ত থেকে তিনি কালাজ্বরের প্রতিষেধক সংক্রান্ত গবেষণার কাজটি করেন। তারপর ১৯২৩ খ্রিস্টাব্দে অতিরিক্ত চিকিৎসক হিসেবে তিনি যোগ দেন কলকাতা মেডিকেল কলেজে। অবসর গ্রহণের পর ১৯২৭এ 'প্রফেসর অফ ট্রপিক্যাল ডিজিস' রূপে যোগদান করেন কারমাইকেল মেডিকেল কলেজে (যেটি বর্তমানে পরিচিত আর জি কর মেডিকেল

কলেজ ও হাসপাতাল হিসেবে)। এর সঙ্গে 'ন্যাশনাল মেডিকেল ইন্সটিটিউট'এ একই বিষয়ের বিভাগে যুক্ত হন। পাশাপাশি প্রাণ-রসায়ন (বায়োকেমিস্ট্রি) বিভাগের প্রধান এবং সাম্মানিক অধ্যাপক হিসেবে দায়িত্ব পালন করেন কলকাতা বিশ্ববিদ্যালয়ের কলেজ অফ সায়েন্সে।

চিকিৎসা বা অধ্যাপনার কাজে নিযুক্ত থাকার পাশাপাশি সদাসক্রিয় ছিল উপেন্দ্রনাথের গবেষক মন। ছাত্রাবস্থাতেই গবেষণার কাজে তাঁকে প্রথম উৎসাহিত করেছিলেন কলকাতা মেডিকেল কলেজের অধ্যক্ষ স্যার গেরার্ল্ড বমফোর্ড। তারপর পেশাগত জীবনে প্রতিষ্ঠালাভের সঙ্গে সঙ্গে ক্যাম্পবেল মেডিকেল স্কুলের সুপারিন্টেনডেন্ট স্যার রবার্ট নিল ক্যাম্পবেলেরসঙ্গে তিনি গবেষণা শুরু করেন। নিরক্ষীয় উষ্ণ অঞ্চলের ব্যাধিগুলির বিষয়ে অর্থাৎ 'ট্রপিক্যাল ডিজিস'এর অনুসন্ধানে মগ্ন হন। 'রেতে মশা দিনে মাছি' নিয়ে জ্বরের শহর কলকাতায় মশাবাহিত ম্যালেরিয়া এবং কোয়ার্টন ফিভার বিষয়ে কাজ শুরু করেন। *anopheles ludlowii* নামক একটি মশা আবিষ্কার করেন কলকাতাতেই। এই আবিষ্কার বিষয়ে বিশ্ব স্বাস্থ্য সংস্থার ম্যালেরিয়া বিষয়ক কমিটির সদস্য স্যার গর্ডন কোভেল উল্লেখ করেছিলেন 'Brahmachari's finding of anopheles ludlowii in Calcutta was of great significance.' ইতিমধ্যে ঔপনিবেশিক ভারতের পূর্বাঞ্চলে বারংবার অজানা জ্বর মানবমনে ত্রাস সৃষ্টি করেছিল। এই জ্বর চিকিৎসক-বিজ্ঞানীদের ধোঁয়াশায় ফেলে দিয়েছিল। এর আগে ১৮৬০ এর দশকে বর্ধমানে দেখা দেওয়া এক ভয়ানক জ্বর এতই প্রাণহানির কারণ হয়েছিল যে সরকারি রাজস্ব আদায়ের পরিমাণ কমে গিয়েছিল। তার নাম দেওয়া হয় 'ওল্ড বর্ধমান ফিভার'। এই 'ওল্ড বর্ধমান ফিভার' নিয়ে উপেন্দ্রনাথ ১৯১১ সালে একটি গবেষণাপত্রও পেশ করেন। তার শিরোনাম ছিল 'On the Nature of the Epidemic Fever in Lower Bengal commonly known as Burdwan Fever, প্রকাশিত হয়েছিল ইন্ডিয়ান মেডিকেল গেজেটে। 'ওল্ড বর্ধমান ফিভার' আর এই অজানা জ্বরকে প্রথমে একই রোগ বলে মনে করেছিলেন বিখ্যাত আই.এম.এস লিওনার্ড রজার্স। এই মতকে স্বীকার করলে বর্ধমান জ্বরের আগের অর্থাৎ ১৮২৪-২৫ সালের যশোরের 'জ্বর-বিকার'কেও এই একই রোগ হিসেবে চিহ্নিত করতে হয়। মারাত্মক বর্ধমান জ্বরের অনুসরণে এই অজানা জ্বরকে দমদম জ্বরওবলা হত, যেহেতু দমদম সেনাছাউনি ও তার পার্শ্ববর্তী অঞ্চল থেকে রোগী আসত বেশি। জ্বরটির চরিত্র ছিল বিভ্রান্তি সৃষ্টিকারী। উপসর্গের সাদৃশ্যের কারণে একে ম্যালেরিয়া বা বর্ধমান জ্বরের সঙ্গে মিলিয়ে ফেলার সম্ভাবনা ছিল প্রবল। কিন্তু জ্বরটি ছিল সংক্রামক এবং কুইনাইনে সারত না। উনিশ শতকের শেষদিকে আসামে এই জ্বর মহামারীর আকার নিয়েছিল। স্থানীয় মানুষেরা, বিশেষতগারোরা একে বলত 'ব্রিটিশ গভর্নমেন্ট ডিজিস' বা 'সরকারী বেমারি'। বেশিরভাগ সময়ে আক্রান্ত রোগীর গায়ের চামড়া কালো হয়ে মৃত্যুর কারণে কালাজ্বর হিসেবে পরিচিত। বিশ শতকের শুরুতে ১৯০৩ খ্রিস্টাব্দে বিজ্ঞানী উইলিয়ম বুগ লিসম্যান এবং চার্লস ডোনোভানের অক্লান্ত চেষ্টায় আক্রান্ত রোগীদের প্লীহার রস পরীক্ষা করে কালাজ্বরের জীবাণুকে শনাক্ত করা সম্ভব হয়। পৃথক পৃথকভাবে গবেষণা করেও প্রায় একই সময়ে তাঁরা একই সিদ্ধান্তে উপনীত হন। ফলে কালাজ্বর সৃষ্টিকারী জীবাণুটির বৈজ্ঞানিক নামের গণ লিসম্যান ও প্রজাতি ডনোভান রাখা হয়। রোনাল্ড রস 'Note on the bodies recently described by Leishman and Donovan' এই শিরোনামে প্রকাশিত গবেষণাপত্রের মাধ্যমে পরজীবীর বৈজ্ঞানিক নাম দেন লিশম্যানিয়া ডনোভানি। প্রমাণিত হয় কালাজ্বর লিসম্যানিয়াসিসের চরম রূপ। চিকিৎসাবিজ্ঞানে যা 'ভিসেরাল লিসম্যানিয়াসিস' নামে পরিচিত। ১৯২৪ খ্রিস্টাব্দে কলকাতার স্কুল অফ ট্রপিক্যাল মেডিসিনে নলস্, ন্যাপিয়ার এবং স্মিথ আবিষ্কার করেন একপ্রকার অতিক্ষুদ্র বালিমাছির দ্বারা (Sandfly) এই রোগের

সংক্রমণ ঘটে। এর বৈজ্ঞানিক নাম *phlebotomus argentipes*। কালাজ্বরের জীবাণু আক্রান্ত ব্যক্তির রোগপ্রতিরোধ ক্ষমতাকে সম্পূর্ণ বিনষ্ট করে দেয়, ফলে মৃত্যুহার হয় সর্বাধিক।

কালাজ্বরের জীবাণু এবং সংক্রমণের কারণ বিষয়ে কিছু তথ্য পাওয়া গেলেও সবচেয়ে গুরুত্বপূর্ণ সমস্যাটি ছিল অমীমাংসিত। তা হল এই রোগের প্রতিকার এবং প্রতিষেধক। বিশ্বব্যাপী এই বিষয়ে গবেষণা চলেছিল। স্যার লিওনার্ড রজার্স প্রথম কালাজ্বরের ওষুধ হিসেবে ব্যবহার করেছিলেন পটাসিয়াম অ্যান্টিমনিয়াল টারট্রেট, যা টারটার এমিটিক বলে পরিচিত। কিন্তু এই ওষুধে কাজ হলেও ওষুধটি ছিল অত্যন্ত বিষাক্ত, ফলে পার্শ্বপ্রতিক্রিয়া প্রবল। এমতাবস্থায় উপেন্দ্রনাথ কালাজ্বরের প্রতিষেধক বিষয়ে গবেষণায় সম্পূর্ণ মনোনিবেশ করেন। ঔপনিবেশিক শাসনে পরাধীন দেশে তাঁর এই গবেষণার পথ মসৃণ ছিল না। অজস্র প্রতিবন্ধকতা। পরিকাঠামোর সমস্যা, লোকবলের অভাব, আর্থিক অনুদানের অভাব ছিল নিত্যসঙ্গী। ক্যাম্পবেল হাসপাতালের অপরিসর একটি ঘরে ১৯১৫ থেকে ১৯২১ খ্রিস্টাব্দ অবধি চলেছিল গবেষণা। কেমন ছিল সেই ঘর, তার বর্ণনা পাওয়া যায় পরবর্তীকালে উপেন্দ্রনাথের নিজের বক্তব্য থেকে। ১৯২৯ সালে এশিয়াটিক সোসাইটির সভাপতির ভাষণে তিনি উল্লেখ করেছেন "I shall never forget that room where urea stibamine was discovered. The room where I had to labour for months without a gas point or a water tap and where I had to remain concented with an old kerosene lamp for my work at night, still remains but the signs of a laboratory in it have completely disappeared."কাজের সঙ্গী ছিলেন তিনজন সদ্য এম এস সি পাস করা ছাত্র শ্রী পরিমল বিকাশ সেন, শ্রী সারদাচরণ চৌধুরী, শ্রী যুধিষ্ঠির দাস এবং দু'জন লাইসেন্সিয়েট ডাক্তার ছিল না। মেধা, নিষ্ঠা আর শ্রমকে মূলধন করে তিনি অসাধ্য সাধনের পথে অগ্রসর হলেন। সেই অপরিসর ঘরই হয়ে উঠল তাঁর তীর্থক্ষেত্র। রসায়নশাস্ত্রে নিজের অসামান্য ব্যুৎপত্তিকে গবেষণায় ব্যবহার করে তৈরি করলেন অসংখ্য যৌগ। পরীক্ষা করলেন তাদের স্থায়িত্ব এবং বিষক্রিয়া। শেষপর্যন্ত আবিষ্কৃত হল ইউরিয়া-অ্যান্টিমনির স্থিতিশীল যৌগ ইউরিয়া স্টিবামাইন। বর্তমান নীলরতন সরকার মেডিকেল কলেজের দশ হাত বাই ছয় হাত ঘরের এই মাহাত্ম্য হয়তো ভবিষ্যতের কাছে অজানাই থেকে যেত যদি না এক শ্বেতপাথরের ফলকে লেখা থাকত "এখানে উদিত হয়েছিল নতুন আলো, বিতরণ করেছিল আরাম, এনেছিল যন্ত্রণার উপশম, বিস্তৃত করেছিল জ্ঞানের পরিধি, প্রসারিত করেছিল বিজ্ঞানের দিগন্ত।" কিন্তু ওষুধ আবিষ্কৃত হলেও কলকাতা স্কুল অফ ট্রপিক্যাল মেডিসিনের সাহেব-কর্তাদের তাতে বিশেষ আগ্রহ ছিল না। তাঁরা ব্যবহার করছিলেন জার্মানির 'নিওস্টিবোসান' ওষুধটি। অগত্যা পরীক্ষা করার জন্য উপেন্দ্রনাথ বেছে নিলেন আসামের চা-বাগানের কালাজ্বর আক্রান্ত কুলি-মজুরদের। আক্রান্তেরা দ্রুত সুস্থ হয়ে উঠতে লাগল। পাস্তুর ইন্সটিটিউট শিলং, কালাজ্বর কমিশন, আসামের চা বাগানের চিকিৎসকরা ওষুধ প্রয়োগে সাফল্য পেলেন। এই আবিষ্কার প্রসঙ্গে প্রখ্যাত চিকিৎসক ও বিজ্ঞানী হেনরি এডওয়ার্ড শর্ট জানিয়েছিলেন 'It was a dramatic success, overnight, a death rate of 90% was transformed into a cure rate of 90%.' আসামের গভর্নর স্যার জন হেনরি কের (১৯২২-১৯২৭) তাঁর বিদায়ী ভাষণে উল্লেখ করলেন "The progress in the campaign against Kala-azar in Assam has been phenomenally rapid and if it continued at the present rate there is excellent prospect of the dread scourge being brought under complete control in a few years. Dr. Brahmachari's researches

in the treatment of kala-azar were one of the most outstanding contributions in tropical therapeutics, as a result of which three lakhs of human lives were saved in the Province of Assam during the course of tenyears." ক্রমশ কলকাতার বিভিন্ন হাসপাতালে এমনকি দেশের বিভিন্ন প্রান্তেও এর ব্যবহার শুরু হল। চমকপ্রদ সাফল্যের খতিয়ান আসতে লাগল। ১৯২২ খ্রিস্টাব্দে 'ইন্ডিয়ান জার্নাল অফ মেডিকেল রিসার্চ' এ প্রকাশিত হল যে ওষুধটি নিরাপদ, পার্শ্বপ্রতিক্রিয়াহীন।বিশ্বের দরবারেও এটি স্বীকৃতি লাভ করল। তবে দুঃখজনক ঘটনা এই যে, বাংলা সাহিত্যের ব্যতিক্রমী বিরল প্রতিভাধর স্রষ্টা সুকুমার রায় কালাজ্বরে আক্রান্ত হয়ে মারা গিয়েছিলেন ১৯২৩ খ্রিস্টাব্দের ১০ সেপ্টেম্বর। তার আগেই কালাজ্বরের প্রতিষেধক আবিষ্কৃত হয়ে গিয়েছিল। বিস্ময়ের কথা এটাই, ইউরিয়া স্টিবামাইনের ব্যবহারে আক্রান্ত রোগীদের দ্রুত রোগমুক্তি এবং মৃত্যুহার হ্রাসের খবর ইন্ডিয়ান জার্নাল অফ মেডিকেল রিসার্চে প্রকাশিত হয়েছিল। তবুও সুকুমার রায়ের চিকিৎসায় নিযুক্ত কোনও চিকিৎসক এটি প্রয়োগে উৎসাহ দেখাননি। সুকুমার রায়ের অকালমৃত্যুর দশদিন পরে ক্যালকাটা মেডিকেল ক্লাবের এক সভায় ড. নীলরতন সরকারের বক্তব্যেউপেন্দ্রনাথের আবিষ্কৃত জীবনদায়ী এই ইউরিয়া স্টিবামাইন বিপুল প্রশংসিত হয়। সারা বিশ্বের কালাজ্বরাক্রান্ত মানুষ তাঁর এই সফল আবিষ্কারে পুনর্জীবন লাভ করে। সেদিক থেকে বিচার করলে আন্তর্জাতিকভাবেই চিকিৎসাবিজ্ঞান হুগলি কলেজের এই প্রাক্তনীর কাছে ঋণী। ভারততথাবিশ্বমানচিত্রে 'কেমোথেরাপিউটিক'
গবেষকহিসেবেইতাঁরপ্রতিভারবিশিষ্টতা প্রমাণিত।

উপেন্দ্রনাথ ব্রহ্মচারী তাঁর কর্মজীবনে দেশ বিদেশ থেকে প্রভূত পুরস্কার ও সম্মান লাভ করেন। তার মধ্যে সর্বাধিক গুরুত্বপূর্ণ একাধিকবার নোবেল পুরস্কার জন্য মনোনয়ন লাভ। নোবেলের জন্য 'ফিজিওলজি ও মেডিসিন' বিভাগে ১৯২৯ খ্রিস্টাব্দে এবং ১৯৪২ খ্রিস্টাব্দে মনোনয়ন লাভ করেন। ১৯২৯ সালে তাঁর নাম সুপারিশ করেন ভারতীয় জীবরসায়নবিদ ও ওষুধবিশারদ সুধাময় ঘোষ। ১৯৪২ এ সুপারিশ করেন ঊষাপ্রসন্ন বসু, এম এন বসু, সুবোধচন্দ্র মহলানবিশ, সি সি বসু এবং সুধাময় ঘোষ। এছাড়াও তিনি কলকাতা বিশ্ববিদ্যালয় প্রদত্ত গ্রিফিথ স্মৃতি পুরস্কার (১৯২১), কলকাতা স্কুল অফ ট্রপিক্যাল মেডিসিন অ্যান্ড হাইজিন প্রদত্ত মিন্টো মেডেল (১৯২১), এশিয়াটিক সোসাইটি অফ বেঙ্গল প্রদত্ত উইলিয়ম জোন্স পদক, বাংলার গভর্নর জেনারেল লর্ড লিটন প্রদত্ত কাইজার-ই-হিন্দ স্বর্ণপদক (১৯২৪) লাভ করেন। লর্ড লিটন তাঁকে অভিনন্দিত করে জানান "Your research work in 'Kala-azar' has been of the utmost value not only to this province, but to India generally, and the treatment which you evolved through that work has deprived the disease of its terrors. I congratulate you on your achievements and this further recognition which his Majesty the King Emperor has been pleased to give to your humane work." ১৯১১তে তিনি 'রায়বাহাদুর' খেতাব পেয়েছিলেন। ১৯৩৪ খ্রিস্টাব্দে ব্রিটিশ সরকার তাঁকে 'নাইটহুড' প্রদান করে। ফেলো নির্বাচিত হন 'লন্ডনের রয়াল সোসাইটি অফ মেডিসিন', 'ন্যাশনাল ইন্সটিটিউট অফ সায়েন্সেস কলকাতা'র। ১৯২৮-২৯ খ্রিস্টাব্দে এশিয়াটিক সোসাইটির বাংলা শাখার সভাপতি হন। এছাড়া ১৯৩৬ সালে সভাপতিত্ব করেনইন্দোরে অনুষ্ঠিত ভারতীয় বিজ্ঞান কংগ্রেসের ২৩তম অধিবেশনে। ভারতীয় জাদুঘরের ট্রাস্টি বোর্ডের ভাইস চেয়ারম্যান হন।

বিজ্ঞানসাধনার পাশাপাশি সমাজসেবামূলক কাজের সঙ্গেও তিনি যুক্ত ছিলেন। ১৯৩৯ খ্রিস্টাব্দে কলকাতায় বিশ্বের দ্বিতীয় ব্লাডব্যাঙ্ক নির্মাণে গুরুত্বপূর্ণ ভূমিকা

নিয়েছিলেন। ভারতীয় রেডক্রশ সোসাইটির বাংলা শাখার কার্যনির্বাহ সমিতির প্রথম ভারতীয় সদস্য ছিলেন। বিভিন্ন জনহিতকর কাজে অনুদান দিতেন নিয়মিত। বিভিন্ন হাসপাতালে ওষুধ দান করে তার পূর্ণাঙ্গ হিসাব রেডক্রশ সোসাইটির মারফৎ বাংলার গভর্নরের কাছে পাঠাতেন। পূর্বস্থলীর ভিক্টোরিয়া মেমোরিয়াল ইন্সটিটিউশন নামক বিদ্যালয়টি বিভিন্ন কারণে শাসকের রোষানলে পড়ে। পৈতৃক ভিটের প্রতি টানে বর্ধমানের পূর্বস্থলীতে সেই উচ্চ বিদ্যালয় পরিচালনে বিপুল সহায়তা করেছিলেন। পরবর্তীতে এই বিদ্যালয় তাঁর পিতার নামাঙ্কিত হয় ('পূর্বস্থলী নীলমণি ব্রহ্মচারী ইন্সটিটিউশন')। অত্যন্ত তীক্ষ্ণ ছিল তাঁর বিষয়বুদ্ধিও। তাই বাঙালি উদ্যোগপতি হিসেবেও তাঁর কথা স্মরণ করা যেতে পারে। কারণ ইউরিয়া স্টিবামাইন আবিষ্কারের পর ওষুধ সংক্রান্ত গবেষণা এবং ওষুধ প্রস্তুতির জন্য নিজের কর্ণওয়ালিস স্ট্রিটের বাসভবনেই ১৯২৪ সালে প্রতিষ্ঠা করেন ব্রহ্মচারী রিসার্চ ইন্সটিটিউট। বাথগেট কোম্পানির মাধ্যমে কালাজ্বরের ওষুধ বাজারে বিক্রি করেন। আবিষ্কৃত ওষুধের ফর্মুলা পারিবারিক বৃত্তের বাইরে প্রকাশকরেননি। পেটেন্ট না নিলেও বাজারে অন্য সংস্থা (দি ইউনিয়ন ড্রাগ কোম্পানি) একই নামে ওষুধ বিক্রি করলে তাদের বিরুদ্ধে মামলা করেছেন। ব্রহ্মচারী রিসার্চ ইন্সটিটিউট যথেষ্ট সুনাম অর্জন করে এবং পরবর্তীতে তাঁর দুই কৃতি পুত্র (রায়চাঁদ প্রেমচাঁদ বৃত্তিধারী) ফণীন্দ্র নাথ এবং নির্মল কুমারের যৌথ পারিবারিক কারবার হিসেবেও এই প্রতিষ্ঠান আর্থিক স্বচ্ছলতার ধারা অক্ষুণ্ণ রাখতে সমর্থ হয়। কেমিস্ট হিসেবে এখানে যুক্ত ছিলেন জে এম দাশগুপ্ত, তারাপদ ভট্টাচার্য, ড রাধাকৃষ্ণ ব্যানার্জী প্রমুখ।

উপেন্দ্রনাথ ব্রহ্মচারী সফল চিকিৎসক এবং গবেষক হবার সঙ্গে সঙ্গে সুলেখকও ছিলেন। বিজ্ঞানের প্রতি অনুরাগের সঙ্গে ইংরেজিতে ছিল অসামান্য ব্যুৎপত্তি। বিজ্ঞানের নানা বিষয় অত্যন্ত সহজে তিনি ব্যাখ্যা করতে পারতেন। অজস্র প্রবন্ধ ও গ্রন্থ লিখেছেন। যেমন — 'Kala-azar and its Treatment', 'Gleanings from my research'। তাছাড়া কালাজ্বরের ওপর তাঁর বিখ্যাত বই 'A Treatise on Kala-azar'। তাঁর গবেষণা জীবনের ব্যাপ্তি চারদশক জুড়ে বিস্তৃত। কালাজ্বর ছাড়াও সারাজীবন গবেষণা চালিয়ে গেছেন ম্যালেরিয়া, ইনফ্লুয়েঞ্জা এবং মধুমেহ (ডায়াবেটিস)র মত ব্যাধিগুলিকে নিয়ে। কালাজ্বর নিয়ে তাঁর মোট গবেষণাপত্রের সংখ্যা ৬৮। ম্যালেরিয়ার ওপরে তাঁর গবেষণাপত্রের সংখ্যা ৩৭। জনস্বাস্থ্য সম্পর্কে তাঁর সুচিন্তিত মতামত মেলে ভারতীয় বিজ্ঞান কংগ্রেসের ২৩তম অধিবেশনে সভাপতির ভাষণে। সেখানে সত্যদ্রষ্টা এই বৈজ্ঞানিক মারীগ্রস্ত এই দেশের জনস্বাস্থ্যের জন্য পুষ্টিকর আহার্য এবং পয়ঃপ্রণালীর গুরুত্ব সম্পর্কে সচেতনতার বার্তা দেন।

উপেন্দ্রনাথের কর্মজীবন যে সময়পর্বে দুরন্ত গতিতে আপন লক্ষ্যের দিকে ধাবিত হয়েছিল, পরাধীন দেশের পক্ষে তা বড় সুসময় ছিল না। পরাধীনতার গ্লানি, বঙ্গভঙ্গের প্রতিবাদ, বিপ্লবের আহ্বান দেশকে উত্তাল করে তুলেছিল। জনমানসে জেগে উঠছিল স্বাধীনতার আকাঙ্ক্ষা। কিন্তু উপেন্দ্রনাথের চেতনায় সেই আগ্নেয় সময়েরছায়াপাতের খবর তেমন মেলে না। ব্যক্তিত্ববান নিরাবেগ এই মানুষটি ধর্মাচরণে নিঃস্পৃহ ছিলেন চিরকাল। ছিলেন ছাত্রদরদী। ১৯৩০ খ্রিস্টাব্দের এশিয়াটিক সোসাইটি অব বেঙ্গলের সভাপতির অভিভাষণে তাঁর এই দরদী মনোভাবের সাক্ষ্য মেলে- "When I recall my mind that I had the privilege ofteaching and examining many hundreds of medical students in medicine, and remember the raw and restive youths to whom I lectured, and then look around and see the resulting product, I feel with Sir Ernest Rutherford that a transformation has occurred that is much more wonderful than the transformation of radium and must have involved

much more energy in the process...”। সরস্বতীর এই বরপুত্র লক্ষ্মীদেবীরও কৃপাধন্য ছিলেন। তাঁর বইয়ের প্রতি ছিল গভীর আগ্রহ। বাড়িতে গড়ে তুলেছিলেন অসামান্য গ্রন্থাগার। এছাড়া ছিল উদ্যানরচনার আর বিভিন্ন গাড়ির নেশা। লাউডন স্ট্রিটের (যা এখন উপেন্দ্রনাথ ব্রহ্মচারী স্ট্রিট) বাড়িতেই করেছিলেন ফার্ন, অর্কিডের চমৎকার বাগান। দার্জিলিং-এও ছিল তাঁর বাড়ি ‘হোয়াইট হাউস’ সংলগ্ন অর্কিড বাগান। অভিজাত সামাজিক জীবনযাপন করতেন। লাউডন স্ট্রিটের বাড়িতেই মাসে একদিন বিজ্ঞানী, চিকিৎসকদের নিয়ে আলোচনাসভা হত। প্রাসাদোপম বাড়িতে সাহেবসুবোদের তারকাখচিত ‘পার্টি’গুলি ছিল শহরের অন্যতম আলোচ্য বিষয়। জীবনের শেষ ষোল বছর আক্রান্ত ছিলেন মধুমেহ রোগে। ১৯৪৬ খ্রিস্টাব্দের ৬ ফেব্রুয়ারি তিনি প্রয়াত হন। তাঁর প্রয়াণের পরে চিকিৎসাজগতের বিখ্যাত পত্রিকা ‘Lancet’ এ ১৯৪৬, ৯ মার্চ সংখ্যায় প্রকাশিত হয়েছিল ‘কলকাতার বিশাল বাড়িতে উপেন্দ্রনাথ তাঁর ব্রিটিশ ও ভারতীয় বন্ধুদের আমন্ত্রণ জানাতেন। তা ছিল চমৎকার। আলাপচারিতার বিষয়ে গভীরতার নজির থাকত। যদি সমস্ত বিশিষ্ট ভারতীয়রা এবং সেই সঙ্গে আজ ব্রিটিশ আধিকারিকরা নিজেদের উদার মত বিনিময় করতেন তবে ভারত আজ যে নানা আসুবিধেয় ভুগছে, এসব দেখা দেওয়ার আগেই সমস্যার সমাধান হয়ে যেত।’

স্যার উপেন্দ্রনাথ ব্রহ্মচারীর জন্মের সার্ধশতবর্ষ সমাগত। নিরপেক্ষ দূরত্ব থেকে ফিরে দেখলে অনুভূত হয় একনিষ্ঠ এই বিজ্ঞানসাধক আক্ষরিক অর্থেই সেকালে ‘কাল’জয়ে সমর্থ হয়েছিলেন। সাক্ষাৎ মৃত্যুর দূত কালাজ্বরের বিরুদ্ধে লড়াইতে ইউরিয়া স্টিবামাইন হয়ে উঠেছিল ব্রহ্মাস্ত্র। সাধারণ মানুষের মুখে কালাজ্বরের সঙ্গেই উচ্চারিত হতে শুরু করেছিল ‘ব্রহ্মচারী’। জনতার দরবারেতাই তিনিই মুকুটহীন সম্রাট। এই আবিষ্কারের পথে উপেন্দ্রনাথকে পেরোতে হয়েছিল অগণন বাধাবিপত্তির প্রাচীর। যুগান্তকারী এই আবিষ্কারের পরেও স্বদেশ এবং বিদেশের ক্ষমতাসীন ব্যক্তিবর্গের কাছে এর উপযোগিতা প্রতিষ্ঠায় সংগ্রামে অবতীর্ণ হতে হয়েছিল। আত্মবিশ্বাসের বলে বলীয়ান উপেন্দ্রনাথ সাফল্যের সঙ্গে তার মোকাবিলা করেন। অর্থ, যশ, সম্মান, সমাদর, কৃতজ্ঞতা সবই লাভ করেন এক জীবনে। পরাধীন দেশে বিজ্ঞানের মঙ্গলস্পর্শে মৃত্যুর মহা অমঙ্গলকে জয় করার অগ্রপথিক তিনি।জ্ঞান ও কর্মের দীপ্তিতে উজ্জ্বল এক জ্যোতিষ্ক। সারস্বত সাধক। সাধ্যবস্তু লাভের জন্য ঘাত-প্রতিঘাতমুখর উপল-বন্ধুর পথেই তাঁর চির পরিব্রাজন। বিস্মৃতির আবছায়া তাঁর প্রাপ্য নয়। যে গৌরবময় উত্তরাধিকার তিনি ভবিষ্যতের জন্য সঞ্চিত রেখে গেছেন, তাকে বহন এবং সমৃদ্ধ করার যোগ্যতা অর্জনই হতে পারে তাঁর প্রতি নিবেদিত যথার্থ শ্রদ্ধাঞ্জলি।

তথ্যসূত্র:

১.সংসদ বাঙালি চরিতাভিধান, প্রথম খণ্ড, সাহিত্য সংসদ, কলকাতা, ২০১০

২.জাতীয়চরিতাভিধান, (নিশীথরঞ্জনরায়সম্পাদিত) প্রথমখণ্ড, পশ্চিমবঙ্গরাজ্যপুস্তকপর্ষদ, কলকাতা, ১৯৮৯

৩. উপেক্ষিত চিকিৎসক-গবেষক উপেন্দ্রনাথ ব্রহ্মচারী, শ্যামল চক্রবর্তী, অক্ষর পাবলিকেশানস্, কলকাতা, ২০২৪

৪. চিকিৎসা বিজ্ঞানে বাঙালি, অরুণকুমার চক্রবর্তী, সিগনেট বুকশপ, কলকাতা, ১৯৬০

৫. নোবেল পুরস্কারের জন্য মনোনীত হুগলি মহসিন কলেজের এক প্রাক্তনী, পীযূষ কান্তি গঙ্গোপাধ্যায়, Hooghly College :175

৬.আলোক প্রবাহে একটি জ্যোতিষ্ক : স্যার ইউ এন ব্রহ্মচারী, Hooghly College :175

৭.চক্রব্যূহেবৈজ্ঞানিক, স্বাতীভট্টাচার্য, মিত্রওঘোষপাবলিশার্সপ্রাঃলিঃ, কলকাতা, ২০০৫

৮. Biographical Memoirs of Fellows of the Indian National Science Academy, vol 4, Indian National

৯. The Shaping of Indian Science, vol. 1: (1914-1947), Universities Press (India) Private Limited, Hyderabad, 2003

১০. Pillars of Modern India (1757-1947), Syed Jafar Mahmud, Ashish Publishing House, New Delhi, 1994

১১. A Treatise on Kala-Azar, Upendranath Brahmachari, John Baale, Sons & Danielesson, Ltd., London, 1928. A History of Tropical Medicine, H. Harold Scott, vol. 1, Baltimore, 1942

১২. Sir UN Brahmachari: His life & his science, Kaushik Bharati, Indian Journal of Physiology and Allied Sciences, Volume 76 Issue 2, 2024

১৩. Sir UN Brahmachari: A Forgotton Scientist, Anindita Joardar, International Journal of Science and Research (IJSR), Volume 12 Issue 11, November 2023

১৪. Biographical Memoirs of Fellows of the Indian National Science Academy, Vol.4., Indian National Science Academy, New Delhi, 1976

১৫. Upendra Nath Brahmachari: A pioneer of modern medicine in India, Vigyan Prasar, Department of Science and Technology (DST), Government of India, New Delhi

১৬. Dr. Upendranath Brahmachari: The Unsung Hero of Indian Medical Research, U Kawalkar, A Mankar, A Gaidhane, et al. (August 04, 2024), Cureus 16(8): e66148. DOI 10.7759/cureus.66148

১৭. Upendranath Brahmachari, Indian Scientists: The Saga of Inspired Minds, Sukanya Datta, Vigyan Prasar, Department of Science and Technology, 2016

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

Sir Upendranath Brahmachari and His Urea Stibamine

The Glorius Science and History Revisited

Rajarshi Ghosh

Department of Chemistry, The University of Burdwan, Burdwan 713104, India

E. mail: rghosh@chem.buruniv.ac.in

Received : 18:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract : The molecular drug *urea stibamine* discovered by Sir Upendranath Brahmachari, the eminent physician of Campbell Medical School (presently, Nil Ratan Sircar Medical College & Hospital, Kolkata), saved the lives of innumerable people from the then deadly disease *Kala-azar* not only in India but also in abroad. Previous to Sir Brahmachari, another noted physician of Kolkata Sir Leonard Rogers received good response from the patients suffering from *Kala-azar* on application of tartar emetic which was the potassium and antimony salt of tartaric acid. But this drug had several side effects. Sir Brahmachari suggested to replace the drug by sodium and antimony salt of tartaric acid. Though this gave good response, but because of slow recovery, scientists were searching for another better drug. Next to this, Sir Brahmachari used colloidal solution of antimony which was not much successful. Finally, urea stibamine, a co-crystalized product of *p*-stibanilic acid and urea, was discovered by Sir Upendranath Brahmachari. The drug was extremely successful for saving lives of the people suffering from *Kala-azar*.

Keywords: Upendranath Brahmachari, *Kala-azar*, urea stibamine

1. Introduction

Discovery of the molecular drug *urea stibamine* by Sir Upendranath Brahmachari, Kolkata), may be considered as one of the great discoveries in the twentieth century in India. The drug worked very successfully on application to the patients suffering from the deadly disease *Kala-azar*. The disease was first reported in Jessore in the presidency division of Bengal in the year 1824-25 [1] with clinical symptoms of relapses, progressive emaciation, enlargement of spleen and lever, and occurrence of certain complications [1]. Unfortunately, no fewer than 75,000 people died in that division of the country, who were suffering from the disease. Gradually the disease spread to the adjacent district Nadia, then to Hooghly and Burdwan. The disease in Dumdum (Kolkata) and Burdwan was known as *Dumdum fever* and *Burdwan fever*, respectively. It was introduced to the town Dacca (now Dhaka in Bangladesh) in 1862. It was spread in North Bengal and Bihar within next ten years. The mortality rate of the diseases was so high that no persons was there to burn or bury the dead bodies which were either left in the houses or thrown in rivers or other water bodies [1]. In Bihar, the disease was named as *Kala dukh*. Probably the disease reached Assam and first reported in Garo hills in 1875. The reason for this spread to the north eastern part of the country was thought to be the newly developed surface transport and steamer services of the British Government in Assam with Bengal [1]. There the disease was known as *Sarkari bimari* or disease of the British Government [1]. In Assam, the disease was so dangerous that the mortality rate was 95 percent [1]. Similarly, the population of the district of Burdwan decreased drastically because of the outbreak of *Kala-azar* [2]. The disease also spread to

the other parts of the country like Madras presidency, United province (presently Uttar Pradesh and adjacent areas), etc in the beginning of twentieth century. Several noted British physicians came forward to the characterization and medical treatment of the disease. Search for a suitable drug to beat the high rate of mortality of *Kala-azar* was in force once the causative parasite was discovered in 1903 by Charles Donavan and William Leishman [3]. After the hard effort, a very successful drug *urea stibamine*, which had a magical success towards the recovery of *Kala-azar* in India, was developed by Sir Upendranath Brahmachari in 1922 [4]. The reason for this success of the drug was the disruption of the metabolism of the causative parasite by *urea stibamine* leading the parasite to death. The victory of *urea stibamine* against *Kala-azar* in Assam, which was a highly *Kala-azar* affected area, is recorded in the farewell address of Sir John Kerr, once Governor of Assam [5],"Dr Brahmachari's researches in the treatment of *Kala-azar* were one of the most outstanding contributions in tropical therapeutics, as a result of which three lakhs of human lives were saved in the Province of Assam during the course of ten years." Colonel H E Shortt, Director of Kala-azar Commission in British India, stated [5], "We found Urea Stibamine an eminently safe and reliable drug and in seven years we treated some thousands of cases of Kala-azar and saw thousands more treated in treatment centres. The acute fulminating type characteristic of the peak period of an epidemic responds to treatment extraordinarily promptly and with an almost dramatic cessation of fever, diminution in the size of the spleen and return to normal condition of health."

2. Discovery of causative agent for *Kala-azar*

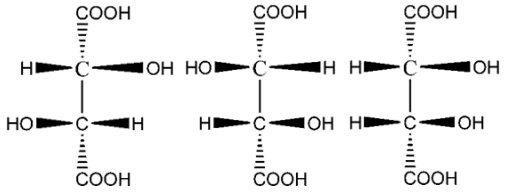
The British medical officer Lieutenant-General William Boog Leishman (b.1865 - d.1926) came to India in 1890s and returned England in 1897 [6]. Returning England he joined Netley Hospital. There he found a parasite in the spleen of a dead British soldier who was once posted in Dumdum, Kolkata and attacked with *Dumdum fever*. This work was published in 1903 [7]. Interestingly, another British medical officer as well as Professor of Physiology in Madras Medical College, Charles Donovan (b.1863 – d.1951) discovered the same parasite at around same time. His work was also published in the same journal in 1903 as was of Dr Leishman [8]. Dr Donovan sent the results of his work to the Nobel laureate Ronald Ross and French biologist Charles L A Laveron (b.1845 – d.1922). Laveron won the Nobel prize in Physiology or Medicine of in 1907. Charles L A Laveron named the parasite as *Piroplasma donavani*. After this Ronald Ross named the parasite as *Leshmania donavani*, Laveron (Genus: Leshmania, Species; donavani) [9]. Next to that, scientists started to investigate the carrier of this parasite. In 1940, on joint effort of School of Tropical Medicine, Calcutta; Kala-azar Commission and Indian Research Fund Association it was discovered that a particular fly *Phlebotomus argentipes* (sand fly) is the carrier of the parasite *Leshmania donavani*, Laveron. After this, the disease *Kala-azar* was named as *Leishmaniasis* or *visceral Leishmaniasis*.

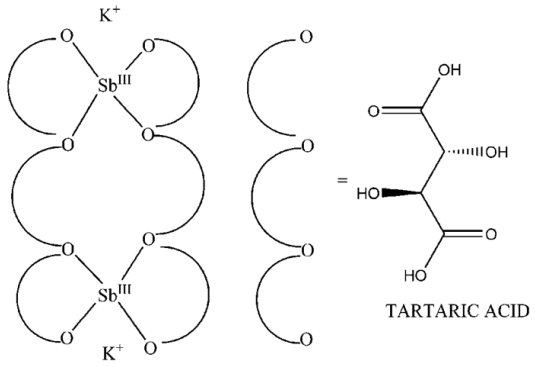
3. Search for a drug and discovery of urea stibamine

Chemistry and biology of pharmaceuticals were not well-developed in the early twentieth century even in Europe. Discovery of a drug for a particular ailment was based on the chemical and biological intuition, and knowledge from the previous discovery(ies) of the discoverer. In between fifteenth and sixteenth century, antimony (latin – Stibium) was considered as a universal drug for all the diseases. Because of this, monks started to drink wine in the cup made of antimony to be healthy. The tartaric acid from the wine reacted with antimony resulting the salt of tartaric acid. However, uptake of huge amount of antimony by the monks was fatal. They started to suffer from various unknown diseases. This is why the element was named as anti-monk. From 'anti-monk', the name 'antimony' originated [10].

Tartar emetic, which is a (coordination) compound of potassium

and antimony, was first applied to *Kala-azar* patients intravenously by the Brazilian physician Vianna [10] in 1913. Though tartar emetic is said to be a double salt of tartaric acid with potassium and antimony [10], the present author opines that it was a coordination compound. The structures of tartaric acid and potassium-antimony compound of tartaric acid are shown in Schemes and Coordination chemistry was already established then, the father of coordination chemistry was awarded Nobel prize in that very 1913.



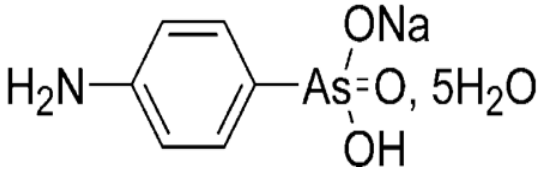


Scheme 1: Different isomers of tartaric acid

Scheme 2: Potassium and antimony

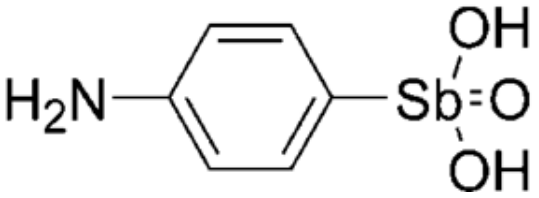
compound of tartaric acid (tartar emetic)

In India, tartar emetic was first applied to the *Kala-azar* patients by Sir Leonard Rogers [10]. Tartar emetic as a drug was not very successful because in a tropical country like India the molecule in the solution started to be dissociated on bacterial attack. British physician and Professor of School of Tropical Medicine pointed out severe other complications of the patients on treatment of tartar emetic like coughing, vomiting, pneumonia, joint pain, lung, kidney and bowel complications [10]. In this situation, Upendranath Brahmachari suggested to use sodium antimonial tartarate and it gave a very good response. Major Murison, Director of Public Health, Assam recorded [10], "The treatment of the disease in Assam with tartar emetic began in 1919, when only a comparatively small number of cases were treated. It was soon realized that this drug was not without its dangers and it was soon replaced by sodium antimonyl tartarate, which was found much safer and gave much more satisfactory results." But this drug was also not the final solution. The main problem with this drug was that the recovery was slow. Patients had to continue treatment for a prolonged time, which was not possible for the poor people. So a substitute was necessary. Now Upendranath suggested the intravenous injection of colloidal antimony solution [11]. This was also not much successful. Next to this, Upendranath was interested with atoxyl. This was an organometallic compound of arsenic (Scheme 3).



Scheme 3: Atoxyl

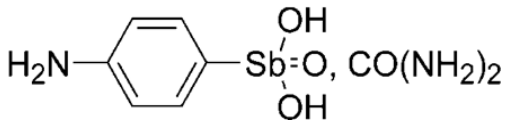
Atoxyl was a successful drug for sleeping sickness. Upendranath considered antimony in place of arsenic in atoxyl. There was a reason for this consideration. The parasites responsible for sleeping sickness and *Kala-azar* had some similarities in character. So Upendranath synthesized *p*-stibanilic acid (Scheme 4) with antimony in +5 oxidation state and started to apply this on patients' body [10].



Scheme 4: *p*-Stibanilic acid

The drug was successful but a single limitation of this drug was the pain suffered by the patients during the injection of the

drug. So Upendranath started to think about. The anesthetic property of urea was already known. After having a lot of experimental effort, Upendranath designed the drug as the combination of *p*-stibanilic acid and urea, which was named as *urea stibamine* by him. The drug was actually a salt of, rather to say a cocrystal of *p*-stibanilic acid and urea (Scheme 5).



Scheme 5: Urea stibamine

The rest is the history. The use of *urea stibamine* crossed the border of India. It was started to be used in China, Sicily, Italy, France, Egypt and Greece. Naturally, as was in many other events, British people could not accept the radical success of an Indian, who discovered a drug working in a situation with very limited financial and infrastructural facilities. The work was done in a room in Campbell Medical School, Kolkata, where there was no running water and no gas lamp [12]. British people disseminated that the discovery by Upendranath Brahmachari was due to sudden luck of him [5].

4. Sir Upendranath Brahmachari: a brief life-sketch

Upendranath Brahmachari was born on 7 June 1875 in Jamalpur, district Mungair of Bihar in British India. His father Dr Nilmani Brahmachari was a railway physician in East Indian Railways and mother was Sourav Sundari devi. After having early education in Jamalpur, Upendranath was admitted to Hooghly College (now Hooghly Mohsin College) with Honours in Mathematics and Chemistry. Then he joined Presidency College, Calcutta and obtained his MA degree with first class in Chemistry. Here he came in close contact of Sir P C Rây, and the love and affection of Sir Rây was showered to Upendranath throughout his life. His career in Medical science was also brilliant. He received MB degree standing first in Medicine and Surgery in 1889. In 1902, he received MD and in 1904, he was awarded PhD from Calcutta University for his research on "Studies in Haemolysis". He joined Provincial Medical Service in 1889. In 1901, he was appointed as a teacher of Pathology and Materia Medica in Dacca Medical School. In 1905, he returned Kolkata and joined Campbell Medical School and served the school for at least twenty years. After his retirement from Government service, he joined Carmichael Medical College (now R G Kar Medical College, Kolkata). Besides *Kala-azar*, he had significant contribution in discovering proper medical treatment of other deadly diseases like malaria, etc [13].

Several recognitions were conferred on him, to name a few, Rai Bahadur (1911) by British Government, Coates Medal and Griffith Memorial Prize by Calcutta University, Minto Medal (1921) by School of Tropical Medicine, The Kaisar-i-Hind Gold Medal (1921) by British Government, Knighthood (1934) by British Government [13].

Very interestingly, he was nominated for Nobel prize in Physiology or Medicine for six times during 1929 to 1942 [14]. Upendranath Brahmachari passed away on 6 February 1946.

5. Conclusion

Very interestingly, *Kala-azar* was found to be almost removed from the globe after 1940s. Definitely the reason was not *urea stibamine*. The wide use of Dichloro Diphenyl Trichloroethane (DDT) during second World War for the pest control destroyed the sand flies along with the causative parasite for *Kala-azar* [3]. But the disease did not disappear completely. No vaccine is yet discovered. Among the drugs available now, the pentavalent antimony compounds are the first choice. Some other compounds are also being used [15]. In spite of several hesitations of the British Government to credit Upendranath Brahmachari, his intelligence, hard work and ultimate success to discover a life-saving drug had made him legend in his life-time. His son Dr Phanindranath Brahmachari

remembered the dedications of his father with the words "Work in his sleep, work in his dream as well as work in his waking hours" [16]. He was very disciplined throughout his life and was a *terror* to his students, particularly in Examination halls. Upendranath was described as *rough and rude* by his nature [16]. It is astonishing as well as pleasing to find out the emotion of the so called *rough and rude* Upendranath through his presidential address in The Asiatic Society in 1929 [12]: "But I recall with delight that memorable night in Calcutta Campbell Hospital at Sealdah when after a very hard day's work at about 10 PM in a little room in smoky dimly burning kerosene lamp, I found that my experiments in the preparation of this compound were up to my expectations. But I did not then know that night that Providence had put into my hands a wonderous thing and that this little thing would save the lives of millions of my fellow-men."

References

[1] Sengupta, P. C. (1947); History of Kala-azar in India, Indian Medical Gazette, May, 281-286

[2] Rogers, L. (1897), The lower Bengal (Burdwan) epidemic fever reviewed and compared with the present Assam epidemic malarial fever (Kala-azar), Indian Medical Gazette, November, 401-408

[3] Roy, S. (1998); Discovery of urea stibamine by U. N. Brahmachari: a reappraisal, Science and Culture, 64, 157-158

[4] Brahmachari, U. N. (1922); Chemotherapy of antimonial compounds in Kala-azar infection, Indian Journal of Medical Research, 10, 492-522

[5] Brahmachari, P N. Biographical memoirs of Sir Upendranath Brahmachari (1875-1946), Dr P N Brahmachari, Indian National Science Academy, p 15

[6] William Boog Leishman (1865-1926), Obituary notices of fellows deceased, Proceedings of Royal Society B, 1928, p ix

[7] Leishman, W. B. (1903) On the possibility of occurrence of trypanosomiasis in India, Indian Medical Gazette, May, 1252-1254

[8] Donovan, C. (1903) The itiology of one of the heterogeneous fevers of India, Indian Medical Gazette, November, 1401

[9] Ross, R. (1903) Further notes on Leishman bodies, Indian Medical Gazette, November, 1401

[10] (1941) Conquest of Kala-azar, Science and Culture, VI, 528-534

[11] Brahmachari, U. N. Rai Bahadur (1915) A preliminary report on the treatment of Kala-azar with intravenous injection of metallic antimony, Indian Medical Gazette, December, 455-457

[12] Proceedings of the Asiatic Society of Bengal for 1929, p xvi

[13] Brahmachari, P N. Biographical memoirs of Sir Upendranath Brahmachari (1875-1946), Dr P N Brahmachari, Indian National Science Academy, pp 7-42

[14] https://www.nobelprize.org/nomination/archive/show_people.php?id=1279

[15] Monzote, L. (2009) Current treatment of Leishmaniasis: A review, The Open Antimicrobial Agent Journal, 1, 9-19

[16] Brahmachari, P N. Biographical memoirs of Sir Upendranath Brahmachari (1875-1946), Dr P N Brahmachari, Indian National Science Academy, p 28

Volume : 12 No. 1 & 2
June, 2025

Urea Stibamine to Modern Chemotherapeutics Against Kala-Azar: The Legacy of Upendranath Brahmachari and the On-going Journey of Drug Development

Dr. Amit Roy

UGC-Assistant Professor
INSA Young Scientist
Department of Biotechnology
Savitribai Phule Pune University Ganeshkhind Road, Pune- 411007
Maharashtra, INDIA
Email: amitathens@gmail.com

Received : 21:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract: Visceral leishmaniasis (VL), also known as Kala-Azar, is a potentially fatal parasitic disease caused by *Leishmania donovani* and transmitted by the bite of infected female Phlebotomus sandflies. The groundbreaking research of Indian scientist Dr. UpendranathBrahmachari in the early 20th century led to the development of urea stibamine (1922), a pentavalent antimonial compound for the treatment of VL. This compound remained the cornerstone of VL therapy for several decades. However, increasing drug resistance and toxicityprompted the search for alternative therapies. Over the time, treatment regimen for VL included sodium stibogluconate, amphotericin B (both deoxycholate and liposomal forms), miltefosine, and paromomycin. These conventional therapeutic measures possess many drawbacks such as toxicity, several side effects, efficacy variance, high cost and drug resistance which lead to the treatment failure. Therefore, continued efforts for the development of newer drugs which are less toxic, cheaper and have high efficacy are underway for the VL control and subsequent elimination. This search led to the development of 3,3′-diindolylmethane (DIM), a natural compound which is not only a potent inhibitor of *Leishmania* DNA topoisomerase I (LdTopILS) that acts as a topoisomerase poison, but also induce inhibition of F0F1-ATP synthase, leading to mitochondria dependent programmed cell death in *Leishmania* parasites. Furthermore, phenyl derivative of DIM (DPDIM), methyl derivative (DMDIM), and methoxy derivative (DMODIM) demonstrated inhibition of LdTopILS activity, with DPDIM being most potent among the three derivatives. Selective flavonoids such as baicalein, luteolin and quercetin inhibit LdTopILS enzyme activity and have differential mechanism to induce the stabilization ofDNA-topoisomerase Icleavable complex as evident from the camptothecin (CPT) resistant mutant topoisomerase I. Recent study has shown that hesperidin (HSP), another flavonoid is a catalytic inhibitor of LdTopILS that binds with free enzyme and does not stabilize DNA -topoisomerase I cleavable complex. HSP induces antileishmanial response by formation of cellular reactive oxygen species, resulting in depolarization of mitochondrial membranepotential and DNA fragmentation. This topoisomerase I induced programmed cell death in leishmanial cells correspond to the decreased parasites burden after HSP treatment in infected BALB/c mice. Recent studies focused on repurposing of HIV-1 protease inhibitors for the treatment of VL. Amprenavir (APV) exerts antileishmanial response by LdTopILS induced programmed cell death, while APV exerted inhibition of *L.donovani*parasitesat lower concentration when APV was used in combination with ritonavir (RTV) via inhibition of LdTopILS. Thus, these compounds must be exploited further fortherapeutic purpose against VL as well as HIV-VL co-infection.

Introduction:

Leishmaniasis is a vector borne parasitic disease caused by protozoan parasites of genus *Leishmania* and transmitted by the infected Phlebotomine sand flies. The three clinical manifestations of the disease are cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis (MCL) and visceral leishmaniasis (VL). Amongst the three forms, visceral leishmaniasis or Kala-Azar is the most fatal one (1,2).

Visceral leishmaniasis is the most severe and potentially fatal form of the disease if left untreated. It is primarily caused by *Leishmania donovani* in the Indian subcontinent and East Africa, and *Leishmania infantum* (also known as *L. chagasi*) in the Mediterranean, Middle East, and South America. VL is characterized by systemic infection of the reticuloendothelial system (WHO). According to WHO (2023), VL cases are most prevalent inBrazil, Ethiopia, India, Kenya, Somalia, South Sudan, and Sudan. Moreover, immune compromised individuals, are at a significantly high risk of developing VL, with co-infection posing therapeutic challenges and contributing to higher mortality rates. HIV-VL co-infection is the major reservoir developing the risk for systemic VL. Despite progress in disease control, VL burden remains high in endemic regions, emphasizing a continued struggle that dates back more than a century. Moreover, unavailability of vaccine for human VL makes it desirable to search for potent antileishmanial agents which have better efficacy, minimal toxicity and affordable.

Dr.Upendranath Brahmachari's Contribution:

In the early 20th century, Kala-Azar (visceral leishmaniasis) was a devastating disease in India, particularly in regions like Bihar, West Bengal and Assam. At the time, the available treatment was tartar emetic (antimony potassium tartrate) which was crude and dangerous. Although it could kill the parasites, but caused life threatening side effectsincluding heart problems and damage to organs (3).

Dr. Upendranath Brahmachari, a prominent Indian scientist and physician began experimenting with different organic compounds of trivalent antimony (Sb^{3+}), the active element in tartar emetic. His aim was to reduce the toxicity while retaining or improving the compound's ability to kill *Leishmania* parasites.Following years of dedicated research and experimentationoften conducted under difficult circumstances and with scarce resources at Campbell Hospital in Calcutta, Dr.Brahmachari made a significant scientific breakthrough in 1922. He successfully developed urea stibamine, a compound formed by combining urea with para-amino phenyl stibnic acid. This chemical, also referred to as para-amino phenyl-stibnic acid urea, benefited from the inclusion of a urea group, which improved its solubility which might have enhanced its effectiveness in the body (4,5). The use of this drug reduced the mortality rate and increased the recovery rate up to 95%. Urea stibamine proved efficient not only in India, but also in other countries, including Greece, France, and China (3). Thus, the dedicated efforts of Dr.Bramhachari brought relief to millions of people who were affected by the disease and transformed the disease into one that could be effectively managed and treated. Dr. Upendranath Bramhachari was nominated for the Nobel Prize in Medicine in 1929 and 1942 for his ground-breaking achievement. But, unfortunately, he did not receive the prize. Over the time, the manufacturing of the urea stibamine was discontinued due to increased resistance and toxic effects of the drug which led to the development of better alternatives such as sodium stibogluconate in 1950 (2).

Conventional therapeutics and their drawbacks:

The conventional therapeutic measures for treatment of VLrelies on pentavalentantimonials (used in combination therapy), paromomycin, amphotericin B (AmB) and liposomal amphotericin B (L-AmB).

Pentavalent antimonials (e.g., sodium stibogluconate and meglumine antimoniate):

The pentavalent antimonials were widely accepted and reliable for the treatment of VL. However, their efficacy declined drastically in parts of India due to emerged drug resistance (2,6)

Amphotericin B (conventional and liposomal forms): The deoxycholate amphotericin B (AmB) is effective and has been extensively used for VL treatment. However, its adverse effects such as nephrotoxicity with associated hypokalemiaresistricted its use. The liposomal amphotericin B (L-AmB) is a less toxic formulation of AmB recommended by the WHO for VL treatment. But its widespread use is limited by high cost, requirement for hospitalization, and cold-chain storage (2,6).

Miltefosine: Miltefosine was the first oral drug approved for VL, offering convenience of administration. However, concerns regarding teratogenicity, gastrointestinal side effects, and increasing resistance limit its utility (2,6).

Paromomycin: Paramomycin is currently used in combination therapies as its parenteral administration pose toxicity issue and practical challenges (2,6).

Thus, these agents are backed with severe side effects, toxicity, efficacy variance and high cost. In addition to this, the emerged resistance to these drugs is the major cause for treatment failure (6). Therefore, improved therapeutic strategies are desirable for elimination of the disease. In this context, there has been an ongoing search for finding desirable antileishmanial agent which is less toxic and have high efficacy. Recognizing the limitations of current treatments, the research work is dedicated to discovering novel therapeutic agents and molecular targets.

Leishmania DNA topoisomerase I (LdTopILS) as a drug target:

Leishmania DNA topoisomerase I (LdTopILS) is an attractive drug target as it possesses striking structural differences from human counterpart, human DNA topoisomerase I (hTopI). LdTopILS is a bi-subunit enzyme consisting of a large subunit (LdTopIL), 73 kDaand a small subunit (LdTopIS), 29 kDa. LdTopIL is encoded by the gene located on chromosome 34 and, LdTopIS is encode by the gene present on chromosome 4(7). Therefore, developing compounds that inhibit LdTopILS hold significant potential as a therapeutic strategy against VL.

Ongoing search for potent antileishmanial agents:

3,3-diindolylmethane (DIM) is derived from the digestion of indole-3-carbinol. It is widely found in cruciferous vegetables, such as broccoli, brussels sprouts,cabbage, etc. It is revealed that DIM exhibits potent inhibitory activity against *Leishmania donovani* DNA topoisomerase I enzyme (LdTopILS), a crucial enzyme involved in relieving topological stress during DNA replication and transcription in parasites. DIM functions as a class I topoisomerase inhibitor, also known as a topoisomerase poison, which exert its effect by stabilizing the transient topoisomerase I-DNA cleavable complex, thereby preventing the re-ligation of the DNA strand and ultimately inducing DNA damage and cell death.This mechanism of DIM's inhibitory action resembles that of camptothecin (CPT), a well-characterized topoisomerase I poison (8). DIM exhibits a high binding affinity not only towards the free enzyme but also towards the DNA substrate, thisbinding property enhances its ability to trap the cleavable complex and increase cytotoxic stress within the parasite. Therefore, DIM holds significant promise as an antileishmanial agent with its ability to selectively poison *Leishmania* DNA topoisomerase I while being a naturally derived compound adds to its potential therapeutic value.

The resistance mechanism of leishmanial cells towards DIM was studied by developing DIM-resistant *Leishmania* parasites through gradual exposure which led to single-nucleotide mutations in LdTopILS, with amino acid substitutions F270L and K430N in the large subunit, and N184S in the small subunit. The mutant enzymeis no longer inhibited by DIM. Transfection of these mutant genes into wild-type parasites confirmed that the altered topoisomerase I confers resistance. Notably, DIM fails to stabilize the topoisomerase I–DNA complex in the F270L mutant (9).

In addition to targeting LdTopILS, DIM exhibits potent antileishmanial activity by inhibiting mitochondrial F□F□-ATP synthase in *Leishmania* parasites. This inhibition led to significant increase in mitochondrial ROS, which is likely due to stabilization of topoisomerase I-DNA cleavable complex. DIM also induces mitochondrial membrane depolarization, ATP depletion, and oxidative stress, collectively triggering the release of cytochrome c into the cytosol and activating caspase-like proteases. To confirm the role of mitochondria in DIM-induced programmed cell death (PCD), mitochondrial DNA-depleted cells (mtDDCs) were generated. These cells showed resistance to DIM, failing to produce mitochondrial ROS or exhibit ATP depletion. These findings strongly suggest that DIM-induced leishmanial cell death is mitochondria-dependent and mediated by ROS generation (10).

To overcome resistance to 3,3′-diindolylmethane (DIM), three novel derivatives- DPDIM (2,2′-diphenyl-3,3′-diindolylmethane), DMDIM (2,2′-dimethyl-3,3′-diindolylmethane), and DMODIM (5,5′-dimethoxy-3,3′-diindolylmethane) were developed and evaluated for their anti leishmanial efficacy. Among these, DPDIM demonstrated the most potent activity, both as a topoisomerase I poison and as an inhibitor of *Leishmania* parasite growth. All three compounds were effective in reducing parasite burden and inducing cell death in DIM-resistant axenic amastigotes, with DMODIM showing the least potency. Mechanistically, the compounds stabilize the topoisomerase I- DNA cleavable complex and exhibit DNA-binding affinity, with DPDIM displaying the highest affinity toward substrate DNA (11). Therefore, these findings highlight the potential of these compounds as promising antileishmanial agents for further therapeutic development.

The other investigational compounds that were evaluated for their antileishmanial potential includes curcumin. It was observed that curcumin, a polyphenol, induced programmed cell death by elevation of cytosolic calcium levels followed by generation of ROS which resulted in depolarization of mitochondrial membrane potential and release of cytochrome c into the cytosol which ultimately caused DNA fragmentation in *Leishmania* parasites (12). Furthermore, mechanism of copper salisylaldoxime (CuSAL) was evaluated *in vitro* and *in vivo* which indicated that CuSAL reduces splenic and hepatic parasites burden and induce LdTopILS mediated cell death in *Leishmania donovani* cells (13).

Hesperidin (HSP), a natural flavonoid, has recently been investigated for its antileishmanial properties. HSP functions as a catalytic inhibitor of LdTopILS, demonstrating high binding affinity without stabilizing the topoisomerase I-DNA cleavable complex. This inhibition triggers oxidative stress in the parasites, leading to mitochondrial membrane depolarization and subsequent release of cytochrome c into the cytoplasm. These events activate caspase-like proteases 9 and 3, ultimately result in apoptotic death of the leishmanial cells. (14).

Recent studies have focused on repurposing HIV-1 protease inhibitors as

potential antileishmanial agents. Among them, amprenavir (APV), a potent HIV-1 protease inhibitor, was evaluated for its efficacy against *Leishmania donovani*. APV was found to selectively inhibitLdTopILS without affecting the catalytic activity of human topoisomerase. This selective inhibition triggered downstream events leading to programmed cell death (PCD) in the parasite (15). Furthermore, co-administration of APV with ritonavir (RTV), another HIV-1 protease inhibitor, enhanced the antileishmanial efficacy of APV. The APV-RTV combination exhibited a synergistic effect, enabling a reduced dose of APV to significantly lower parasite burden when used in combination with RTV (16).

Conclusion:

The current research emphasizes on utilization of natural compounds with inherent antileishmanial properties and repurposing of the established compounds for the treatment of VL. These findings underscore the importance of in-depth preclinical and clinical investigations to validate the safety, pharmacokinetics, and therapeutic potential of these compounds in context of VL. Moreover, as the global efforts strive toward the goal of VL elimination, the repurposing of well-established antiretroviral drugs offers a cost-effective and time-efficient approach to address current therapeutic needs. Pertaining to this, continued research and development in this direction is crucial, not only to expand the existing arsenal of antileishmanial agents, but also to overcome emerging challenges and eventual eradication of this neglected tropical disease.

References

1. World Health organization (https://www.who.int/news-room/fact-sheets/detail/leishmaniasis)
2. Drugs for Neglected Diseases Initiative (https://dndi.org/diseases/visceral-leishmaniasis)
3. Saha P, Chaudhury A, Maji AK. Sir U.N. Brahmachari and his battle against Kala-Azar. Trop Parasitol. 2021;11(2):89-91. doi: 10.4103/tp.tp_48_21.
4. Brahmachari UN. Fourth Report on the Treatment of Kala-Azar and Some Blood Reactions in This Disease. Ind Med Gaz. 1917;52(9):319-322.
5. Kawalkar U, Mankar A, Gaidhane A, Talapalliwar M. Dr.Upendranath Brahmachari: The Unsung Hero of Indian Medical Research. Cureus. 2024;16(8): e66148. doi: 10.7759/cureus.66148.
6. Shmueli M, Ben-Shimol S. Review of Leishmaniasis Treatment: Can We See the Forest through the Trees? Pharmacy (Basel). 2024;12(1):30. doi: 10.3390/pharmacy12010030.
7. Das BB, Sen N, Ganguly A, Majumder HK. Reconstitution and functional characterization of the unusual bi-subunit type I DNA topoisomerase from Leishmania donovani, FEBS Lett. 2004; 565 (1-3): 81–88, https://doi.org/ 10.1016/j.febslet.2004.03.078.
8. Roy A, Das BB, Ganguly A, Bose Dasgupta S, Khalkho NV, Pal C, Dey S, Giri VS, Jaisankar P, Dey S, Majumder HK. An insight into the mechanism of inhibition of unusual bi-subunit topoisomerase I from *Leishmania donovani* by 3,3'-di-indolylmethane, a novel DNA topoisomerase I poison with a strong binding affinity to the enzyme. Biochem J. 2008;409(2):611-22. doi: 10.1042/BJ20071286.
9. Roy A, BoseDasgupta S, Ganguly A, Jaisankar P, Majumder HK. Topoisomerase I gene mutations at F270 in the large subunit and N184 in the small subunit contribute to the resistance mechanism of the unicellular parasite *Leishmania donovani* towards 3,3'-diindolylmethane. Antimicrob Agents Chemother. 2009; 53(6):2589-98. doi: 10.1128/AAC.01648-08.
10. Roy A, Ganguly A, BoseDasgupta S, Das BB, Pal C, Jaisankar P, Majumder HK. Mitochondria-dependent reactive oxygen species-mediated programmed cell death induced by 3,3'-diindolylmethane through inhibition of F0F1-ATP synthase in unicellular protozoan parasite *Leishmania donovani*. Mol Pharmacol. 2008 Nov;74(5):1292-307. doi: 10.1124/mol.108.050161.
11. Roy A, Chowdhury S, Sengupta S, Mandal M, Jaisankar P, D'Annessa I, Desideri A, Majumder HK. Development of derivatives of 3, 3'-diindolylmethane as potent *Leishmania donovani* bi-subunit topoisomerase IB poisons. PLoS One. 2011;6(12): e28493. doi: 10.1371/journal.pone.0028493.

12. Das R, Roy A, Dutta N, Majumder HK. Reactive oxygen species and imbalance of calcium home ostasis contributes to curcumin induced programmed cell death in *Leishmania donovani.* Apoptosis. 2008;13(7):867-82. doi: 10.1007/s10495-008-0224-7.
13. Singh MK, Bhaumik SK, Karmakar S, Paul J, Sawoo S, Majumder HK, Roy A. Copper salisylaldoxime (CuSAL) imparts protective efficacy against visceral leishmaniasis by targeting *Leishmania donovani* topoisomerase IB. Exp Parasitol. 2017; 175:8-20. doi: 10.1016/j.exppara.2017.02.010.
14. Lamba S, Mazire P, Roy A. Unveiling the mechanism of hesperidin-induced LdTopI-mediated cell death pathway in protozoan parasite *Leishmania donovani*.Biochimie. 2025; 228:15-31. doi: 10.1016/j.biochi.2024.08.008.
15. Roy A, Behera S, Mazire PH, Kumari B, Mandal A, Purkait B, Ghosh P, Das P, Das P. The HIV -1 protease inhibitor Amprenavir targets *Leishmania donovani* topoisomerase I and induces oxidative stress-mediated programmed cell death. Parasitol Int. 2021; 82:102287. doi: 10.1016/j.parint.2021.102287.
16. Mazire PH, Shingade S, Roy A. Ritonavir enhances the efficacy of amprenavir: A promising combination therapy by targeting *Leishmania* DNA topoisomerase I for treatment of visceral leishmaniasis.Exp Parasitol. 2025; 269:108898. doi: 10.1016/j.exppara.2025.108898.

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

A tribute to Sir U N Brahmachari: An Unsung Hero of Indian Medical Research

Krishna Roy

Ex Professor and Head, Dept of Physiology, Hoogly Mohsin College, Ex-Principal, Bethune College, Kolkata.

Received : 08:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract : Sir U N Brahmachari, the pioneer of tropical medicine , was a renowned medical person as well as a scientist of the last century , He is famous for the discovery of wonder drug urea stibamine for the cure of one of the dreaded and deadliest diseases, Kalazar during 19th century British India. He was also the first Indian to be nominated for Nobel Prize in the category of the Medicine and Physiology. Moreover, he discovered a new form of kala-azar; known as Post-kala-azar dermal leishmaniasis, or dermal leishmaniasis (Brahmachari), post-antimonial dermal leishmaniasis (Brahmachari), and Brahmachari's dermal leishmaniasis, also a new species of mosquitoes which was named after him. In fact, based on Western techniques he was the first Indian to produce pharmaceutical drugs, According to the British doctor H.E. Shortt, urea stibamine saved millions of lives within India and abroad. As a person Brahmachari possessed a vibrant character and contributed profusely to the society. Nowadays, he has become a forgotten hero and therefore after 150 years of his birth, his life and his contribution in the society needs to be revisited for making the people of present generation aware of his contribution in science and society.

Introduction:

There was a time in Bengal when in reference to the disease Kala-azar, people used to utter two words Brahmachari and Urea Stibamine. Such was the level of acceptability of the Scientist Physician Sir U.N .Brahmachary in the society. Almost two hundred years ago, Kala-azar was detected in the Jessore district of undivided Bengal in Indian subcontinent .**(16,17,18)** Nowadays, the disease is technically known visceral leishmaniasis. The name Kala-azar came from two words, black (*'kala'* in Bengali) patches on the skin, along with irre gular fever (*'azar'* from the Bengali *'jor'*). The disease has been found to affect the visceral organs, primarily the liver and spleen, giving rise to hepatosplenomegaly. The disease runs mainly in the tropical countries and, to a lesser extent, in the temperate regions of the world,. But it had the highest prevalence in India in the last two centuries. But this dreaded disease was controlled significantly with the discovery of magic drug Urea Stibamine by Brahmachari **(8)** and just hundred years ago, Brahmachari Research Institute was founded for the large scale production of the medicine Urea Stibamine discovered by Brahmachari himself through his scientific research. **(13,18)** In his time, he was associated with most of the scientific institutions in Calcutta, and was also coveted with several prestigious positions in the society. For his ground breaking work of the discovery of Urea Stibamine , his name was proposed for Nobel Prize in Physiology and Medicine two times. **(14,15)** However, the nominations for both the time became futile. Nowadays, he is a forgotten hero and the present article is a tribute to the dedicated scientist on the occasion of celebration of his 150 years of birth centenary.

Birth of a genius:

Upenndranath Brahmachari came from a respectable family. His father Dr. Nilmani Brahmachari worked with the Eastern Railways under British India and was a respectable Physician in Jamalpur,

now in Bihar, and mother Sourovsundari, a housewife. According Upendranath himself, he was born on 19th December 1873, but official birth record is different. He had three other brothers . His family lineage is extremely glorious, being associated with Sri Chaitanya Mahaprabhu, who took sannyas from his religious master Keshab Mukhodhyay (Bharati). The latter had also given *deeksha* to his own elder brother, Gopal Mukhopadhyay. The family thus acquired surname Bharati and became known as Gopal Bharati Brahmachari Thakur. With the passage of time, 'Bharati' and 'Thakur' were dropped, and only the first name and 'Brahmachari' remained. U.N. Brahmachari was the 9th generation originating from Gopal Brahmachari. (16,18)

Early days of U.N. Brahmachari:

U N Brahmachari's academic career started in the Eastern Railways Boys' School in Jamalpur . After passing School leaving Examination, he enrolled in Hooghly College in Chinsurah and passed First Arts Examination with second division . Next he enrolled in BA class in two disciplines, Mathematics and Chemistry. From this college , he obtained his B.A. Degree under Calcutta University in 1893, with double honors in Mathematics and Chemistry. He stood first in Mathematics in the college for which he was awarded the Thwaytes medal. Thereafter, he obtained his master's degree in Chemistry from Presidency College in 1894 with first class, and second in the merit list. (13,16,18)

Seeking new career in Medical Education :

Upendranath though proved his scholarly aptitude in Chemistry, still he wished to take up a new career in medical profession and therefore joined Calcutta Medical College to study Medicine. He completed his Licentiate in Medicine and Surgery (LMS) here in 1899, followed by M.B. in 1900, standing first both in Medicine and Surgery, for which he received the Goodeve and McLeod Medals, respectively. Even before being awarded his M.D. degree in 1902, under the inspiration and guidance of Sir Gerald Bomford, Principal, Calcutta Medical College, he was appointed at the Dacca Medical School as a Teacher of Physiology and Materia Medica and a Physician in November 1901.(13,18)

Medical and Research Career.

Upendranath had a flair for research work even during his student life and this was noticed and encouraged by Sir Bomford. This can be recorded from his research report in Indian Medical Gazette in January, 1900, entitled " Case of Septic Endocarditis". This was followed by two more papers, " A case of post hemiplegic Athetosis"(May, 1900) in British Medical Journal and Ind. Med. Gaz, and " Field vision in Hysteria" during July, 1901, in Ind. Med. Gaz (13) In Dacca he came in contact with Sir Robert Neil Campbell, who also inspired his research work and accordingly, he started research on mosquito under his guidance and published a few papers .(1,12) In 1902, he completed his M.D. and just after two years, was awarded Ph.D. from Calcutta University . His primary focus was then various aspects of hemolysis and the title of the thesis was " Studies in Haemolysis"(18). In Dacca, Upendranath worked from 1901 to 1905. Thereafter, he came back in Calcutta to join in the Campbell Medical School (now Nil Ratan Sircar Medical College & Hospital) as a teacher of Medicine and First Physician. It is the place where he spent nearly two decades and his ground breaking discovery of Urea stibamine was made. In 1923, he joined the Calcutta Medical College as Additional Physician and worked there till 1927. Beyond this, he formally retired from government service, and joined the Carmichael Medical College (now known as R.G. Kar Medical College & Hospital.) as Professor of Tropical Diseases. During his medical career in Kolkata, he became associated with several other institutes , such as the National Medical Institute, which, after being clubbed with the Calcutta Medical Institute, became the Calcutta National Medical College & Hospital. He was also a Council Member of the prestigious Calcutta School of Tropical Medicine.(16,18) As a Science researcher, he used to carry out

research work on many of the infectious diseases, caused by bacteria, virus, parasites and helminthes , such as influenza, filariasis, leprosy, blackwater fever, cerebrospinal meningitis, and syphilis. He also discovered a rare variety of Malaria fever which recurs every four days (Quartan fever). His keen observation prompted him to discover the cause of Burdwan fever, an epidemic fever of lower Bengal, reported in 19th century, was nothing but dual infection of Malaria and Kala-azar. His research on blackwater fever, showed in the acute phase of the disease, hemolysis occurs in the liver and his designed anti-hemolytic agent served the effective treatment for blackwater fever in those days. Apart from infectious diseases, he also carried out some fundamental research work on non-communicable diseases like diabetes. (13)

Research on Kala-azar and discovery of Brahmachari's Magic Bullet' **Urea Stibamine.** Initially, Brahmachari had a passion for research work in diverse field of infectious diseases , specially in Malaria. (1,12,13) But later, his interest shifted mainly to Kala-azar. When Brahmachari came back to Kolkata from Dacca, two researchers William Leishman and Charles Donovan- jointly discovered the causative agent for Kala-azar, the protozoon *Leishmania donovani* and much later, the disease was identified to be is transmitted by the bite of sandflies (*Phlebotomus argentipes*), carrying the pathogen.(16,18) His researches on Kala -azar started from 1906 onwards(2,3,4,13) and this ultimately led him to discover a type of cutaneous leishmaniasis, or dermal leishmanoid.(7) Nowadays, it is known as – Post -Kala-azar Dermal Leishmaniasis (PKDL) (18). With his immense knowledge in Chemistry, Brahmachari innovatied the first simple and cheap diagnostic test specific for kala-azar using blood from patients, mediated by the flocculation of proteins (Globulin Precipitation Test) proved highly successful.(6) And this knowledge of chemistry led him to search for proper drug for combating the most dreaded disease of the time. He started his journey in a small room in the Campbell School where there was no provision for running water, electric lighting, or even a proper gas point which he later mentioned in his memoirs in 1928 and 1940 (9,13) At first , he was influenced by the magic bullet or the drug salvarson, discovered by Paul Ehrlich for curing another fatal disease syphilis. The drug bearing an amino group at the para position of a phenyl ring and at the other end, arsenic along with side chains , when tested for Kala-azar patients were of no use due to its high toxic effects on in patients. Then he swiched over to administer intravenous injection of antimony potassium tartrate to kala-azar patients from 1915 onwards.(5) This endeavour was unsuccessful for the reluctance of patients, who faced unbearable pain during injection. Finding the failure Brahmachari substituted the arsenic in Ehrlich's magic bullet with antimony (Sb) and added in a side chain a urea molecule for its anesthetic and analgesic properties This discovery of a synthetic drug was made in 1920 through unlimited dedication, labour and zeal and without proper financial support. But eventually and it satisfactorily cured in human volunteer studies and he standardized the dose alsoto get best results with minimum application of drugs. Following discovery, he went on donating the drugs , to several hospitals, and started making it in large scale through establishment of Brahmachari Research Institute. Thus 'Brahmachari's magic bullet' became his life time prestigious research work, which subsequently gave him both fame and wealth. This cheap drug was welcome not only throughout India , but also was widely used in France, China, Italy, Greece etc. as it saved the lives of innumerable number of lives of Kala-azar patients in India (Bihar, Assam and Bengal) and abroad.(17,18) He vividly explained composition of urea stibamine, method of treatment of Kala-azar with it, in his different treatise and research articles (9,10,11,13)

Recognition and Humiliation

Urea stibamine remarkably reduced the mortality rate of patients ten years after its discovery. Contemporary , Government Official, like Dr. Henry Edward Shortt, the then Chairman of the Kala-azar

Commission, and Sir John Henry Kerr, then Governor of Assam, spoke very high about him, for the success rate of survival of the patients by the drug (13,17,18). Throughout his life, Brahmachari received numerous awards, medals, honors, recognitions from various quarters of the country.(13,17,18) To name a few , are the Minto Medal (1921) from the Calcutta School of Tropical Medicine, the Kaiser-I-Hind Medal (1924). He was also coveted with several prestigious positions , e.g. President of the Society of Biological Chemists in India, Founding Member and Vice President of the Physiological Society of India, Founding Fellow of the National Institute of Sciences of India, now known as INSA, President of the Indian Science Congress Association, President of the Indian Chemical Society etc. He also held many distinguished positions, including President of several reputed societies, including the Asiatic Society of Bengal (1928), the Society of Biological Chemists (1932), the Indian Chemical Society (1936), and the Indian Association for the Cultivation of Science (1942). He was elected Chairman of the Indian Red Cross Society (1935), mainly for establishing India's first blood bank at the Calcutta School of Tropical Medicine. He was also elected as the General President of the 23rd Session of the Indian Science Congress (1936) held in Indore. Moreover, he received two prestigious recognition from the British Emperor namely, *Rai Bahadur* (1924) and *Knighthood* (1935). U.N. Brahmachari since then was referred to as Sir U N Brahmachari .

Along with these several recognition, awards and accolades, he was denied due recognition for his dedicated research work which saved lives of millions of people suffering from Kala-azar. He was not considered for the award from one of the oldest and prestigious societies in science, known as the Fellowship of the Royal Society (FRS). For this, Meghnad Saha earnestly tried to procure nomination papers from pertinent Scientists , but the fellowship was under consideration of the authority till his death on 6th February, 1946(17). His name was also nominated for the Nobel prize in the category of Physiology or Medicine, twice, one in 1929 and the other in 1942, with six nominations all together.(14,15,17) All his nominations came from Indian Scientists, with no history of either being awarded Nobel prize in their accounts, or not much known in the scientific community for their research work. . Moreover, Brahmachari never went abroad for higher studies or research work., nor did he have any god father for sending strong recommendation in his favour. It is noteworthy to mention here that urea stibamine was discovered eight years before penicillin, the world's first antibiotic by Alexander Fleming who was awarded the 1945 Nobel Prize in Physiology or Medicine jointly with Ernst Boris Chain and Sir Howard Walter Florey "for the discovery of penicillin and its curative effect in various infectious diseases (19). Even within the country he was not given proper financial aid or room to carry out his research work, nor did he receive cooperation from the contemporary British medical fraternity,. Rather, stalwart Scientist like Sir Leonard Rogers challenged the efficacy of his drug, and openly gave his adverse statement against performance of Brahmachari and his innovated drug etc in the prestigious journal " Nature" in 1939. (17) . All his life, Brahmachari maintained discipline in scientific research. As a person, his charitable nature was well known in his time . He donated profusely to several academic institutions, journal committees (13). Still then, less than hundred years after his death, people have forgotten his life long contribution in the society. Nowadays, treatment of Kala-azar is being made with newer drugs but life long dedication and diligence of Brahmachari in innovative scientific research with meager infra-structure and contemporary amenities available solely in his native motherland , is still a lesson for the present and future generation science researchers.

Acknowledgement : The author is indebted to Dr Kawna Chatterjee, grand daughter of Sir U N Brahmachari for a few information on him and also to Dr Suvodeep Adhikari, an alumnus of Hooghly Mohsin College for his basic research on the life of this famous scientist.

References

1. Brahmachari UN. Quartan Fever in Calcutta and Dacca. Ind Med Gaz. 1902 Mar;37(3):93. PMID: 29003602; PMCID: PMC5156101.
2. Brahmachari UN. Forms of Pyrexia due to Leishman-Donovan Bodies, Sp med. Gaz. Jan 1906.
3. Brahmachari UN. A contribution to the study of Fevers due to Leishman-Donovan Bodies. Calcutta Med. J Oct.1906.
4. Brahmachari UN. Sporadic kala-azar in Calcutta, with notes of a case treated with atoxyl. BMJ. 1908;1 (2474):1286-8. PMCID: PMC2436723.
5. Brahmachari U. Preparation of stable colloidal antimony. Lancet. 1916;188 (4860): 728. DOI:10.1016/ S0140- 6736(01)31744-0.
6. Brahmachari UN. Globulins in kala-azar. Ind Med Gaz. 1917;52(12):429-31. PMCID: PMC5176441.
7. Brahmachari UN . A new form of cutaneous Leishmaniosis-.Dermal Leishmanoid. Ind Med.Gaz.1922;57 :125-127.
8. Brahmachari UN. Chemotherapy of antimonial compounds in kala-azar infection. Part IV: Further observations on the therapeutic values of urea stibamine. By UN Brahmachari, 1922. Ind J Med Res. 1989;89: 393-404. PMID: 2644171
9. Brahmachari, U. London: Treatise on Kala-azar, John Bale, Son‘s & Danielsson Ltd; 1928
10. Brahmachari UN. Antimony treatment of kala-azar. Nature. 1940;145:546. DOI: 10.1038/145546b0.
11. Brahmachari UN. Chemistry of urea stibamine. Nature. 1940;145:1021-2. DOI: 10.1038/1451021b0
12. Campbell RN, Brahmachari UN. A Preliminary Report of the Observations of the Habits of Anopheles. Ind Med Gaz. 1902 Jan;37(1):12-15. PMID: 29003677; PMCID: PMC5156217.
13. Chakrabarti Syamal. Upekshito Chikitsak –Gobeshak Upendranath Brahmachari(in Bengali). 2024. Akhsar Publication, Kolkata ISBN:978-93-94089-52-5
14. Nobel Prize nomination for U.N. Brahmachari in Physiology or Medicine (1926). Available at: https:// www.nobelprize.org/ nomination/archive/show.php?id=11147&mode=normal
15. Nobel Prize nominations for U.N. Brahmachari in Physiology or Medicine (1942). Available at: https:// www.nobelprize.org/ nomination/archive/list.php?prize=3&year=1942;
16. Saha P, Chaudhury A, Maji AK. Sir U.N. Brahmachari and his battle against kala-azar. Trop Parasitol. 2021;11(2):89-91. PMID: 34765528.
17. Singh R, Roy S. UN Brahmachari: Scientific achievements and nomination for the Nobel Prize and the fellowship of the Royal Society of London. Ind J Hist Sci. 2019;54(1): 35-49. DOI: 10.16943/ ijhs/2019/v54i1/49596.
18. Upendra Nath Brahmachari: A pioneer of modern medicine in India. *Vigyan Prasar*, Department of Science and Technology (DST), Government of India, New Delhi. Available at: https:// vigyanprasar.gov.in/brahmachari-upendra-nath.
19. Tan, S. Y.; Tatsumura, Y. Alexander Flemming(1881-1955): Discoverer of penicillin .Dis Singapore Medical Journal.2015; 56 (7): 366367. doi:10.11622/smedj.2015105. PMC 4520913. PMID 26243971 Correspondence: roykrishna1957@gmail.com

Volume : 12 No. 1 & 2
June, 2025

Structural Journey of the Kala-Azar Drug Urea Stibamine (Brahmachari): A Comprehensive Quantum Chemical Study

Snehasis Banerjee

Associate Professor, Department of Chemistry,
Hooghly Mohsin College, Chuchura.

Received : 20:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract: Urea stibamine, a pentavalent antimonial drug developed by Sir Upendranath Brahmachari, was the most effective treatment for kala-azar (visceral leishmaniasis) during the twentieth century. Despite its medical significance, the structural details of the compound—particularly its active principle, S-diphenyl carbamide 4,4-distibinic acid — remain largely unknown in the scientific literature. In this study, we explore the structural features of urea stibamine and its related compound using density functional theory (DFT) and metadynamics within the xTB framework. Conformer–rotamer ensemble sampling tool (CREST) was employed to identify the most stable low-energy conformers obtained from a full molecular dynamics simulation of 100 ps. Out of 52 conformers, the most stable geometry was optimized at the PBE1PBE/ def2-TZVP/6-31G(d,p) level of theory and subjected to vibrational analysis to evaluate thermodynamic properties. The stability of the best conformer was found to be governed by strong π–π stacking interactions and two significant intramolecular hydrogen bonds. To characterize non-covalent interactions, we carried out Quantum Theory of Atoms in Molecules (QTAIM), and Non-Covalent Interaction (NCI) analyses. Frontier molecular orbital (FMO) analysis revealed a HOMO–LUMO energy gap of 4.92 eV, indicating notable chemical reactivity. Furthermore, electronic descriptors such as chemical potential (μ), global hardness (η), softness (S), and electrophilicity index ($\omega = \mu^2+2\eta$) were calculated to compare the reactivity of urea stibamine with other related drug molecules. This study provides a comprehensive quantum chemical insight into the structure and stability of Brahmachari's historic "magic bullet," offering a foundation for future research in antimonial drug design.

Introduction

Kala-azar, or visceral leishmaniasis, is a life-threatening parasitic disease that became a major public health concern in the Indian subcontinent in the 19th century. Early treatments were based on tartar emetic—potassium antimony(III) tartrate—a trivalent antimonial compound [1-6]. Despite being the first successful antimony-based therapy, tartar emetic had significant limitations: it required intravenous administration, caused severe side effects, and was poorly tolerated by patients. Although the dimeric form offered higher antimony content and improved efficacy, the toxicity remained a major obstacle.

This led to the search for safer and more effective antimonial drugs. One step forward was replacing the potassium salt with a purer sodium analogue, marginally reducing adverse effects. However, a more transformative leap came with the development of pentavalent antimony (Sb(V)) compounds, inspired by Paul Ehrlich's arsenical drug Salvarsan (As(III)—the original "magic bullet"[7]. Pentavalent antimonials offered clear chemical and pharmacological advantages: lower systemic toxicity, higher permissible doses, shorter treatment durations, improved patient compliance, and a reduction in mortality—especially by limiting secondary infections such as pneumonia. From a chemical perspective, Sb (V) centers allowed for broader functionalization and better formulation profiles.

Among early Sb(V) compounds, sodium para

-acetyl-amino-phenyl stibiate showed promise in Italy but delivered inconsistent results in tropical regions. In response to these limitations, Sir Upendranath Brahmachari, a physician and chemist, pioneered structural innovations in antimonial drugs. He began with colloidal metallic antimony [8]and soon realized the need for chemical modifications. His landmark achievement was the synthesis of urea stibamine in 1922—a conjugate of para-amino-phenyl-stibinic acid and urea [9]. The urea moiety not only improved solubility and chemical stability but also alleviated the injection pain commonly associated with earlier formulations due to its mild anesthetic properties.

Urea Stibamine marked a significant break-through in therapeutic chemistry. Clinical trials conducted by Shortt and Sen (1923) confirmed its high efficacy in treating kala-azar [7]. Building on this success, Brahmachari developed a series of aromatic pentavalent antimonials—including Stibglycine Amide, Chloro Stibacetin (Stibosan), Stibamine, Ammonium Stibamine (and its polymer), Sodium Stibamine, and Urea Stibamine (see Scheme 1). These compounds were all derived from the p-amino-phenyl-stibinic acid framework, enabling systematic modification around a chemically stable Sb(V) center.

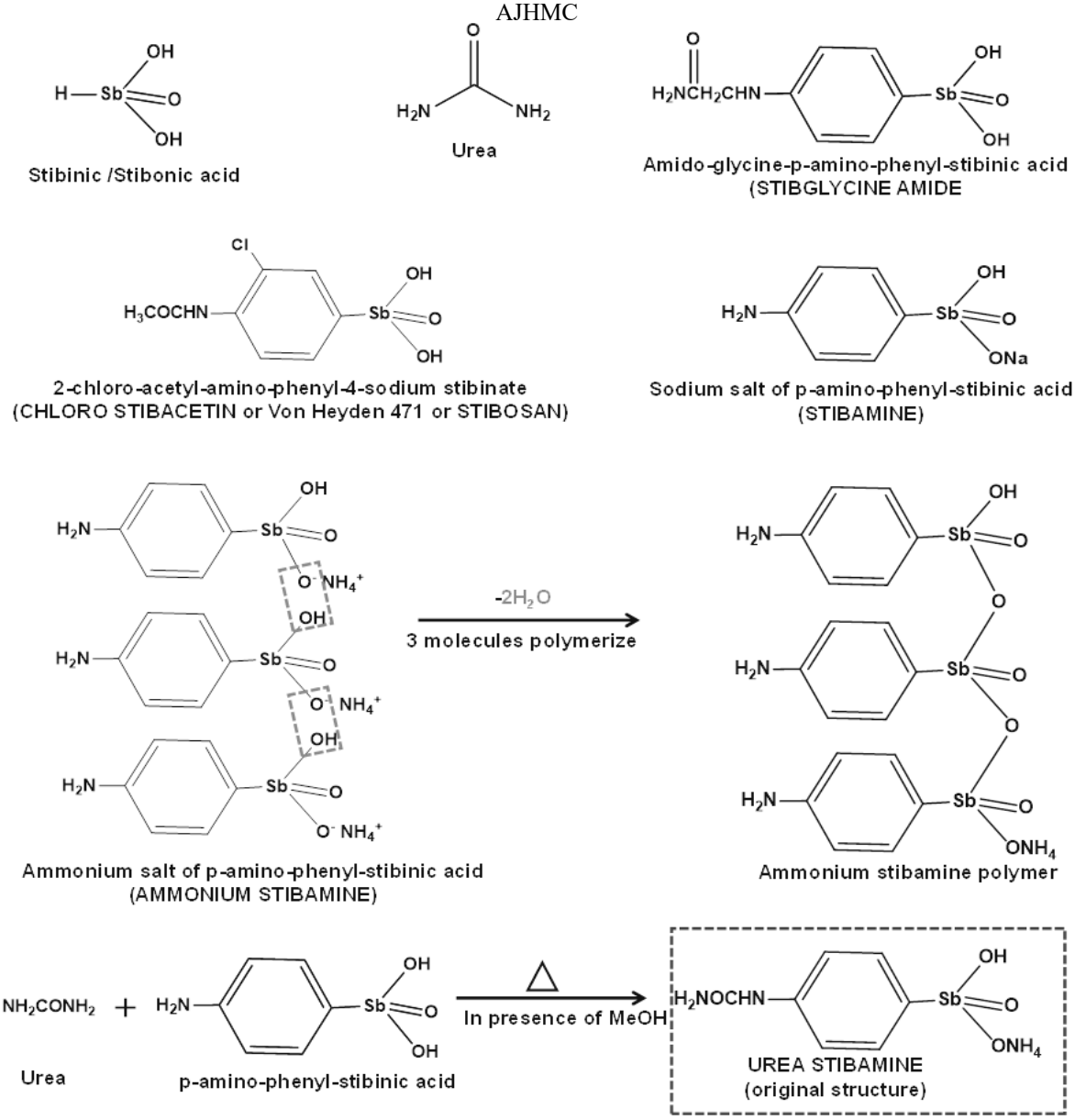
Despite their success, these compounds have never been rigorously analyzed using modern structural or quantum chemical methods. Their electronic structure, stability, and reactivity remain largely unexplored, making them compelling candidates for density functional theory (DFT) studies and modern spectroscopic techniques aimed at under-standing structure–activity relationships.

In recognition of his pioneering contributions, Sir U.N. Brahmachari was honored with numerous awards, including the Minto Medal (1921) and the Kaiser-i-Hind Medal (1924). He was knighted in 1935 and played a significant role in scientific leadership in India. His work led to 95% recovery rates and treatment of over 328,000 patients in Assam by 1933. Despite being nominated for the Nobel Prize in Physiology or Medicine in 1929 and again five times in 1942, Brahmachari did not receive the award—likely due to limited international recognition and the absence of strong nominators. He was also proposed for election as a Fellow of the Royal Society (FRS), but the process was delayed by World War II and remained incomplete at the time of his death in 1946.

Nonetheless, his achievements stand as a testament to early 20th-century medicinal chemistry. The structural ingenuity behind urea stibamine and its analogues remains underappreciated in the literature—especially from a molecular design perspective—and warrants renewed attention through modern chemical analysis.

It was initially proposed that urea stibamine is synthesized by heating urea with p-amino-phenyl-stibinic acid, as illustrated in Scheme 1. While the original structural representation was suggested by Sir U.N. Brahmachari, subsequent investigations—particularly those by Gray et al. and Ghosh et al. — led Brahmachari to revise his proposal. Based on their observations, he concluded that the ‘effective active principle’ of urea stibamine is a di-substituted urea compound, identified as S-diphenyl carbamide 4,4-distibinic acid (DipCarb-DSA), as shown in Figure 2. Despite this historical insight, the detailed structure and chemical characteristics of DipCarb-DSA remain poorly characterized and largely underexplored in the scientific literature.

In the present study, we conducted a comprehensive structural investigation of Stibamine, Urea Stibinic Acid, and Dip Carb-DSA using density functional theory (DFT) for comparative analysis. To obtain a clear and accurate conformation of DipCarb-DSA, molecular dynamics (MD) simulations were performed using a tight-binding method. The most stable conformer identified from the MD simulations was subjected to detailed analysis, including noncovalent interaction (NCI) analysis, quantum theory of atoms in molecules (QTAIM) analysis, and frontier molecular orbital (FMO) analysis focused on the HOMO–LUMO characteristics.



Scheme 1. Antimony-based compounds investigated as therapeutic agents for the treatment of kala-azar.

Computational Details

The selected stibamines and their derivatives were optimized using density functional theory (DFT). Geometry optimizations were performed with the PBE1PBE (also known as PBE0) hybrid functional, as implemented in the Gaussian 09 software package. The 6-31G(d,p) split-valence basis set was employed for all light atoms, while the hypervalent antimony centers were treated using the def2-TZVP triple-zeta quality basis set. All geometry optimizations were carried out without any structural constraints, and the nature of each stationary point was verified through harmonic vibrational frequency analysis.

For the DipCarb-DSA system, molecular dynamics (MD) simulations were carried out at 500 K for a total simulation time of 100 ps, yielding 10,000 frames. These simulations were performed using the CP2K program

[13]. To identify the most stable conformers, conformer–rotamer ensemble sampling was conducted using the CREST (Conformer-Rotamer Ensemble Sampling Tool) methodology. The conformational search employed the GFN2-xTB tight-binding method in conjunction with metadynamics simulations, where the root-mean-square deviation (RMSD) from the reference structure was used as the collective variable to efficiently sample the conformational space.

An energy window of 30 kcal mol^{-1} was applied, wherein conformers within this threshold relative to the most favorable structure were accepted; others were discarded. Additionally, conformers differing by more than 0.1 kcal mol^{-1} in energy and by more than 0.1 Å in RMSD were retained as distinct structures. This protocol has been successfully used in the conformational analysis of transition metal-containing complexes.

Reactivity descriptors were examined using conceptual DFT, including the energies of the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), as well as derived quantities such as chemical potential (μ), hardness (η), softness (S), electronegativity (χ), and electrophilicity index (ω). These descriptors provide insights into the chemical reactivity and stability of the studied systems.

$$E_{gap} = E_{LUMO} - E_{HOMO}$$

$$\text{Chemical potential } (\mu) = \frac{E_{HOMO} + E_{LUMO}}{2}$$

$$\text{Hardness } (\eta) = \frac{E_{LUMO} - E_{HOMO}}{2}$$

$$\text{Softness } (S) = \frac{1}{2\eta}$$

$$\text{Electronegativity } (\chi) = -\mu$$

$$\text{Electrophilicity index } (\omega) = \frac{\mu^2}{2\eta}$$

3. Results And Discussion:

3.1 Structural Analysis

Conformational analysis using the CREST tool yielded 51 distinct conformers of **DipCarb-DSA**. Among them, the most stable structure (denoted as **DipCarb-DSA_I**) features a notably short Sb···Sb distance of 4.17 Å. This conformation is stabilized by π–π stacking interactions and two strong intramolecular hydrogen bonds (1.68 Å), formed between the protonated oxygen atom of one antimony centre and the deprotonated oxygen atom of the other.

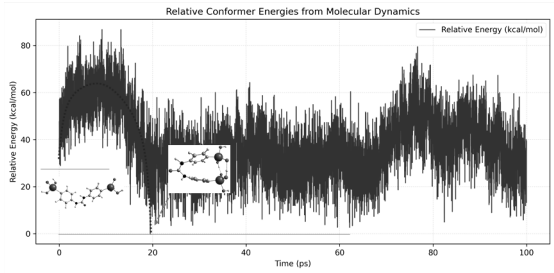


Figure 1: Relative conformer energies from molecular dynamics

Interestingly, visual inspection revealed another conformer, **DipCarb-DSA_II**, which lies 28.3 kcal mol^{-1} (12.2 kcal/mol at DFT level) higher in energy compared to **DipCarb-DSA_I**. This higher-energy conformer adopts an extended linear structure with an Sb···Sb distance of approximately 12.4 Å. It is plausible that, at the elevated simulation temperature of 500K, interconversion between these extreme conformers may occur via dynamic structural fluctuations (Figure 1).

Following the conformational search, the geometry of the lowest-energy conformer (**DipCarb-DSA_I**) and **DipCarb-DSA_I** were further optimized, along with other stibamine derivatives, using a high-level quantum mechanical method (PBE0/def2-TZVP for Sb and 6-31G(d,p) for light atoms). The optimized geometries of all studied structures are presented in Figure 2.

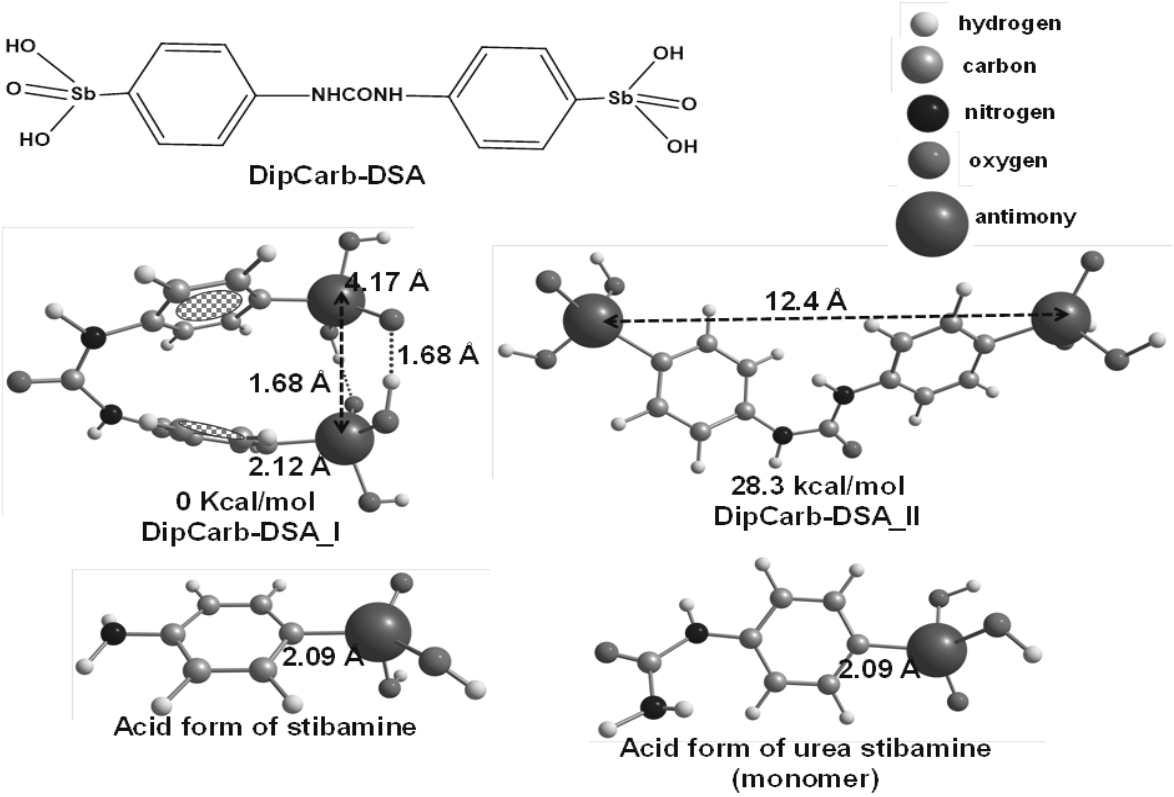


Figure 2: Optimized geometries of stibamines and their derivatives.

3.2 Frontier Molecular Orbital Analysis-Electronic Properties.

To better understand the reactivity indices, we analyzed the frontier molecular orbitals (FMOs), focusing on the HOMO and LUMO of the investigated molecules (Figure 3). In **DipCarb-DSA_I**, the HOMO is delocalized over the π-system of the aromatic ring, while the LUMO is mainly localized on the Sb-centered π* orbital. Among all conformers, **DipCarb-DSA_I** exhibits the lowest HOMO–LUMO gap (4.92 eV), in contrast to the extended structure **DipCarb-DSA_II** (10.9 eV), indicating greater polarizability and higher chemical reactivity—features of a soft molecule. Figure 3 displays the FMOs and corresponding energy gaps. Additionally, the chemical potential (μ = −4.35 eV) reflects a strong nucleophilic nature, supported by a moderate electrophilicity index (ω = 3.85 eV), positive chemical hardness (η = 2.46 eV), and low softness (σ = 0.20 eV^{-1}), suggesting a stable but reactive system.

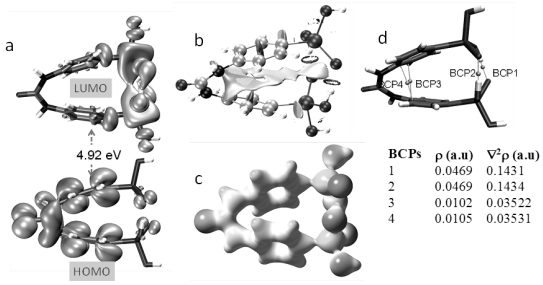


Figure 3:

A. Isosurface plots of FMOs of **DipCarb-DSA_I**.

B. NCI-RDG plot of this conformer.

C. Electrostatic potential ESP plot of the conformer d. QTAIM analysed relevant BCPs

3.3 Non-covalent interactions analysis

Topological analyses based on Bader's Atoms in Molecules (AIM) [14] theory were employed to characterize the electron density features, such as charge density (ρ) and the Laplacian of the charge density($\blacktriangledown^2\rho$). The values of ρ and $\blacktriangledown^2\rho$of the relevant bond critical points (BCPs) clearly indicates the presence of the p-p stacking and strong hydrogen bonds.For an interaction to be classified as a hydrogen bond , it must meet specific criteria: the ρ should fall within the range of 0.002–0.04 a.u. and the $\blacktriangledown^2\rho$ should be between 0.024–0.14 a.u. as established by Koch and Popelier [15,16]. Furthermore, noncovalent interactions (NCIs) were analyzed using the Reduced Density Gradient (RDG)-based NCI index, which allows real-space visualization of both attractive (e.g., van der Waals, hydrogen bonding) and repulsive (steric) interactions. The NCI plot analysis of **DipCarb-DSA_I** (Figure 3) shows that the existence of the strong p-p stacking interactions which is characterized by blue isosurfaces between the two aromatic rings. Also, the presence of two strong hydrogen bonds is supported by the NCI plots.

3.4 Absorption Spectra of the Investigated Conformers

For the absorption spectra, TD-DFT calculations were performed in methanol (MeOH) solvent. The results reveal that conformer **DipCarb-DSA_I** exhibits the lowest-energy transition at 276 nm (HOMO → LUMO, 98% contribution), with the most intense peak at 273 nm. In contrast, **DipCarb -DSA_II** shows a strong, lowest-energy peak at 279 nm, likely arising from an intermolecular charge-transfer transition.

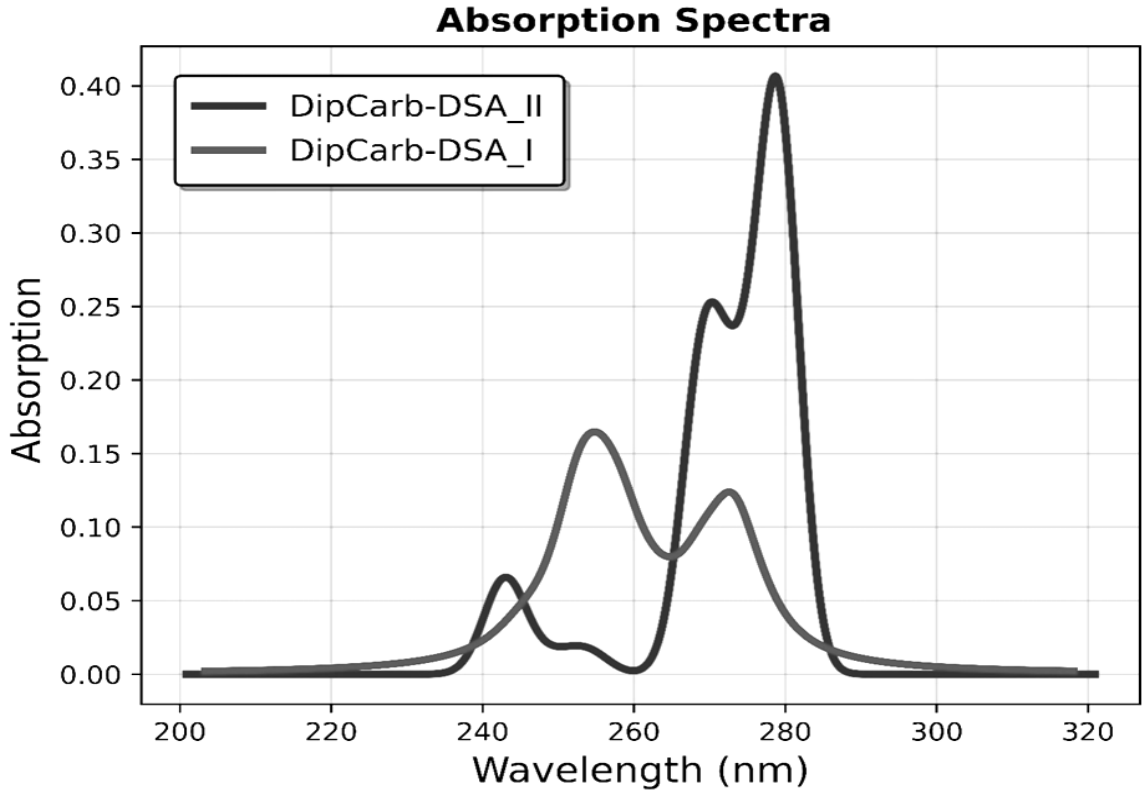


Figure 4: Absorption spectra of the investigated conformers of **DipCarb-DSA** computed at PBE0/def2-TZVP/6-31G(d,p) in MeOH medium.

4. Conclusion

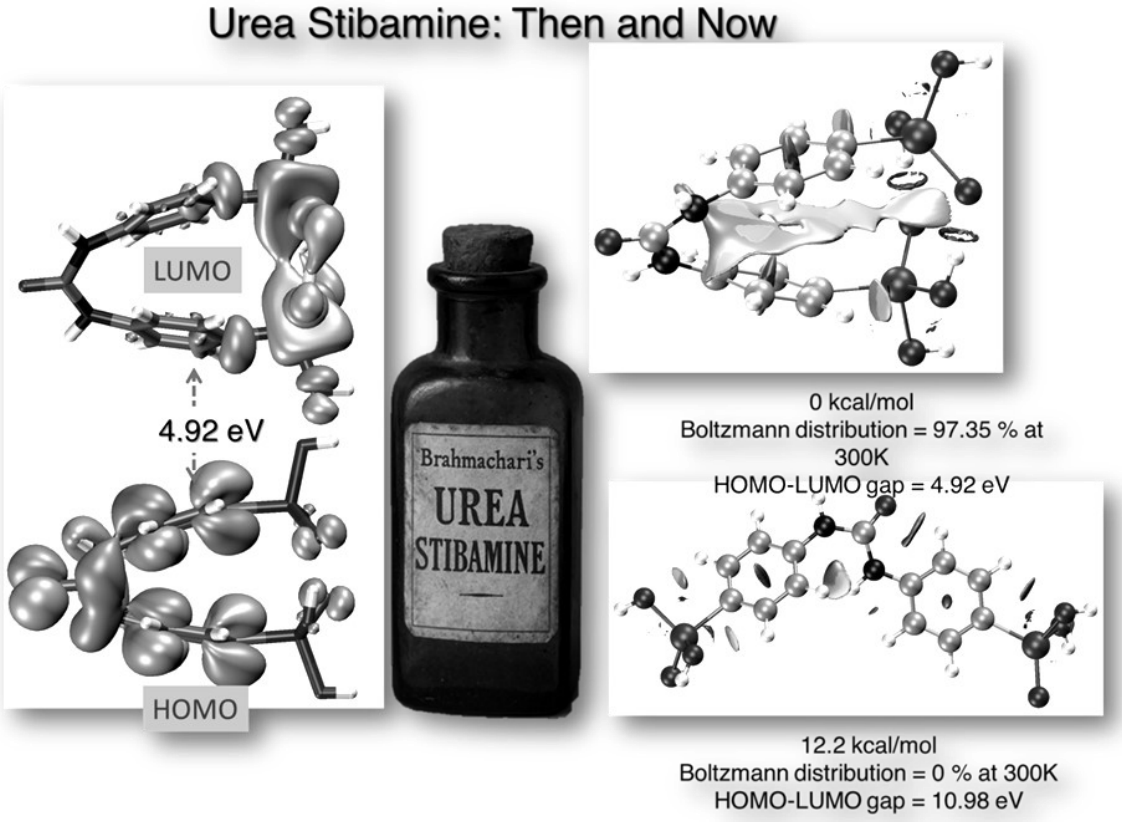
This study offers the first comprehensive quantum chemical characterization of Urea Stibamine and its active principle, **DipCarb-DSA**, illuminating the structural basis of its antileishmanial activity. Through DFT and metadynamics-based conformational sampling, we identified **DipCarb-DSA_I** as the most stable conformer, stabilized by strong π–π stacking and intramolecular hydrogen bonding. Frontier molecular orbital analysis revealed a moderate HOMO–LUMO gap (4.92 eV), indicating of chemical softness and reactivity. Non-covalent interaction (NCI) and QTAIM analyses confirmed the presence of key stabilizing interactions. TD-DFT-derived absorption spectra provided insights into electronic transitions, which, although not yet validated experimentally, may serve as predictive references for future spectroscopic studies. These findings not only validate the structural rationale behind Brahmachari's design but also lay a foundation for future Sb (V)-based drug development using modern quantum chemical tools.

Supporting Information: The Cartesian coordinates of all optimized species, structures of all conformers, and a video of the molecular dynamics simulation are available upon request from the author.

References

[1] Brahmachari, U. N. (1908). Sporadic kala-azar in Calcutta, with notes of a case treated with atoxyl. *The British Medical Journal*, *1*(2474), 1286–1288.
[2] Brahmachari, U. N. (1940). Antimony treatment of kala-azar. *Nature*, *145*, 546.
[3] Ghosh, S. (1928). A simple method for the estimation of antimony in organic antimony compounds. *Indian Journal of Medical Research*, *16*, 457–460.
[4] Brahmachari, U. N. (1940). Chemistry of urea stibamine. *Nature*, *145*, 1021–1022.
[5] Guha, R., Dutta, N., & Mukerji, B. (1943). Antimony content and toxicity of urea stibamine. *Nature*, *151*, 108–109.
[6] Saha, P., Chaudhury, A., & Maji, A. K. (2021). Sir U.N. Brahmachari and his battle against kala-azar. *Tropical Parasitology*, *11*(2), 89–91.
[7] Brahmachari, U. N. (1928). *A treatise on kala-azar*. London: John Bale, Sons & Danielsson Ltd.
[8] Brahmachari, U. N. (1916). Preparation of stable colloidal antimony. *The Lancet*, *188*(4860), 728.
[9] Brahmachari, U. N. (1989). Chemotherapy of antimonial compounds in kala-azar infection. Part IV: Further observations on the therapeutic values of urea stibamine. *Indian Journal of Medical Research*, *89*, 393–404.
[10] Gray, W. H., Trevan, J. W., Bainbridge, H. W., & Attwood, A. P. (1931). The ureides of p-aminophenylstibinic acid. *Proceedings of the Royal Society of London. Series B, Containing Papers of a Biological Character*, *108*(757), 54–83.
[11] Ghosh, et al. (1928). [Title not provided]. *Indian Medical Gazette*, *16*(2), 461–468.
[12] Frisch, M. J., et al. (2016). *Gaussian 09, Revision A.02*. Gaussian, Inc., Wallingford, CT.
[13] Kühne, T. D., Iannuzzi, M., Del Ben, M., Rybkin, V. V., Seewald, P., Stein, F., … Hutter, J. (2020). CP2K: An electronic structure and molecular dynamics software package - Quickstep: Efficient and accurate electronic structure calculations. *The Journal of Chemical Physics*, *152*(19), 194103. https://doi.org/10.1063/5.0007045
[14] Bader, R. F. W. (1990). *Atoms in Molecules - A Quantum Theory*. Oxford University Press. ISBN: 0198558651
[15] Koch, U., & Popelier, P. L. A. (1995). Characterization of C-H-O hydrogen bonds on the basis of the charge density. *Journal of Physical Chemistry*, *99*(24), 9747–9754. https://doi.org/10.1021/j100024a016
[16] Koch, U., & Popelier, P. L. A. (1995). Characterization of C-H-O hydrogen bonds on the basis of the charge density. *Journal of Physical Chemistry*, *99*(24), 9747–9754.

Graphical Abstract



Volume : 12 No. 1 & 2
June, 2025

Of Bugs and Hope: Contribution of the Proteges of Hooghly Mohsin College in the Medical Sciences

Dr. Ashis Kumar Basu, ^Sambuddha Bhattacharjee***

**Associate Professor, Postgraduate Department of Political Science, Hooghly Mohsin College, Chinsurah, Hooghly, West Bengal, India.*
***Guest Faculty and Alumnus, Postgraduate Department of Political Science, Hooghly Mohsin College, Chinsurah, Hooghly, West Bengal, India.*
^Corresponding Author (4sambuddha@gmail.com)

Received : 10:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract: Hooghly Mohsin College, established in 1836, despite being established as general degree college for collegiate education, has been the alma mater to many luminaries in the medical profession. The current paper chronicles the contribution in the medical sciences of the prominent alumni of this institution, namely — Dr. Upendranath Brahmachari, Dr. Sushil Kumar Mukhopadhyay, Dr. Sambhu Nath De, Dr. Bholanath Chakraborty among others. The paper also attempts to contextualize the state of science and medical education while doing so.

Keywords: Hooghly Mohsin College, Medical Sciences, Science Education.

INTRODUCTION

In an essay, published in the periodical, Chikitsa Sammiliani in 1889, one commentator lamented about the lack of independent thought, acceptable research activity and originality among the physicians of Bengal (Gangyopadhyay 1889) –

"Fifty-five years ago, when Lord William Bentinck set up the Calcutta Medical College, who can say what great hopes stirred his heart … But if today he were still alive, he would have witnessed that the physicians of Bengal, like so many children, are still blindly treading along paths according to the manner in which they are led by their European mentors … We are like a lump of clay, we have attained the English world of knowledge, but are not capable of radiating the light of knowledge on our own."

He lamented of the lack of prominent physicians, like Sir Benjamin Brodie and Dr. Ashley Cooper, among the Indians. He estimated that during the period of burgeoning practice by physicians like O'Shaughnessy, Goodeve, Baillie and Charles, no other Indians could match them – possibly, with the exception of Mahendralal Sarkar, Durgacharan Bandyopdhyay and Surya Goodeve Chakravarty.

After a decade, another periodical, *Swasthya*, argued in 1900 that the power of any pestilence increases if people lose their confidence and argued it not to be inappropriate to think that the severity of the plague can be decreased by *samkirtana* –

" … Like the shadow at sunset, faith in religion too is slowly beginning to loom over educted society. Beyond its pale, in uneducated society, among women and among people of lower social strata, this faith is still strong. As it is firm, they bet good results by lying down without food or drink at the altar of gods at Tarakeswar … From these considerations, it is not inappropriate to think that the severity of plague can be decreased by samkirtana. The government can do whatever it believed fit and proper. Let citizens also do whatever they deem proper. If the efforts join hands to yield good, so much the better."

Such contrasting unease, probably, had some similarities with the anxiety between scientism and ecclesiasticism in early modern Europe. The advent of western education in India created such mixed reactions that the second half of the 19th

century and the first half of the 20th century remained torch-bearers in terms of setting the agenda for scientific education in India. Hooghly Mohsin College, a site for significant academic churnings, had her fair share of involvement in these discourses of science. While Sir Ronald Ross, famous for his research in malaria, found *'thy cunning seeds/O million murdering Death,'* and became a Nobel laureate in 1906, many of the Indian researchers were left lurching - away from recognition (Ghosh, 1996). The current paper focuses on the contributions of the medical practitioners and researchers of this institution. However, the context has not been left out.

HOOGHLY MOHSIN COLLEGE AND THE MEDICAL SCIENCES

The current Hooghly Mohsin College began its journey on 1st August, 1836 as The College of Muhammad Mohsin under the direct control of the General Committee of Public Instruction. However, the plan to introduce European medical science in India had already materialized in 1835 through the establishment of Calcutta Medical College (Zachariah, 1936). But interestingly, despite being established as a college for general collegiate education, The College of Muhammad Mohsin had a physician as its first Principal – **Dr. Thomas Alexander Wise**, who had earned himself an M.D. in Pathology from the University of Edinburgh in 1824 had already started his career as an Assistant Surgeon at Hooghly in 1827 (Basu 2018).

Out of curiosity, Dr. Wise engaged himself in the study of literature of traditional medical sciences of India and published articles on *'The Hindu System of Medicine'*, *'The Diseases of the Eye'*, *'The Cholera', 'The Pathology of the Blood'* etc. Apart from medical articles, his publications included a work on history – *'The Barah Bhuyas of Eastern Bengal.*' He served as the Principal of the college until February, 1939. Subsequently, he was appointed as the Secretary of the General Committee of Public Instruction. After serving as the Principal of Jagannath College, Dhaka during the 1840s, Dr. Wise returned to England to earn his FRCS from the Universities of Edinburgh and London (Basu, 2018). This trend of involvement in medical science was reflected among quite a few members of alumni of Hooghly Mohsin College – who had been successful to leave their lasting presence in medical practice and research.

The Indian Medical Gazette published an astonishing piece of information in 1941 – on the mere mention of *Kalazar* by psychoanalysts, nine out of the ten the respondents would invariably utter *Urea Stibamine* or *Bramhachari* – unconsciously (Roy, 2025). Such was the impact of the research carried out by **Dr. Upendranath Bramhachari.**

After finishing his schooling from Jamalpur Boys' School, Upendranath graduated in Mathematics and Chemistry from Hooghly College in 1893. While his father Dr. Neelmani Bramhachari wanted him to be a doctor, Upendranath was keener to study Chemistry. However, as a compromise, he got enrolled at both Presidency College and Calcutta Medical College into Chemistry and Medical Sciences, respectively. He earned his degree in Chemistry in 1894 and he got his L.M.S. in 1898. He was awarded the Goodeve Medal and McLeod Medal for securing the highest marks in medicine and surgery respectively during his MB.

Initially, he was posted at Dhaka Medical School and later was transferred to Campbell Medical School. Later, this would become the institution to be rechristened as Nil Ratan Sarkar Medical College and Hospital. In 1903, it was established that Kalazar is caused by *leishmania donovanii* and in 1921 he could formulate the drug, Urea Stibamine, as an antidote to Kalazar. This finding was published in *Indian Journal of Medical Research* in 1922. Initially this drug was administered among the plantation workers in the tea gardens. The medicine in widespread usage for Kalazar was still a German formulation. Although the British physicians at Calcutta School of Tropical Medicine did not pay much attention to Dr. Bramhachari's research, his drug formulation had already been in use in China, Greece, France and Italy by that time.

Before his retirement, he established 'Bramhachari Research Institute' at his residence at Cornwallis Street in Calcutta in 1927. Although he did not get his formulation patented, he was quite litigious against unscrupulous businessmen using the name of his drug in their businesses. However, Dr. Bramhachari was quite a magnanimous philanthropist. University of Calcutta, Indian Science Congress, Physiological Society of India, Calcutta Medical College, Calcutta Blood Bank have been beneficiaries of his munificence. The journal, *Science & Culture*, was principally a borne out of his monetary contributions.

He earned the Coates Medal in 1928 for his Ph.D. and subsequently, he received the Griffith Award. Although he was shortlisted for the Nobel Prize in Medicine in 1929, the coveted award remained beyond his stretch. He was made a Fellow of Royal College of Medicine, London and Royal College of Tropical Medicine and Hygiene, London. Dr. Brahmachari was knighted in 1935.

Dr. U. N. Brahmachari can be said to have carried forward the legacy of joining Campbell Medical School, currently known as Nil Ratan Sarkar Medical College and Hospital, from Hooghly College from the eminent gynaecologist, **Dr. Dayalchand Shome**. Dr. Shome earned his L.M.S. in first class in 1864 and completed his M.B. in 1865 from Calcutta Medical College after studying at Hooghly College during 1858-59 (Basu, 2018). The textbook that he wrote on gynaecology garnered wide acclaim. His expertise earned him the position of Assistant Surgeon to the Viceroy of India.

Dr. Sushil Kumar Mukhopadhyay, who served for long as the Head of the Department of Opthalmology at Calcutta Medical College, had been another prominent alumnus of Hooghly College (Basu, 2018). He passed F.A. Examination from Hooghly College in 1905 and earned his L.M.S. from Calcutta Medical College in 1910. Later on, he obtained F.R.C.S. (University of Edinburgh), D.O. (University of Oxford) and D.O.M.C. (University of London) due to his excellence in ophthalmology.

Similarly pioneering was **Dr. Sambhu Nath De** (1895-1985). Born to Dasharathi De and Chitreswari Debi, young Sambhu Nath faced the early challenge of penury. After completing matriculation from Garhbati High School with a scholarship and help from his uncle, he got admission into Hooghly Mohsin College and completed his Inter-science with another scholarship. He was selected for admission into Calcutta Medical College for further studies – from where, he completed his MB exam in 1939 and earned his Diploma in Tropical Medicine in 1942. He was appointed as a demonstrator in the Department of pathology in the same college under Prof. B. P. Trivedi, with whom, Sambhu Nath co-authored a few papers. Professor Dr. M. N. Dey at Calcutta Medical College was expeditious to recognize the zeal in young Sambhu Nath. Throughout his training in medical sciences at the college, Sambhu Nath received encouragement from Prof. Dr. Dey.

The Second World War had already been over and Prof. Dr. Dey had been appointed as the Head of the Department of Medicine at Calcutta Medical College. Following his recommendation, Sambhu Nath De started his research under Professor C. R. Cameron at the University of London on hydrochiphalus. However, he ran into difficulties in research as the rats he had been using as the subject of research, kept on perishing with a lung infection. Prof. Dr. Cameron nudged him to pivot to the resultant lung infection and not to the disease and working on this changed course, Sambhu Nath earned his PhD.

During his research at University College, London, Dr. Sambhu Nath De had encountered one research fellow working on the cholera bacteria. After returning to India in 1949 and joining Nilratan Sircar Medical College, Kolkata, Dr. Sambhu Nath De grew engrossed with his research on cholera. Cholera, being one of the oldest epidemic in the world, interest in this disease and some headway in its research had already been made. Dr. John Snow had pointed out for the first time that of cholera being a water born

disease. Italian scientist, Filippo Pacini, discovered that a bacteria is behind cholera infection. A major breakthrough was made by Dr. Robert Koch. On January 7, 1884, he claimed to have successfully isolated the bacillus of cholera in pure culture. Although cholera bacteria was discovered in 1884, the scientists were still unable to find the antidote – Robert Koch was of the belief that it was only because of the scientists who were working with cholera had not much sample of cholera in their own motherland, while India, where cholera was widespread, lacked practitioners and researchers to delve into this question.

Following Koch, many believed that cholera bacteria produced exotoxins. Dr. De refuted this and proved that the toxin produced by *vibrio cholerі* is an endotoxin. He also became the first successful scientist to make a rabbit-model of cholera – which involved ligated intestinal loop in rabbits. He could also explain the reason behind dehydration during cholera. Dr. Sambhu Nath De and Dr. D. N. Chatterjee, his colleague published the findings as a paper, 'Enterotoxicity of Culture-filtrate of Vibrio Cholerae', in *Nature* in December 1958. However, his research faced difficulties due to the new El Tor biotype of cholera bacteria. Beleaguered at the death of Dr. Cameron in 1966, Dr. De took retirement from Calcutta Medical College in 1973 at the age of 58.

In 1978, the Nobel Foundation invited Dr. De to participate in the 43rd Nobel Symposium on Cholera and Related Diarrhoeas. Bose Research Institution had passed a resolution to appoint him as an emeritus scientist in the institution after his invitation by the Nobel Foundation. Although he had intended to research further on the El Tor biotype, he passed away on 15th April, 1985.

Dr. De's research on cholera toxin had touched upon diverse areas, such as, cellular physiology, biochemistry and immunology. Nobel Laureate Professor Joshua Lederberg had nominated Dr. De for the Nobel Prize in Medicine for more than once. However, that recognition remained elusive.

Dr. Bholanath Chakraborty, an eminent homeopath, was born in 1925 at Chinsurah, He completed his B. Sc from Hooghly Mohsin College under University of Calcutta in 1946 and completed his DMS degree from Calcutta Homeopathic Medical College and Hospital in 1950. He also held degrees from the Faculty of Homeopathic Medicine, London and Coombe Hospital, Dublin. Prafulla Chandra Sen, Lata Mangeshkar, Suchitra Sen, Supriya Devi etc were among his patients. The current year marks his birth centenary (Basu, 2018).
Dr. Bholanath Chakraborty Memorial Fundamental Research Laboratory of Homeopathy has been established at Indian Institute of Engineering Science and Technology, Shibpur and is funded by the Central Council of Research in Homeopathy (CCRH), Ministry of AYUSH, Government of India, to investigate and standardize the nature of homeopathic substances in terms of its composition, molecular structure and physical characterization.

Hiralal Sinha, who had been the Chemical Investigator under the Bengal Medical Service, **Dr. Satish Charan Mallik,** the Physician Professor at Calcutta Medical College, who was tireless in his service to the needy at Somra, **Dr. Keshab Chandra Chattopadhyay,** who got initiated to patriotism by Jyotishchandra Ghosh and undertook service to the common at Baidyabati and **Dr. Sadhan Kumar Mitra,** father to Shyamal Mitra, the singer and another illustrious alumnus of Hooghly Mohsin College, carried forward the institutional legacy of contribution to and association with the medical sciences (Basu, 2018).

Apart from them, many of the alumni had traversed the interdisciplinary path of science – **Jogesh Chandra Ray Bidyanidhi** and **Sahay Ram Bose**, being foremost among them. They are not being mentioned further due to paucity of space.

CONCLUSION

The western scientific thinking

considered the local modes of knowledge to be disorganized, scattered or formless. But, in reality, these different indigenous modes acted in parallel to science (Bose, 2006) -

".. they sometimes demanded acceptance as 'science', at other times they entered the arena commonly demarcated as scientific and caused its parameters to change, and other times, through the balancing out of these two types of knowledge, they forced the construction of a hybrid category."

While the number of vernacular medical journals published in the 19th and early 20th century was not a small one, in later years, English became the medium through which teaching and practice of medicine was participated into in Bengal. Not just the medium of instruction, but the content of medical education was also debated upon. Even systems like Ayurveda went through changes in this process of knowledge-formation under the prevalent coloniality and the resultant relations of power (Chatterjee, 1994) –

"This (Ayurveda) separate system was being radically reformulated in an effort to modernize it in accordance with the laws of western science."

The machinations of power under the colonial rule appeared in many forms during the 19th and early 20th centuries. In purported attempts to modernize, schemes under colonialism were often pointed towards destruction of indigenous endeavours. Science and scientism were often appropriated to debase independent modes of thought. Bankimchandra had written, 'The science that would have been our slave had it been our own, has become our master because it is foreign' (Chattyopadhyay 1872). Bankim, however, probably, would have been pleased and optimistic to note the contributions of the subsequent alumni of his alma mater!

References

- Zachariah, Kuruvila (1936), *History of Hooghly College 1836-1936*, B. G. Press, Alipore.
- Mukhopadhyay, S.K. (2011), *Hooghly College 175: Hooghly Mohsin College 175th Anniversary Commemorative Volume,* Hooghly Mohsin College, Chinsurah.
- Basu, Ashis Kumar (2018), *Gorber Praktoni: Itihaase Hooghly Mohsin College*, Avenel Press, Memari.
- Bose, Pradip Kumar (2006), *Health and Society in Bengal: A Selection from Late 19th Century Bengali Periodicals*, Sage Publications, New Delhi.
- Chatterjee, Partha (1994), 'Amader Adhunikota', *Jogsutro, October-December*.
- Chattyopadhyay, Bankimchandra (1872), Bharatbarshiya Vijnansabha, *Bangadarshan.*
- Ghosh, Amitava (1996), *The Calcutta Chromosome*, Penguin Books: Gurugram.
- Roy, Krishna (2025), *Brahmachari O Kalajwar*, Mandas, Kolkata.

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

পত্রপত্রিকার দর্পণে স্যার উপেন্দ্রনাথ ব্রহ্মচারী

ড. দেবায়ন চৌধুরী
সহকারী অধ্যাপক, বাংলা বিভাগ, হুগলি মহসিন কলেজ
dchaudhuribangla@gmail.com

Received : 15:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

স্মরণ শব্দটির সঙ্গে জড়িয়ে থাকে পুনরুদ্ধারের বাসনা। স্মরণক্রিয়ার মধ্যে যে সচেতনতার বোধ, তার নিরিখে বোধহয় দেখা যেতে পারে ব্যক্তি ও সমষ্টির গ্রহণক্ষমতার বিষয়টিকে। যা সময়ের সঙ্গে সঙ্গে নতুনভাবে ধরা দেয়।

সমকাল কীভাবে একজন মানুষকে স্মরণীয় করে তুলছে, তার সূত্রেই পুরোনো পত্রপত্রিকার মধ্যে খুঁজে পাই স্যার উপেন্দ্রনাথ ব্রহ্মচারীর উজ্জ্বল উপস্থিতি। দেড়শো বছর পেরিয়ে আজও বিভিন্ন পত্রিকায় তাঁকে নিয়ে যখন বিভিন্ন লেখা পড়ি, অনুভূত হয় সমকাল থেকে চিরকালে উত্তরণ ঘটে গেছে তাঁর।

'হুগলি মহসিন কলেজের প্রাক্তনী'—উপেন্দ্রনাথ ব্রহ্মচারীর এই পরিচয় আমাদের স্মরণের উত্তরাধিকারকে যে বহুলাংশে প্রভাবিত করেছে, তা নিঃসন্দেহে বলা চলে। প্রসঙ্গত, অধ্যাপক হরিসাধন চট্টোপাধ্যায় প্রণীত 'আমরা বাঙ্গালী' (এইচ, চ্যাটার্জ্জী এণ্ড কোং লি:, কলিকাতা, ১৯৫২) বইটির কথা উল্লেখ করা যেতে পারে, যেখানে 'অমর বাঙ্গালী' শীর্ষক দশম পরিচ্ছেদে হাজি মহম্মদ মহসীন, দ্বিজেন্দ্রলাল রায়, বঙ্কিমচন্দ্র চট্টোপাধ্যায়ের সঙ্গে মুদ্রিত হয়েছে উপেন্দ্রনাথ ব্রহ্মচারীর সংক্ষিপ্ত জীবনকথা। '১৮৭৫ সালে জামালপুরে তিনি জন্মগ্রহণ করেন।'—আলোচ্য গ্রন্থের এই তথ্যটি সবিশেষ গুরুত্বপূর্ণ।

(২)

উনিশ শতকের পত্রপত্রিকায় জনস্বাস্থ্য সম্পর্কিত প্রচুর লেখার খোঁজ পাওয়া যায়। লোকহিতের সঙ্গে অঙ্গাঙ্গীভাবে জড়িয়ে ছিল সারস্বত প্রকল্প। বিশ শতকের অন্যতম গুরুত্বপূর্ণ পত্রিকা, রামানন্দ চট্টোপাধ্যায় সম্পাদিত 'প্রবাসী'-তে 'কালাজ্বর' নিয়ে ধারাবাহিক প্রতিবেদন প্রকাশিত হয়েছে। বঙ্গে কালাজ্বরের প্রকোপ ও সচেতনতা বিষয়ে পাঠকদের দৃষ্টি আকর্ষণ করতে দেখি আষাঢ় ১৩৩০ সংখ্যায়। বলা হচ্ছে—"কোন রোগের উৎপত্তি, সংক্রামণ, প্রভৃতি সম্পর্কে বৈজ্ঞানিক জ্ঞান জন্মিলে, উহার প্রতিষেধক উপায় অবলম্বন করা যায়। সমগ্র বঙ্গের স্বাস্থ্যসমিতির উদ্দেশ্য রোগের চিকিৎসা, ও প্রতিষেধ, দুই-ই। অতএব, আশা করা যায়, এই সমিতি কালা-জ্বরের উৎপত্তি, সংক্রামণ প্রভৃতির গবেষণা সম্বন্ধে বলিবেন না, যে, বিজ্ঞানের এই কাজটা স্বরাজলাভের পর করিলেই চলিবে।"[১] ঔপনিবেশিক কালপর্বে বিজ্ঞানচর্চাকে স্বদেশপ্রেমের সঙ্গে যুক্তভাবে যেমন দেখা হয়, সেইসঙ্গে মনে রাখতে হবে অনেকরকম চোরাস্রোতও বহমান ছিল। বিজ্ঞান গবেষণার সূত্রে অর্থনৈতিক স্বাবলম্বনের প্রতি দৃষ্টি আকর্ষণ করেছিলেন প্রফুল্লচন্দ্র রায়। আশীষ লাহিড়ী 'রাজভক্ত উপেন্দ্রনাথ ব্রহ্মচারী: হাঁসজারু-পুঁজিতন্ত্রর বিড়ম্বনা' প্রবন্ধে ঔপনিবেশিক আবহে বিজ্ঞানীর মতাদর্শগত অবস্থান ও স্বীকৃতির রাজনীতি নিয়ে অসাধারণ আলোচনা করেছেন।[২] যাইহোক, এবার আসি কালাজ্বরের কথায়।

'বঙ্গে কালা-জ্বর' ('প্রবাসী', জ্যৈষ্ঠ ১৩৩০) লেখা থেকে জানতে পারি, ১৯২১ সালের রিপোর্ট অনুযায়ী সে বছর সমগ্র বঙ্গে ১৫৫২ জন মারা গিয়েছিলেন কালাজ্বরে ভুগে। বলা হচ্ছে, অন্তত পঞ্চাশ হাজার মানুষ আক্রান্ত হয়েছিলেন, এবং প্রাণ হারিয়েছিলেন দশ হাজার ব্যক্তি। সরকারি রিপোর্টে এই সংখ্যাটি স্বভাবতই কম ছিল। এই প্রতিবেদনে ট্রপিক্যাল

স্কুল অব মেডিসিনের অধ্যাপক ও কালাজ্বরের গবেষক নেপিয়ারের নাম রয়েছে। সরকারের ওপর ভরসা না করে অধিবাসীদের সহায়তায় চাঁদা তুলে চিকিৎসার ব্যবস্থা করার কথা বলা হয়েছে। এই লেখায় আমরা উপেন্দ্রনাথ ব্রহ্মচারীর উল্লেখ পাইনি। আসামে ব্যাপকভাবে কালাজ্বর হত। আসাম সরকারের ব্যবস্থাপনায় বিশেষ চিকিৎসালয়ের সংবাদ প্রকাশিত হয়েছে 'প্রবাসী'র আশ্বিন ১৩২৯ সংখ্যায়। 'প্রবাসী' বৈশাখ ১৩৩১ সংখ্যায় দেখি, পল্লীগ্রামের প্রায় তিনশো চিকিৎসককে 'কালাজ্বরের চিকিৎসা সম্বন্ধে শিক্ষা দেওয়া হইয়াছে।' প্রসঙ্গত, ১৯২২ সালে ১৮০০০ জন কালাজ্বর আক্রান্ত হাসপাতালে ভর্তি হয়েছিলেন। শুধু তাই নয়, কালাজ্বরে মৃত্যু হলেও তাকে অজ্ঞতাবশত ম্যালেরিয়ায় মৃত্যু বলে চালানো হত।

'প্রবাসী' পত্রিকায় প্রকাশিত 'বিজ্ঞান-চর্চ্চায় ভারতীয় প্রতিভা' প্রবন্ধে চিকিৎসাশাস্ত্রে গবেষণার প্রসঙ্গে সুশোভন দত্ত লিখেছেন— "চিকিৎসা বিজ্ঞানে বিশিষ্ট আবিষ্কারের মধ্যে সর্ উপেন্দ্রনাথ ব্রহ্মচারীর কালাজ্বরের প্রতিষেধক urea-stibamine আবিষ্কারই সর্ব্বাপেক্ষা উল্লেখযোগ্য। ৩০ বৎসর পূর্ব্বে বাংলা দেশ ও আসামের বহু অংশে কালাজ্বর মড়ক রূপে দেখা দিত এবং এই রোগে মৃত্যুর হার ছিল শতকরা ৯৫। সর্ উপেন্দ্রনাথ কর্ত্তৃক urea-stibamine আবিষ্কারের পর এই রোগ দমন করা সহজসাধ্য হয়। আসাম-সরকার বহুলপরিমাণে এই ঔষধ-প্রয়োগের ব্যবস্থা করিয়া আসাম প্রদেশকে কালাজ্বরের মড়কের হাত হইতে উদ্ধার করেন। আসামের স্বাস্থ্য বিভাগের ভারপ্রাপ্ত কর্ত্তার ময়তে বিগত কয় বৎসরে আসামে urea-stibamine প্রয়োগে কয়েক লক্ষ লোকের প্রাণরক্ষা হইয়াছে।"[৩]

উপেন্দ্রনাথ ব্রহ্মচারীর মৃত্যুর পর 'প্রবাসী' পত্রিকায় নিম্নোক্ত সংবাদ মুদ্রিত হয়েছিল --

সর উপেন্দ্রনাথ ব্রহ্মচারী

সর উপেন্দ্রনাথ ব্রহ্মচারী সহসা হৃদযন্ত্রের ক্রিয়া বন্ধ হইয়া পরলোকগমন করিয়াছেন। মৃত্যুকালে তাঁহার বয়স ৭০ বৎসর হইয়াছিল। ভারতীয় চিকিৎসকদের মধ্যে সর উপেন্দ্রনাথের স্থান অতি উচ্চে। কিন্তু একটি বিষয়ে তাঁহার স্থান সকলের উর্দ্ধে। সর উপেন্দ্রনাথই সম্ভবতঃ প্রথম ভারতীয় চিকিৎসক যিনি একটি রোগ ধরিয়া তাহার মূল পর্য্যন্ত অনুসন্ধান করিয়া রোগের প্রতিষেধক ঔষধ আবিষ্কারে রোগবিস্তার বন্ধ করিয়াছেন। কালাজ্বরের ন্যায় একটি মারাত্মক ও ব্যাপক রোগ সর উপেন্দ্রনাথের ব্যক্তিগত গবেষণার ফলে প্রায় নির্ম্মুল হইয়াছে। যে গবেষণা করা উচিত ছিল গবর্ন্মেণ্টের, তাহা একাকী তিনিই সাধন করিয়া সাফল্য অর্জন করিয়াছেন। ইহার পূর্ব্বে ভারতবর্ষে কুষ্ঠরোগ ও ম্যালেরিয়া লইয়া বহু গবেষণা হইয়াছে কিন্তু তাহাতে ভারতবাসীর বিশেষ কিছু কৃতিত্ব নাই। চিকিৎসাবিজ্ঞানে সর উপেন্দ্রনাথের দান অবশ্য এই আবিষ্কারের মধ্যেই সীমাবদ্ধ নয়; চিকিৎসক ও রাসায়নিক হিসাবেও তিনি বিপুল সম্মান ও মর্য্যাদার অধিকারী হইয়াছিলেন। ১৯৩৬ সালে তিনি ভারতীয় বিজ্ঞান-কংগ্রেসের সভাপতি নির্ব্বাচিত হন। বহু বৎসর তিনি কলিকাতা বিশ্ববিদ্যালয়ের সিন্ডিকেটের সদস্য এবং ফ্যাকাল্টি অব সায়েন্স এন্ড মেডিসিনের ডীন ছিলেন। দুইবার তিনি এশিয়াটিক সোসাইটির সভাপতি নির্ব্বাচিত হন। তিনি ইণ্ডিয়ান এসোসিয়েশন ফর কাল্টিভেশন অফ সায়ান্সেরও সভাপতি ছিলেন।[৪]

(৩)

বিখ্যাত ব্যক্তির প্রয়াণের পর জীবনকর্ম আলোচনার যে প্রবণতা লক্ষিত হয়, তারই সূত্রে উদ্ধৃত করা যেতে পারে 'যুগান্তর' পত্রিকার নিম্নোক্ত প্রতিবেদনকে--

পরলোকে ডাঃ ব্রহ্মচারী

স্বনামধন্য চিকিৎসক ও চিকিৎসাবিজ্ঞানী স্যার ইউ এন ব্রহ্মচারী (উপেন্দ্রনাথ ব্রহ্মচারী) মহোদয়ের আকস্মিক মৃত্যুসংবাদে আমরা মর্ম্মাহত হইলাম।

পাশ্চাত্য চিকিৎসাবিদ্যায় পারদর্শিতা লাভ করিয়া যে কয়জন ভারতবাসী চিকিৎসাক্ষেত্রে অতুলনীয় খ্যাতির অধিকারী হইয়াছেন এবং বিবিধ মৌলিক আবিষ্কার ও উদ্ভাবনের দ্বারা চিকিৎসা-বিজ্ঞানের পুষ্টিসাধন করিয়া বিশ্ববিখ্যাত হইয়াছেন, ডাঃ ব্রহ্মচারী তাঁহাদেরই অন্যতম। সুরেশ সর্ব্বাধিকারী, গুডিভ চক্রবর্ত্তী, কেদারনাথ দাস, নীলরতন সরকার প্রমুখ প্রখ্যাত চিকিৎসক একে একে গত হইয়াছেন—ডাঃ ব্রহ্মচারীও আজ লোকান্তরিত হইলেন। এক্ষণে আমাদের চিকিৎসা জগতে ডাঃ বিধানচন্দ্র রায় মহাশয় ভিন্ন ঠিক এরূপ প্রতিভা ও প্রতিপত্তিসম্পন্ন চিকিৎসক ও চিকিৎসা বিজ্ঞানে পাণ্ডিত্যের অধিকারী বোধ হয় আর কেহই থাকিলেন না। সর্ব্ব ক্ষেত্রেই বিগত শতাব্দীর তুলনায় বঙ্গদেশ বর্ত্তমান শতাব্দীতে অনেক পিছাইয়া পড়িয়াছে—চিকিৎসাক্ষেত্রে দিকপাল শ্রেণীর পুরুষদের লোকান্তর সেই সর্ব্বতোমুখী ক্ষয়দশারই একটি বিশিষ্ট নিদর্শন। কালাজ্বরের অব্যর্থ ঔষধ 'ইউরিয়া ষ্টিবামাইন' আবিষ্কারকরূপেই ডাঃ ব্রহ্মচারী সারা জগতে প্রসিদ্ধ হইয়াছিলেন—শুধু প্রসিদ্ধিই এক্ষেত্রে বড় কথা নয়, লক্ষ লক্ষ নরনারী তাঁহার এই আবিষ্কৃতির ফলে নিশ্চিত মৃত্যুর হাত হইতে রক্ষা পাইয়াছেন, ইহাই সানন্দে ও সগর্ব্বে স্মরণ করিবার যোগ্য। ইনসুলিন, পণ্ট্রোসিল, স্যালভারসন, পেনিসিলিন, ডি ডি টি, এম বি ৬৯৩ প্রভৃতি বিশ্ববিশ্রুত ঔষধগুলির মতোই ডাঃ ব্রহ্মচারীর এই আবিষ্কারও সারা জগতের ব্যাধি-বিধ্বস্ত মানুষকে স্বাস্থ্য ও শান্তির আশ্বাস দিয়াছে—মৃত্যুর বিরুদ্ধে পৃথিবী ব্যাপিয়া জীবনের যে সংগ্রাম চলিয়াছে, তাহাতে বিপন্ন ও অশক্ত মানুষের আত্মরক্ষার অস্ত্র যাঁহারা আবিষ্কার করিয়া ধন্য হইয়াছেন, ডাঃ ব্রহ্মচারী তাঁহাদেরই একজন এবং বিশিষ্ট একজনই, কাজেই তাঁহার মৃত্যুতে আজ একই সঙ্গে ভারত তথা জগৎ একজন সত্যকার মানব-বন্ধু হারাইল।

বৃটিশ শাসনের আওতায় ভারতবর্ষে আজ পাশ্চাত্য চিকিৎসা-পদ্ধতিই সবিশেষ প্রসারলাভ করিয়াছে—বেশীরভাগ চিকিৎসা বিদ্যার্থীই আজ বৈদেশিক চিকিৎসা বিজ্ঞানে পারদর্শিতা লাভ করেন এবং সেই শিক্ষাই শিক্ষিত ডাক্তার দিয়া চিকিৎসা করানোকে জনগণও অকপট প্রদ্ধায় অনুমোদন করেন। এই সুযোগে বৈদেশিক চিকিৎসা গ্রন্থ, ঔষধ ও যন্ত্রপাতির একচেটিয়া ব্যবসা যেমন দেশের বুকে সবলে চাপিয়া বসিয়াছে, তেমনি এ দেশের নিজস্ব আয়র্ব্বেদীয় চিকিৎসা-পদ্ধতিও যুগোচিত প্রয়োজনের সঙ্গে সংস্কার এবং পোষকতার অভাবে ক্রমশঃ ক্ষীয়মান হইতে চলিয়াছে। বৈদেশিক চিকিৎসা-বিদ্যার যতটা অংশ সার্ব্বভৌম, তাহা সশ্রদ্ধভাবে গ্রহণ ও স্বীকারে কোনই বাধা নাই, একথা বলাই বাহুল্য—কিন্তু এদেশীয় চিকিৎসা-বিদ্যার যেটুকু অংশ গ্রহণীয় বা স্বীকার্য্য, তাহার সঙ্গে খাপ খাওয়াইয়াই তাহা করা উচিত ছিল, তাহা হইলে ভারতের একটি নিজস্ব চিকিৎসাপদ্ধতি অতি সহজেই গড়িয়া উঠিত—সেই পথে গ্রন্থাদি রচনা, ঔষধ ও যন্ত্রপাতি নির্ম্মাণ, বৈজ্ঞানিক বীক্ষণাগার ও উৎপাদনাগার ইত্যাদিও সুসাধ্য হইত এবং চিকিৎসার জন্য ভারতকে এমন পদে পদে বিদেশী বিজ্ঞান ও বৈদেশিক ব্যবসায়ের দুয়ারে মাথা হেঁট করিয়াও থাকিতে হইত না। ভারতবাসীর অতুলনীয় আবিষ্করণী প্রতিভাও পাশ্চাত্য ফারমাকোপিয়ার এবং বিভিন্ন পেটেণ্ট দাওয়াইয়ের দৌরাত্ম্যে নিষ্পিষ্ট হইয়া তাহার আত্মস্বাতন্ত্র্য হারাইত না। দুঃখের বিষয় আমাদের পরাধীনতাজনিত পরানুকরণই আমাদের সকল দুর্ভাগ্যের মূল—তাই পাশ্চাত্য চিকিৎসা বিজ্ঞানকে আমরা শুধু গ্রহিতারূপে গ্রহণই করিয়াছি, দাতারূপে তাহার সম্পদ বৃদ্ধি করিতে পারি নাই।

এই দুর্ভাগ্যের মধ্যেও যাঁহাদের প্রতিভা কোন না কোন বিশিষ্ট আবিষ্কৃতির পথে প্রবাহিত হইয়া সারা জগতের কল্যাণ করিয়াছে তাঁহারা বাস্তবিকই নমস্য। তাঁহারা আজিকার দিনে যেমন উজ্জ্বল আত্ম-স্বাতন্ত্র্যের উদাহরণস্থলরূপে ভারতীয় মনীষার ক্ষেত্রে স্মরণীয় হইয়াছেন, তেমনি আগামী দিনে যখন চিকিৎসাবিদ্যা ও

ব্যবসায়ের সর্ব্বাঙ্গীন স্বাজাত্যকরণ হইবে, সেদিনও তাঁহারা পুরোবর্ত্তী নেতারূপেই বরণীয় হইবেন। ডাঃ ব্রহ্মচারীর দান সেদিন আরো গৌরবের সঙ্গে কীর্ত্তিত হইবে। কিন্তু কেবলমাত্র আবিষ্কারকরূপেই ডাঃ ব্রহ্মচারীর সামগ্রিক পরিচয় সীমাবদ্ধ ছিল না—তিনি চিকিৎসক এবং চিকিৎসা-বিদ্যা শিক্ষকরূপেও অবিসম্বাদী শ্রেষ্ঠতার অধিকারী ছিলেন। বিভিন্ন সময়ে তিনি ক্যাম্বেল হাসপাতাল, কারমাইকেল মেডিক্যাল কলেজ ও কলিকাতা মেডিক্যাল কলেজের সঙ্গে সংযুক্ত ছিলেন—জাতীয় এবং আন্তর্জ্জাতিক বিভিন্ন চিকিৎসা-বিজ্ঞান সম্পর্কীয় প্রতিষ্ঠানের সভ্য অথবা নেতারূপেও তাঁহার নাম সর্ব্বত্র বিদিত ছিল। চিকিৎসাবিদ্যা সংক্রান্ত কতকগুলি সর্ব্বজনস্বীকৃত পুস্তক ও প্রবন্ধের রচয়িতা এবং কলিকাতা বিশ্ববিদ্যালয়ের একজন ফেলো হিসাবেও তাঁহার সুনাম ছিল। তাঁহার এই বহুমুখে ব্যাপ্ত কর্ম্মী-জীবনও তাঁহার বৈজ্ঞানিক জীবনের চেয়ে কম গৌরবাত্মক নয়। সুখের বিষয় যে, প্রতিভার এই বৈশিষ্ট্য ও বহুমুখিতার যোগ্য সমাদরও তিনি পাইয়াছেন। একাধারে প্রভূত অর্থ এবং প্রচুর সম্মান তিনি অর্জ্জন করিয়া গিয়াছেন। ১৯৩০ সালের বিজ্ঞান কংগ্রেসে দেশবাসী তাঁহাকে চিকিৎসা-বিজ্ঞান শাখার সভাপতি মনোনীত করিয়া সম্মানীত করেন, সরকারী সম্মাননাও তাঁহার লাভ হইয়াছিল। ৭০ বৎসরে আসিয়া এই বহু কর্ম্মান্বিত জীবনের অবসান হইল—ইহাকে কেহই অকালমৃত্যু বলিবেন না, কিন্তু যে স্থান তিনি শূন্য করিয়া গিয়াছেন তাহা সহসা পূর্ণ হইবে না, তাঁহার মৃত্যুর বেদনা তাই সারা দেশকেই ব্যথিত করিয়াছে। আমরা তাঁহার শোকসন্তপ্ত পত্নী ও পুত্রদ্বয়কে আন্তরিক সমবেদনা জানাইতেছি।[৫]

জাতীয়তাবাদী দৈনিক 'যুগান্তর'-এর পাশাপাশি অবিভক্ত কমিউনিস্ট পার্টির দৈনিক পত্রিকা 'স্বাধীনতা'-য়'স্যার উপেন্দ্রনাথ ব্রহ্মচারীর মৃত্যু' সংবাদ প্রকাশিত হয়েছিল ১৯৪৬ সালের ৭ ফেব্রুয়ারি।[৬] উপেন্দ্রনাথ ব্রহ্মচারীর মৃত্যুর খবর মুদ্রিত হয়েছিল কোচবিহার স্টেট প্রেস থেকে প্রকাশিত 'কোচবিহার দর্পণ' পত্রিকাতেও—

পরলোকে স্যার উপেন্দ্রনাথ ব্রহ্মচারী--

কলিকাতার বিখ্যাত চিকিৎসক ডাক্তার স্যার উপেন্দ্রনাথ ব্রহ্মচারী গত ৬ই ফেব্রুয়ারী পরলোক গমন করিয়াছেন। ডাক্তার ব্রহ্মচারী যে কেবল একজন বিখ্যাত চিকিৎসক চিকিৎসক ছিলেন তাহা নহে, তিনি একজন বিশ্ববিশ্রুত বিজ্ঞানীও ছিলেন। তিনি কালাজ্বরের মহৌষধ "ইউরিয়া ষ্টিবামাইন" আবিষ্কার করিয়াছিলেন। বহু বিজ্ঞান-পরিষদের সহিত তাঁহার যোগ ছিল ; তিনি বিভিন্ন সময়ে বিজ্ঞান কংগ্রেস ও বঙ্গীয় রয়াল এসিয়াটীক সোসাইটির সভাপতি ছিলেন। তিনি একদিকে ডাক্তারী শাস্ত্রে এম্-ডি এবং অপরদিকে বিজ্ঞানে পি-এইচ্-ডি উপাধি লাভ করিয়াছিলেন। তাঁহার মৃত্যুতে চিকিৎসা ও বিজ্ঞানজগতের অপূরণীয় ক্ষতি হইল।[৭]

তথ্য হিসেবে উল্লেখ করা যেতে পারে, ১৯৩৯ সালে তিনি ইন্ডিয়ান অ্যাসোসিয়েশন ফর দি কালটিভেশন অফ সায়েন্স প্রদত্ত 'কোচবিহার প্রফেসরশিপ স্বর্ণপদক' লাভ করেছিলেন।

(৪)

শ্যামল চক্রবর্তী তাঁর 'উপেক্ষিত চিকিৎসক-গবেষক উপেন্দ্রনাথ ব্রহ্মচারী' (অক্ষর পাবলিকেশানস্, ২০২৪) বইতে 'Science and Culture' পত্রিকার ৯ মার্চ ১৯৪৬ সংখ্যায় প্রকাশিত শ্রদ্ধা-নিবন্ধটি অন্তর্ভুক্ত করেছেন। উপেন্দ্রনাথ ব্রহ্মচারীর বই, গবেষণাপত্র ও নির্বাচিত বক্তৃতার কালানুক্রমিক বিবরণের পাশাপাশি এই গ্রন্থে উঠে এসেছে 'Nature', 'Indian Journal of History of Science', 'Lancet' প্রভৃতি পত্রিকায় মুদ্রিত সংবাদের প্রাসঙ্গিক অংশবিশেষ। 'আনন্দবাজার পত্রিকা', 'শতভিষা' সহ বিভিন্ন বাংলা পত্রিকায় উপেন্দ্রনাথের মূল্যায়ন গৃহীত হয়েছে এই জীবনীগ্রন্থে।

পরিশেষে বলতে পারি, সাম্প্রতিক সময়ে উপেন্দ্রনাথ ব্রহ্মচারীর জন্মসার্ধশতবর্ষ উপলক্ষে বেশ কয়েকটি লেখা প্রকাশিত হয়েছে 'আনন্দবাজার পত্রিকা'য়। যার মধ্যে উল্লেখযোগ্য হল-- কৃষ্ণা রায়ের 'সাহেবরা প্রথমে গুরুত্ব দেননি তাঁর ওষুধকে' শীর্ষক নিবন্ধ।[৮] উপেন্দ্রনাথ ব্রহ্মচারীর জীবনের গুরুত্বপূর্ণ ঘটনাগুলির পাশাপাশি লেখক তুলে ধরেছেন তাঁর উদার মনোভাবের কথা। বিজ্ঞান পত্রিকা 'সায়েন্স ও কালচার'-এর মূল পৃষ্ঠপোষক ছিলেন তিনি। ১৮৭৩ সালের ১৯ ডিসেম্বর তারিখকে মান্য করে উপেন্দ্রনাথ ব্রহ্মচারীর জন্মসার্ধশতবর্ষ পালন করা হয়েছে একথা আমরা সকলেই জানি। যদিও আমরা ভিন্ন মত পোষণ করি। কলেজের রেকর্ডবুকে তাঁর জন্মসাল ১৮৭৫। যাইহোক, দ্য সায়েন্স অ্যাসোসিয়েশন অব বেঙ্গল ও নীলরতন সরকার মেডিক্যাল কলেজ কর্তৃপক্ষের 'সার্ধশতবর্ষে' উপেন্দ্রনাথ স্মরণ-উদ্যোগের কথা জানতে পারি ১৬ ডিসেম্বর ২০২৩ তারিখের 'আনন্দবাজার পত্রিকা' থেকে। ১২ ডিসেম্বর ২০১৯ সালে বিনয় বিশ্বাস 'আনন্দবাজার পত্রিকা'-য় একটি চিঠি লেখেন 'কালাজ্বর নির্মূল প্রকল্প' (১০ ডিসেম্বর) প্রতিবেদনে উপেন্দ্রনাথ ব্রহ্মচারীর অনুপস্থিতি লক্ষ করে। সেইসূত্রে পত্রলেখক উল্লেখ করেছেন উপেন্দ্রনাথের ইউরিয়া স্টিবামাইন আবিষ্কার, ব্রহ্মচারী রিসার্চ ইন্সটিটিউট স্থাপন, নোবেল পুরস্কারে নাম প্রস্তাব, নাইট উপাধি প্রাপ্তি প্রভৃতি বিষয়। আর এভাবেই স্মরণ-বিস্মরণের মধ্য দিয়ে নতুনভাবে প্রাসঙ্গিক হয়ে উঠছেন হুগলি মহসিন কলেজের প্রাক্তনী স্যার উপেন্দ্রনাথ ব্রহ্মচারী। সংবাদ থেকে কাব্যে উত্তরণের এই পথটুকু আবিষ্কার করতে চেয়েই আক্ষরিক-আয়নার মুখোমুখি হয়েছি আমরা, এবার আত্ম-আবিষ্কারের পালা...

তথ্যসূত্র:

১. 'প্রবাসী', ২৩শ ভাগ, ১ম খণ্ড, ৩য় সংখ্যা, আষাঢ় ১৩৩০, পৃ: ৪৩১

২. রাজভক্তউপেন্দ্রনাথব্রহ্মচারী: হাঁসজারু-পুঁজিতন্ত্ররবিড়ম্বনা – ৪নম্বরপ্ল্যাটফর্ম

৩. 'প্রবাসী', ৪৩শ ভাগ, ২য় খণ্ড, ষষ্ঠ সংখ্যা, চৈত্র ১৩৫০, পৃ: ৫১১

৪. 'প্রবাসী', ফাল্গুন, ৪৫শ ভাগ, ২য় খণ্ড, ৫ম সংখ্যা, ১৩৫২, পৃ: ৩৯২

৫. 'যুগান্তর', ৮ই ফেব্রুয়ারি ১৯৪৬, পৃ: ২

৬. 'উপেক্ষিত চিকিৎসক-গবেষক উপেন্দ্রনাথ ব্রহ্মচারী', শ্যামল চক্রবর্তী, অক্ষর পাবলিকেশানস্, ত্রিপুরা ও কলকাতা, প্রথম প্রকাশ, ফেব্রুয়ারি ২০২৪, পৃ: ১২২

৭. 'কোচবিহার দর্পণ', ফাল্গুন ১৩৫২, ৮ম বর্ষ ১১শ সংখ্যা, পৃ: ৪৯২

৮. https://www.anandabazar.com/rabibashoriyo/upendranath-brahmachari-doctor-who-discovered-medicines-to-treat-kala-azar/cid/1483824

কৃতজ্ঞতা স্বীকার : আশিস কুমার বসু

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

উপেন্দ্রনাথ ব্রহ্মচারীর ইউরিয়া স্টিবামিন: ঔপনিবেশিক ভারতে চিকিৎসা বিজ্ঞানের এক যুগান্তকারী উদ্ভাবন

*ড. অতনু সাহা[1] এবং ড. পিয়ালী ঘোষ[2]

[1]সহকারী অধ্যাপক

স্নাতকোত্তর শারীরবিদ্যা বিভাগ, হুগলি মহসিন কলেজ

[2]সহযোগী অধ্যাপক

রসায়ন বিভাগ, নবগ্রাম হীরালাল পল কলেজ

*যোগাযোগকারী লেখকের email:

atanu.physiol@gmail.com dchaudhuribangla@gmail.com

Received : 18:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

সারাংশ: উপেন্দ্রনাথ ব্রহ্মচারী ছিলেন এক বিশিষ্ট বাঙালি চিকিৎসাবিজ্ঞানী ও গবেষক, যিনি ভারতীয় চিকিৎসা বিজ্ঞানে এক নতুন দিগন্তের সূচনা করেন। তাঁর সবচেয়ে গুরুত্বপূর্ণ আবিষ্কার ছিল ইউরিয়া স্টিবামিন—একটি রাসায়নিক যৌগ যা কালাজ্বর রোগের প্রতিষেধক হিসেবে ব্যবহৃত হয়। উনিশ শতকের শুরুর দিকে ভারতবর্ষে কালাজ্বর এক প্রাণঘাতী মহামারী রূপে ছড়িয়ে পড়েছিল। এই পরিস্থিতিতে ব্রহ্মচারীর গবেষণার ফলাফল ছিল যুগান্তকারী। ইউরিয়া স্টিবামিন ব্যবহারে লক্ষ লক্ষ মানুষের প্রাণ রক্ষা সম্ভব হয় এবং চিকিৎসা বিজ্ঞানে একটি নতুন দৃষ্টান্ত স্থাপিত হয়। এই আবিষ্কার শুধু ভারতে নয়, আন্তর্জাতিক পরিসরেও উচ্চ প্রশংসা লাভ করে এবং ঔপনিবেশিক ভারতের বৈজ্ঞানিক অবদানকে বিশ্বদরবারে তুলে ধরে। এই প্রবন্ধে উপেন্দ্রনাথ ব্রহ্মচারীর ইউরিয়া স্টিবামিন আবিষ্কারের প্রেক্ষাপট, তার বৈজ্ঞানিক গুরুত্ব এবং পরবর্তী সময়ে চিকিৎসাক্ষেত্রে এর প্রভাব নিয়ে আলোচনা করা হয়েছে।

ভূমিকা

ভারতীয় চিকিৎসাবিজ্ঞানের ইতিহাসে উপেন্দ্রনাথ ব্রহ্মচারীর নাম স্বর্ণাক্ষরে লেখা থাকবে। তিনি ছিলেন একজন অসাধারণ বাঙালি চিকিৎসক, বিজ্ঞানী ও গবেষক, যিনি কেবল ভারতবর্ষ নয়, সমগ্র বিশ্বজুড়ে চিকিৎসাবিজ্ঞানে গুরুত্বপূর্ণ অবদান রেখেছেন। তাঁর সবচেয়ে উল্লেখযোগ্য আবিষ্কার হলো "ইউরিয়া স্টিবামিন"—একটি রাসায়নিক যৌগ যা কালাজ্বর (visceral leishmaniasis) চিকিৎসায় ব্যবহৃত হতো। এই প্রবন্ধে উপেন্দ্রনাথ ব্রহ্মচারীর আবিষ্কার, বিশেষত ইউরিয়া স্টিবামিনের উদ্ভাবন এবং মেডিকেল সায়েন্সে তার প্রভাব আলোচনা করা হবে।

উপেন্দ্রনাথ ব্রহ্মচারী: সংক্ষিপ্ত জীবনী

উপেন্দ্রনাথ ব্রহ্মচারী জন্মগ্রহণ করেন ১৮৭৩ সালের ১৯শে ডিসেম্বর, সরকারি নথি হিসাবে ১৮৭৫ সালের ৭ই জুন বিহারের জামালপুরে, মতান্তরে পূর্বস্থলী। তাঁর পিতা ডা. নীলমণি ব্রহ্মচারী ছিলেন জামালপুরে ইস্ট ইন্ডিয়ান রেলওয়ের একজন চিকিৎসক এবং তাঁর মাতা ছিলেন শ্রীমতি সৌরভ সুন্দরী দেবী [1]।

শৈশবে উপেন্দ্রনাথ তাঁর স্কুল শিক্ষা সম্পন্ন করেন ইস্টার্ন রেলওয়ে বয়েজ হাই স্কুলে। এরপর তিনি বর্তমানে হুগলি মহসিন কলেজ ভর্তি হন এবং ১৮৯৩ সালে গণিত ও রসায়নে অনার্সসহ বি.এ ডিগ্রি লাভ করেন। পরের বছর, তিনি কলকাতার প্রেসিডেন্সি

কলেজ থেকে রসায়নে এম.এ ডিগ্রি অর্জন করেন। এরপর তিনি কলকাতা মেডিক্যাল কলেজে ভর্তি হয়ে ১৮৯৯ সালে চিকিৎসা ও সার্জারিতে লাইসেন্সিয়েট ডিগ্রি এবং ১৯০০ সালে ডাক্তারি ডিগ্রি লাভ করেন। ১৯০২ সালে তিনি ডাক্তারি শাস্ত্রে এমডি ডিগ্রি এবং ১৯০৪ সালে কলকাতা বিশ্ববিদ্যালয় থেকে শারীরবিদ্যায় পিএইচ.ডি ডিগ্রি অর্জন করেন।

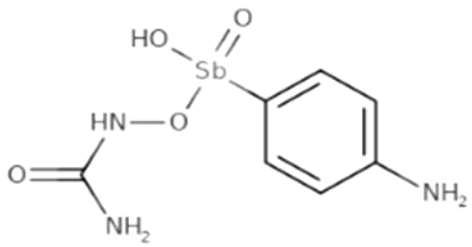
চিকিৎসাশাস্ত্রে পড়াশোনা শেষ করার পর তিনি ১৯০১ থেকে ১৯০৫ সাল পর্যন্ত ঢাকা মেডিক্যাল স্কুলে শারীরবিদ্যা ও ম্যাটেরিয়া মেডিকার শিক্ষক হিসেবে নিযুক্ত হন। এরপর ডা. ব্রহ্মচারী ক্যাম্পবেল মেডিক্যাল স্কুলে (বর্তমানে নীলরতন সরকার মেডিক্যাল কলেজ) যোগ দেন এবং ১৯২৭ সালে কলকাতা মেডিক্যাল কলেজ থেকে অবসর গ্রহণ করেন। অবসর নেওয়ার পর তিনি কারমাইকেল মেডিক্যাল কলেজ, কলকাতায় ট্রপিক্যাল ডিজিজ বিভাগের অধ্যাপক হিসেবে যোগ দেন।

কালাজ্বর: এক প্রাণ সংশয়কারী ব্যাধি

উনিশ শতকের শেষ দিকে এবং বিশ শতকের শুরুতে ভারতবর্ষে কালাজ্বর বা visceral leishmaniasis এক মরণব্যাধি হিসেবে ছড়িয়ে পড়েছিল। কালাজ্বরের প্রকোপ ছিল বিশেষত বিহার ও বাংলার গ্রামাঞ্চলে। এই রোগের কারণে কয়েক হাজার লোকের মৃত্যু হয়। এটি একটি পরজীবীঘটিত রোগ যা Leishmania donovani নামক প্রোটোজোয়া দ্বারা হয় এবং বালির মাছি (sandfly) এর মাধ্যমে ছড়ায়। সেইসময় ভারতবর্ষের অর্থনৈতিক অবস্থা ও চিকিৎসা পরিকাঠামো খুবই দুর্বল ছিল। ফলে তৎকালীন সময়ে এই রোগের কার্যকর কোনো প্রতিকার ছিল না। ইউরোপীয় ও ব্রিটিশ চিকিৎসকরা অনেকবার চেষ্টা করেও কার্যকর ওষুধ আবিষ্কার করতে ব্যর্থ হয়েছিলেন। ঠিক সেই সময়েই উপেন্দ্রনাথ ব্রহ্মচারী ইতিহাস গড়ে তুললেন।

কালাজ্বর: এক প্রাণ সংশয়কারী ব্যাধি

উনিশ শতকের শেষ দিকে এবং বিশ শতকের শুরুতে ভারতবর্ষে কালাজ্বর বা visceral leishmaniasis এক মরণব্যাধি হিসেবে ছড়িয়ে পড়েছিল। কালাজ্বরের প্রকোপ ছিল বিশেষত বিহার ও বাংলার গ্রামাঞ্চলে। এই রোগের কারণে কয়েক হাজার লোকের মৃত্যু হয়। এটি একটি পরজীবীঘটিত রোগ যা Leishmania donovani নামক প্রোটোজোয়া দ্বারা হয় এবং বালির মাছি (sandfly) এর মাধ্যমে ছড়ায়। সেইসময় ভারতবর্ষের অর্থনৈতিক অবস্থা ও চিকিৎসা পরিকাঠামো খুবই দুর্বল ছিল। ফলে তৎকালীন সময়ে এই রোগের কার্যকর কোনো প্রতিকার ছিল না। ইউরোপীয় ও ব্রিটিশ চিকিৎসকরা অনেকবার চেষ্টা করেও কার্যকর ওষুধ আবিষ্কার করতে ব্যর্থ হয়েছিলেন। ঠিক সেই সময়েই উপেন্দ্রনাথ ব্রহ্মচারী ইতিহাস গড়ে তুললেন।



ইউরিয়া স্টিবামিন এর রাসায়নিক গঠন

রসায়নের দৃষ্টিতে ইউরিয়া স্টিবামিন

ইউরিয়া স্টিবামিন হল অর্গানিক অ্যান্টিমনি যৌগ, যা স্টিবামিন শ্রেণির অধীনে পড়ে। এই যৌগে অ্যান্টিমনি (Sb) ধাতু একটি মূল উপাদান হিসেবে কাজ করে এবং এটি ইউরিয়া মলিকিউলের সঙ্গে যুক্ত হয়ে অণুজীব ধ্বংস করে। অ্যান্টিমনির দুই ধরণের জারক সংখ্যা আছে, +5 এবং +3। অণুজীবের কোষে অ্যান্টিমনির জারণ সংখ্যার পরিবর্তন হয় এবং এই পরিবর্তন অণুজীবের দেহকোষকে ধ্বংস করার ক্ষেত্রে খুব

গুরুত্বপূর্ণ ভূমিকা নেয়। উপযুক্ত রাসায়নিক পদ্ধতির সাহায্যে এমন একটি মেডিসিনাল গুণ সম্পন্ন জৈব-যৌগ সংশ্লেষ করার ক্ষেত্রে তাঁর গভীর জ্ঞানের পরিচয় পাওয়া যায়।

মেডিকেল সায়েন্সে এর প্রভাব

কালাজ্বর নিয়ন্ত্রণে যুগান্তকারী অবদান:

ইউরিয়া স্টিবামিনের আবিষ্কারের ফলে কালাজ্বর ব্যাধির চিকিৎসা করা সম্ভব করা হয়। ১৯২০-এর দশকে ভারতবর্ষে যে বিশাল সংখ্যক মানুষের প্রাণহানি ঘটছিল, তা অনেকটাই রোধ হয় এই ওষুধ ব্যবহারের মাধ্যমে [3, 4]।

স্বনির্ভর গবেষণার দৃষ্টান্ত:

ব্রহ্মচারী নিজের পরীক্ষাগারেই এই ওষুধ উদ্ভাবন করেছিলেন, কোনো বিদেশি সাহায্য বা বড় গবেষণাগার ছাড়াই। তিনি প্রমাণ করেছিলেন যে স্বনির্ভর গবেষণা করেও আন্তর্জাতিক মানের আবিষ্কার সম্ভব। এই সকল গবেষণা অনেক ক্ষেত্রে গবেষকদের উদ্বুদ্ধ করে।

ভারতীয় বিজ্ঞানীদের জন্য প্রেরণা:

উপেন্দ্রনাথ ব্রহ্মচারীর কাজ ভবিষ্যতের বহু ভারতীয় বিজ্ঞানী ও গবেষককে উদ্বুদ্ধ করেছে। তাঁর উদ্ভাবনী শক্তি এবং বিজ্ঞানমনস্কতা একাধিক প্রজন্মের চিকিৎসাবিজ্ঞানী ও গবেষকদের জন্য পথপ্রদর্শক হিসেবে কাজ করেছে।

ফার্মাকোলজির ক্ষেত্রে নতুন দিগন্ত:

তাঁর গবেষণা প্রমাণ করেছিল যে অ্যান্টিমনি-ভিত্তিক যৌগ জীবাণুনাশক হিসেবে কার্যকর হতে পারে, যা পরবর্তীতে আরও গবেষণার ভিত্তি স্থাপন করেছিল।

আন্তর্জাতিক স্বীকৃতি ও সম্মান

উপেন্দ্রনাথ ব্রহ্মচারীর এই অসামান্য অবদানের জন্য তিনি ভারত সরকারের পক্ষ থেকে নাইট উপাধি (Sir) লাভ করেন ১৯৩৪ সালে। এছাড়া, তিনি নোবেল পুরস্কারের জন্য মনোনীত হন, যদিও শেষ পর্যন্ত পুরস্কার তিনি পাননি। তবে তাঁর কাজ আন্তর্জাতিকভাবে স্বীকৃত এবং প্রশংসিত হয় [5]।

বর্তমান প্রেক্ষাপটে প্রাসঙ্গিকতা

আজকের দিনে যদিও ইউরিয়া স্টিবামিন ব্যবহৃত হয় না এবং আরও আধুনিক ওষুধ ব্যবহার করা হয়, তবে চিকিৎসাবিজ্ঞানের ইতিহাসে এটি একটি মাইলফলক। উন্নয়নশীল দেশে সংক্রামক রোগের বিরুদ্ধে স্থানীয় চিকিৎসাবিজ্ঞানীদের গবেষণার গুরুত্ব আজও অপরিসীম, আর ব্রহ্মচারীর জীবন তারই প্রকৃষ্ট উদাহরণ [6]।

উপসংহার

উপেন্দ্রনাথ ব্রহ্মচারী শুধু একজন চিকিৎসক বা গবেষকই ছিলেন না, তিনি ছিলেন মানবতার সেবায় নিবেদিত এক মহান বিজ্ঞানী। ইউরিয়া স্টিবামিন আবিষ্কারের মাধ্যমে তিনি লাখো মানুষের প্রাণ বাঁচিয়েছেন এবং চিকিৎসাবিজ্ঞানে এক নতুন অধ্যায়ের সূচনা করেছেন। ভারতীয় বিজ্ঞান ও চিকিৎসাক্ষেত্রে তাঁর অবদান চিরস্মরণীয়। তাঁর জীবন ও কাজ আজও আমাদের অনুপ্রেরণার উৎস এবং তাঁর মতো বিজ্ঞানীদের কাজ অনুসরণ করেই আগামী দিনে আরও স্বাস্থ্যবান ও বিজ্ঞানমনস্ক সমাজ গঠনের স্বপ্ন দেখা যায়।

তথ্যসূত্র:

1. **Brahmachari, U. N.** (1922). *"A new method of treatment of kala-azar: With an introduction of urea stibamine."* The Indian Medical Gazette, Vol. 57, pp. 285–288.

2. **Biswas, B. C.** (1988). *"Dr. U.N. Brahmachari and the conquest of kala-azar."* Indian Journal of History of Science, Vol. 23, pp. 178–182.

3. Mukherjee, S. (2010). *"Science and Nationalism in Colonial India: A Historical Review."* Indian Journal of History of Science, Vol. 45, pp. 313–329.

4. Sen, S. (2005). *"Science in Colonial India."* New Delhi: Oxford University Press.

5. The Asiatic Society, Kolkata – উপেন্দ্রনাথ ব্রহ্মচারী সম্পর্কিত জীবনীমূলক প্রবন্ধ এবং আর্কাইভ সংরক্ষণাগার।

National Institute of Communicable Diseases (NICD), India – কালাজ্বর রোগ এবং এর ইতিহাস সম্পর্কিত সরকারি নথিপত্র ও প্রতিবেদন।

Volume : 12 No. 1 & 2
June, 2025

Caraka Saṃhitā and its Relevance in Public Health Sector: A Study

Dr. Sanchita Kundu[1], [*]Dr. Shreyasee Majumdar[2],

1. Assistant Professor, Department of Sanskrit, Hooghly Mohsin College, Chinsurah, Hooghly
2. Assistant Professor, Department of Philosophy, Hooghly Mohsin College, Chinsurah, Hooghly
** Corresponding author: Dr. Shreyasee Majumdar (shreyasee.m15@gmail.com).*

Received : 01:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract: Improved health care is an important aspect of a prospering country. In this relation we are reminded of U.N.Brahmacari, hailed from West Bengal, India who was nominated several times for Nobel Prize in physiology or medicine. He contributed a lot in medical field. India from ancient times was gifted with brilliant scholars who contributed largely to health-care. Ayurveda among other system of medicine has a great impact in public health sector. Dhanvantarī the physician of the gods according to Hindu mythology is considered as the father of Āyurveda. Ācārya Caraka, a well-known physician, is credited to have revised the original *Agniveśa Saṃhitā*, that later came to be known as *Caraka Saṃhitā* - a magnum opus of *Āyurveda śāstra*. Caraka opined that disease results due to imbalance in three dosās (vāta, pitta, kapha) and that can be restored through medicine. *Caraka Saṃhitā* offers more than medicinal knowledge—it maps a philosophy of life, rooted in balance, observation, and the rhythms of nature. It not only enriches our understanding of traditional healing but also offers timeless guidance for shaping a more balanced, patient-centred, and sustainable model of health in the modern world. This paper aims to highlight the relevance of *Caraka Saṃhitā* in public health sector in modern days and how it can lead to well-being at large.

In today's critical scenario where illness is rampant in every family and economic inflation gaining force, *Caraka Saṃhitā* and its invaluable messages and simple techniques can usher a new horizon for public health sector.

Keywords: *Caraka Saṃhitā, Sushruta Saṃhitā*, Āyurveda, Ashtānga Sthānas, Dināchārya, Rituchārya

Introduction:

While discussing about public health and well-being, contribution of U.N. Brahmachari can never be forgotten. He discovered urea stibamine that brought a revolution in treatment of kala-azar, saving millions of lives. His work greatly improved healthcare in India. From ancient time India is blessed with brilliant physicians and scholars who worked for the well-being of mankind and contributed largely to public health sector. Ācārya Caraka, the father of General Medicine and Ācārya Suśruta, the father of Surgery are important figures of medical science in ancient India. *Caraka Saṃhitā* along with *Suśruta Saṃhitā* is earlier texts of Ayurveda, a branch of Atharvaveda. *Caraka Saṃhitā* deals with General medicine while Suśruta *Saṃhitā* deals with surgery and its related techniques.[1] The *Caraka Saṃhitā* is the oldest known Hindu text on Ayurveda (Ayur=Life + Veda=Science i.e Life science). Life has progressed a lot; people are keen in adopting sophisticated and luxurious lifestyle. Some may think that *Caraka Saṃhitā* written thousands of years ago is hardly relevant in today's modern world. But the scenario is different. People have not advanced in true sense- they fail to grasp the true essence of life. The world has not yet been disciplined in the major aspects

of life. Modern individuals—men and women alike—no longer realise the interconnectivity of mind, body, nature, and spirit. They are drawn to the sensuous allure of a commercial world that promises quick returns and instant healing. In their eyes, all that glitters is gold—leaving little regard for nature's all-encompassing rhythm and the time it demands for true alignment. This attitude stands in stark contradiction to the very essence of the *Caraka Saṃhitā*: the fulfilment of the self through a profound understanding of the mind, the body, and the spiritual necessity that shapes the complete human being. But what does that fulfilment truly mean? To grasp it, one must journey back to the millennia-old Vedic age—specifically, to the spiritual heart of the four Vedas and most profoundly, to the Āyurveda**.**

Discussion:

Āyurveda views the body as a manifestation of energy (*prāṇa)*—a vehicle for the soul's journey toward higher states of consciousness, ultimately culminating in Supramental consciousness, which is synonymous with immortality. It does not regard the human body through a materialistic lens, as merely labour for production. Instead, the dictum of the Veda is to uphold the sanctity of body and mind throughout this transitional journey from birth to death.

Rooted in Sānkhya philosophy, Āyurveda sees health as a balance between body (Śarira), mind (Mānaṣa), and spirit (Ātman). The Tridoṣa theory—explaining bodily functions and the root causes of disease—embodies this understanding. Ayurveda places strong emphasis on preventive health care through proper diet (Āhara), lifestyle (Vihāra), and individualized treatment.[2]

The Indian understanding of Ayurveda is inherited, flowing like a quiet river from the ancient wellspring of the *Caraka Saṃhitā*. This revered compendium, both profound and practical, offers more than medicinal knowledge—it maps a philosophy of life, rooted in balance, observation, and the rhythms of nature.

Composed of 120 chapters, the *Caraka Saṃhitā* is divided into eight luminous sections, or Sthānas—each a chamber of wisdom, echoing with the voices of sages, healers, and time itself.

The text begins with the Sūtra Sthāna which comprises of thirty chapters that form the soul of the text. Here, the essence of Ayurveda is laid bare: its foundational beliefs, its holistic view of health, and the mindful approach a physician must adopt.

Then follows the Nidāna Sthāna, a concise yet vital section of eight chapters, where the roots of disease are unearthed. It speaks not only of afflictions but of imbalance—how wind, fire, and earth within us can falter and lead to suffering.

The Vimāna Sthāna is meditative in tone, offering inner instruction to the healer. In its eight chapters lie discussions on taste and digestion, discipline and diet, and the moral preparation required to wield the art of healing wisely.

The Śarira Sthāna, also spanning eight chapters, explores the human form—not as a mere vessel, but as a sacred architecture. Here, the mysteries of birth, the mapping of organs, and the physical-mental connection are gently unfolded.

The twelve chapters of the Indrīya Sthāna are subtle and intuitive. They teach the physician to see beyond the visible—to listen to the body's whispers, to read the omens of decline, and to predict the course of illness from signs often overlooked.

The Cikitsā Sthāna (section on therapeutics) spans thirty chapters of healing methods. Here, the art becomes action—covering diseases from fevers to madness, with treatments that are as intricate as they are compassionate.

In the Kalpa Sthāna twelve chapters guide the preparation of medicines, drawing from earth, forest, and flame. It is a place where roots become remedies, and timing and technique are as critical as the ingredients themselves.

The text culminates in the Siddhi Sthāna —twelve chapters that extend beyond cure, offering a vision of complete well-being. The philosophy that resonates here is that health begets harmony, body is temple and life is a sacred journey.

These eight sections together form the whole of Āyurveda. They do not just teach how to treat disease—they invite the healer to understand life itself, in all its fragility and splendour and systematically addressing the theoretical and practical dimensions of Ayurvedic science.

The Caraka Saṃhitā stands as pioneering and foundational work in the field of Ayurveda, its authority shaped centuries of India's medicinal knowledge tracing back to a compendium by Agniveśa. Agniveśa Saṃhitā attributed to Acharya Agniveśa is an ancient medical text. Ātreya who was believed to be the initiator of Ayurveda had six disciples – Agniveśa, Bhela, Jatukarṇa, Parāsara, Hārita, and Keśarapanī.[3] Each wrote his own Saṃhitā or text, and Agniveśa is said to have had the best version. Caraka is thought to have revised the samhita written by Agnivesa. The revised version is what came to be known as *Caraka Saṃhitā*, which is believed to have taken shape between 100 BCE and 200 CE.[4]

Āyurveda views the body as a manifestation of energy—or prāṇa- a vehicle for the soul's journey toward higher states of consciousness, ultimately culminating in Supramental consciousness, which is synonymous with immortality. It does not consider the human body through a materialistic lens, as merely labour for production rather upholds the sanctity of body and mind through this transitional journey from birth to death.

On Diet and Lifestyle, *Caraka Saṃhitā* in Sūtra Sthāna, 1.45 advises:

āhāravihārasyasantulanaṃjīvanasyayaśasi/
svadharmesannidhāyam-
sarvaṃyatrasukaṃpaśyet//[5]

For a healthy and happy life proper diet and lifestyle are essential. When in harmony with one's own nature, one can achieve a sense of well-being and contentment.

This is a foundational principle in modern wellness practices, where diet and lifestyle management (such as nutrition, sleep hygiene, and exercise) are keys to achieving and maintaining good health.

One of the seminal contributions of the *Caraka Saṃhitā* lies in the discourse of the three doshas—Vāta, Pitta, and Kapha—subtle physiological energies that govern the body's inner workings. This ancient framework comes in line with modern understandings of homeostasis and metabolic equilibrium, forming a philosophical precursor to today's personalized medicine. Caraka's subtle insight into *Prakṛti*, or individual constitution, something strikingly parallels the contemporary focus on genomic-guided therapies and personalized healthcare routines.

Equally important is the idea of Agni, the body's digestive and metabolic fire, which plays a key role in preventing illness in *Āyurveda*. Modern research is now beginning to recognize how vital gut health and a balanced microbiome are for strong immunity and overall well-being—showing just how relevant Ayurvedic wisdom remains today.

The *Caraka Saṃhitā* also focuses on the importance of following daily and seasonal routines—Din*ā*ch*ā*rya and Rituch*ā*rya—to remain aligned in tune with nature's cycles. These practices are now mirrored in modern science, especially in fields like chronobiology and lifestyle medicine, which help manage stress, sleep issues, and metabolic conditions. Modern health experts now support similar routines to help deal with stress, sleep problems, and lifestyle-related diseases.

While *Caraka Saṃhitā* may not provide surgical or emergency solutions, its principles of balance, prevention, and personalization can beautifully complement modern allopathic care. Together, they offer a more comprehensive, human-centric model of healing—one that not only treats disease but also nurtures health.

The wisdom of the *Caraka Saṃhitā*, though rooted in ancient times, continues to hold remarkable relevance in today's healthcare landscape. Its holistic view of health—as a balance between the physical, mental, and environmental—mirrors the growing global shift toward integrative and preventive medicine. On the intricate subject of mental health, his suggestion from the *Caraka Saṃhitā*, Sūtra Sthāna, 16.12:

cittavṛttisamyomātyagadoṣādyupakrameṇaca/
Manovṛttiścaniṣtheyaḥprajñātadvadvidhānikā //[6]

The regulation of mental activities (Citta) leads to greater mental clarity and health, which can be cultivated through proper practices and mindfulness.

This verse is quite relevant in today's world, where mental health issues are on the rise. The practice of mindfulness,

Concepts such as gut health, personalized care, lifestyle regulation, and mind-body harmony, long championed in Āyurveda, are now increasingly recognized in modern clinical research and public health strategies. In this way, the *Caraka Saṃhitā* not only enriches our understanding of traditional healing but also offers timeless guidance for shaping a more balanced, patient -centred, and sustainable model of health in the modern world. Most remarkably, the *Caraka Saṃhitā* explicitly emphasizes the vital need for a pollution-free environment to sustain a healthy life.

In *Caraka Saṃhitā*, Sūtra Sthāna, 5.14 it is described

tuṃburuśaktisaṃyuktā, paryāvaraṇasamāyitā/
rogonāśakarīścaiva,nirāmayatamaṃpriyat//[7]

This verse emphasizes the role of a balanced, well-protected environment—fortified with natural energies—in eliminating disease and promoting optimal health. In modern terms, it highlights how clean air, water, and surroundings contribute significantly to disease prevention and long -term well-being. The verse offers a didactic reminder that health is deeply intertwined with environmental harmony—an idea gaining increasing relevance today.

Further, *Caraka Saṃhitā* has given much emphasis on the role, qualities and duties of Physician in health care sector. Physician is a part and parcel of public health sector. Āchārya Caraka has used various terminologies to designate a Physician: Vaidya, Bhīṣaka, Chikitṣaka, Parīkṣaka. We find description of essential qualities of a physician in two places of *Caraka Saṃhitā* - in the 9th chapter of Sūtra sthāna and 8th chapter of Vimāna sthāna. The important qualities of a physician as highlighted by Caraka are: Excellence in medical knowledge, an extensive practical experience, dexterity, purity of mind and character, Infallibility of prescriptions, all the requisite equipment, possession of normal sense faculties, knowledge of various natural manifestations and presence of mind. The first four are essential qualities while the later five qualities are more advanced qualities which too are required for being a good physician.

Conclusion:

The *Caraka Saṃhitā's* teachings provide enduring insights that remain remarkably relevant in today's world. By emphasizing balance in all aspects of life, including diet, lifestyle, mental health, and environmental harmony, it resonates with contemporary wellness movements and integrative healthcare practices. As society increasingly prioritizes the interconnectedness of mind and body, holistic health approaches, and proactive prevention, the ancient wisdom of Āyurveda, as captured in the *Caraka Saṃhitā* offers a profound framework for achieving optimal health and well-being.

References

1. Sharma, Nayana, (2015) "Charaka Samhita and Sushruta Samhita" *Wisdom Library*, https://www.wisdomlib.org/hinduism/essay/charaka-samhita-and-sushruta samhita/d/doc1146960.html
2. Guha, Amala (2007), "What is the Philosophy of Ayurvedic medicine", *Taking charge of your wellbeing*, https://www.takingcharge.csh.umn.edu
3. Sebastian, C.D (2021) "Ayurveda and the medical knowledge in ancient India: Shadows and realities", *Indian Journal of Medical Ethics,* DOI: 10.20529/IJME.2021.085
4. Meulenbeld, G.L, (1999) *History of Indian Medical Literature, Vol IA*, Groningen: Forsten, p.114
5. "आहारविहारस्यसन्तुलनंजीवनस्ययशसि/ स्वधर्मेसन्निधायंसर्वंयत्रसुखंपश्येत्॥//", Agniveśa, (1948) *Caraka Saṃhitā*, translated by Kaviraj Atridev Gupta, Varanasi: Bhargav Pustakalay, p.8
6. "चित्तवृत्तिसंयमात्योगदोषाद्युपक्रमेणच/ मनोवृत्तिश्चनिष्ठेय: प्रज्ञांतद्वद्विधानिका॥", Ibid, p.167
7. "तुंबुरुशक्तिसंयुक्ता, पर्यावरणसमायिता। रोगनाशकरीश्चैव, निरामयतमंप्रियत्॥", Ibid, p.68

Bibliography

1. Adarsh K R & Sunitha G R (2021), "*Charaka Samhita* in the light of Ganitha Shastra". *International Journal of Ayurveda and Pharma Research*, DOI: https://doi.org/10.47070/ijapr.v9i10.2079
2. Adarsh K R (2024), "The Ancient Art of Discussion: Insights from Charaka Samhita" *International Journal of Ayurveda and Pharma Research*, DOI: https://doi.org/10.47070/ijapr.v12i8.3327
3. Agniveśa, (1948) *Caraka Saṃhitā*, translated by Kaviraj Atridev Gupta, Varanasi: Bhargav Pustakalay.
4. Augustyn, Adam, (2025), "Ayurveda –medical system", https://www.britannica.com/science/Ayurveda accessed on 14.04.2025.
5. Bhavana, K.R & Shreevathsa (2014), "Medical geography in *Caraka Samhita"*, *An International Quarterly Journal of research in Ayurveda,* DOI: 10.4103/0974-8520.158984
6. Dutta, B, kumar V, & Sharma, R (2021), "Contribution to Charaka and Sushruta Samhita in the field of kaumarbhritya", *World Journal of Pharmaceutical and Medical Research, wjpmr, 2021,7(10),61-64, ISSN 2455-3301,* www.wjpmr.com accessed on 14.04.2025.
7. Guha, Amala (2007), "What is the Philosophy of Ayurvedic medicine", *Taking charge of your wellbeing*, https://www.takingcharge.csh.umn.edu
8. Majumder, B., & Roy, S.(2022)."Qualities of physician in light of carakasamhita – A literary study", *International Research Journal of Ayurveda and Yoga*
9. Meulenbeld, G.L, (1999) *History of Indian Medical Literature, Vol IA*, Groningen: Forsten.
10. Rogers, Kara (2012), "Charaka-samhita: Indian medical text", https://www.britannica.com/topic/Charaka-samhita accessed on 14.04.2025.
11. Saha.P, Chaudhury.A, Majhi.AK,(2021) "Sir U.N.Brahmacari and his battle against Kala-Azar" *Tropical Parasitology*, DOI: 10.4103/tp.tp 48 21.
12. Sebastian, C.D (2021) "Ayurveda and the medical knowledge in ancient India: Shadows and realities", *Indian Journal of Medical Ethics,* DOI: 10.20529/IJME.2021.085
13. Sharma, P.V., (1998). *Caraka Saṃhitā*, Varanasi: Chaukhamba Orientalia.
14. Sharma, R.K & Dash, Bhagwan (2018), *Caraka Saṃhitā Vol-I*, Varanasi: Choukhamba Sanskrit Series
15. Sharma, Nayana, (2015) "Charaka Samhita and Sushruta Samhita" *Wisdom Library*, https://www.wisdomlib.org/hinduism/essay/charaka-samhita-and-sushruta samhita/d/doc1146960.html

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

বাঙালির বিজ্ঞান সাধনার প্রথমপর্ব ও উপেন্দ্রনাথ ব্রহ্মচারী

ড. অনন্য ভট্টাচার্য
সহকারী অধ্যাপক, বাংলা বিভাগ, হুগলি মহসিন কলেজ
ananya.bangla@gmail.com

Received : 19:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

উনিশ শতকের প্রথম প্রহর থেকেই নবচেতনার আলোকিত উদ্ভাসে স্পন্দিত হয়েছিল বাঙালির মন-মনন ও চৈতন্য। শিকড়-সন্ধানী বাঙালি সেই সময় প্রতীচ্যের জ্ঞান-বিজ্ঞান-সাহিত্য-শিল্পকলার আলোকে খুঁজে ফিরছে আত্মপরিচয় ও আত্ম-অভিজ্ঞান। শিক্ষিত জনসমাজের এক বড়ো অংশ তখন যুক্তিবাদী মনন ও চেতনার কষ্টিপাথরে যাচাই করে নিচ্ছে চিরকালের আচার-প্রথা ও সংস্কারের যৌক্তিকতা। এরই সঙ্গে বিজ্ঞানচর্চার সূত্রে বাঙালি তার বৈজ্ঞানিক মনন ও এষণার মধ্য দিয়ে বিজ্ঞান গবেষণার নতুন দিগন্ত সৃষ্টিতে তৎপর হয়ে উঠেছে।

অবশ্যই এর অন্যতম কারণ ছিল উনবিংশ শতকের জাতীয়তাবাদী স্বাদেশিক প্রেরণা। মেধাবী তরুণ বাঙালি বিজ্ঞানীরা বিজ্ঞান সাধনায় আত্মনিয়োগ করেছিলেন মূলত দেশ ও সমাজসেবার ঐকান্তিক প্রেষণা থেকেই। বিজ্ঞানী মাত্রেই সত্যান্বেষক। জড় ও জীবজগতের রহস্যের কারণ সন্ধানই তাঁদের কাজ। কিন্তু এই কাজের সঙ্গে সামাজিক দায়ও যুক্ত থাকে। বিশেষ করে পরাধীন ভারতে ঔপনিবেশিক সমাজ কাঠামোর মধ্যে থাকা অশিক্ষা ও স্বাস্থ্যহীনতার কারণে পঙ্গু ও দুর্বলতর স্বদেশবাসীর বৌদ্ধিক ও শারীরিক অক্ষমতা ও হীনম্মন্যতা দূর করে একটি সবল সক্ষম জাতি হিসেবে ভারতবাসী ও বাঙালিকে গড়ে তোলার অন্তর্গূঢ় বাসনা বরাবরই সক্রিয় ছিল নবচেতনার আলোকপ্রাপ্ত বাঙালি বিজ্ঞানীদের মধ্যে।

উনিশ শতকের প্রথমপর্বে এদেশে যতটুকু বৈজ্ঞানিক গবেষণা ও আবিষ্কার হয়েছিল তার সমস্ত সুফলটুকু ভোগ করেছে ব্রিটিশ সাম্রাজ্যবাদী শাসকেরা। বিজ্ঞানীদের গবেষণালব্ধ আবিষ্কারকে তারা কখনই দেশীয় মানুষের স্বার্থে মানবসেবার কাজে নিয়োজিত করেননি। বৈজ্ঞানিক আবিষ্কারকে পেটেন্টের মাধ্যমে সুরক্ষিত করে তাকে লাভজনক ব্যবসায়িক স্বার্থে ব্যবহার করাই ছিল তাদের মুখ্য উদ্দেশ্য। অশিক্ষা ও অজ্ঞানতার কারণে নানাধরণের সংক্রামক ব্যাধি ও মহামারীর প্রকোপে পড়ে বাংলার গ্রামের মানুষের তখন মুমূর্ষুদশা। ম্যালেরিয়া, কলেরা, ডেঙ্গি, কালাজ্বরের মতো সংক্রামক ও প্রাণঘাতী রোগের আতঙ্ক নিয়েই তখন প্রতিদিনের যাপনকর্ম। বাঙালি বিজ্ঞানীরা উপলব্ধি করেছিলেন, নানাধরণের আধি-ব্যাধির সঙ্গে প্রতিনিয়ত লড়াই করে বেঁচে থাকা ক্ষীণজীবী বাঙালি জাতির পক্ষে কোনও গঠনমূলক কাজই হওয়া সম্ভব নয়। কারণ স্বাস্থ্যহীন, রুগ্নজাতি কখনই দেশ ও জাতির উন্নতি ও বিকাশের সহায়ক হতে পারে না। ফলত নানাধরণের বৈজ্ঞানিক গবেষণার মধ্য দিয়ে সংক্রামক ও মহামারীর প্রতিরোধে উপযুক্ত চিকিৎসা পদ্ধতির আবিষ্কার করে তাকে মানবসেবায় নিয়োজিত করা অনেক বাঙালি বিজ্ঞানীদের কাছেই এক পবিত্র দায় হয়ে উঠেছিল।

বিজ্ঞানচর্চা ও গবেষণার প্রাথমিক পর্যায়ে শিক্ষিত মেধাবী বাঙালি তরুণদের বিজ্ঞান-গবেষণায় উৎসাহিত করতে উদ্যোগী হয়েছিলেন রামমোহন রায়। পরবর্তীকালে মহেন্দ্রলাল সরকার, লাফো, আশুতোষ মুখোপাধ্যায়, জগদীশচন্দ্র বসু, প্রফুল্লচন্দ্র রায়ের অনুপ্রেরণায় জাতীয়তাবাদী বিজ্ঞানচর্চার ক্ষেত্রটি প্রস্তুত হয়েছিল। একসময় বাঙালি বিজ্ঞানীদের একক ও যৌথ প্রচেষ্টায় তৈরি হল নানা ধরণের বিজ্ঞান গবেষণা কেন্দ্র। ব্রিটিশ সরকার বাঙালি বিজ্ঞানীদের গবেষণার জন্য পর্যাপ্ত আর্থিক সহযোগিতা করেনি কখনও।

বৈজ্ঞানিক গবেষণায় নিযুক্ত বাঙালিরা গবেষণার উপযুক্ত পরিকাঠামোটুকুও পাননি। বাঙালি বিজ্ঞানী ও ইউরোপীয় বিজ্ঞানীদের মধ্যে বেতন বৈষম্যেও ছিল দুস্তর পার্থক্য। তবু নানাধরণের আর্থিক-সামাজিক প্রতিকূলতার মধ্যেও একজন তন্নিষ্ঠ আদর্শবান দেশব্রতী হিসেবেই বাঙালি বিজ্ঞান-সাধকরা দেশসেবার লক্ষ্যে গবেষণাকর্ম চালিয়ে গেছেন অক্লান্তভাবে। এক্ষেত্রে মনে পড়ে যায় জগদীশচন্দ্র বসুর উক্তিটি : 'অবসাদ দূর করিতে হইবে। দুর্বলতা ত্যাগ করিতে হইবে। ভারতই আমাদের কর্মভূমি, সহজপন্থা আমাদের জন্য নহে।'[১]

উনিশ শতকের জাতীয়তাবাদী বিজ্ঞানচর্চার পরম্পরা সূত্রেই উপেন্দ্রনাথ ব্রহ্মচারীর মতো এক প্রথিতযশা চিকিৎসা-বিজ্ঞানীর আবির্ভাব হয়েছিল। হুগলি কলেজ (বর্তমান হুগলি মহসিন কলেজ), প্রেসিডেন্সি কলেজ, কলকাতা বিশ্ববিদ্যালয়ে শিক্ষাজীবনের এক বড়ো অংশ অতিবাহিত হয়েছিল তাঁর। তৎকালীন হুগলি কলেজ ও প্রেসিডেন্সি কলেজের স্বদেশি আবহাওয়া ও জাতীয়তাবাদী চেতনা নিশ্চিতভাবেই তাঁর জাতীয়তাবাদী মনন ও চেতনা তৈরির সহায়ক হয়েছিল। পরবর্তীকালে গবেষণারত অবস্থায় আচার্য প্রফুল্লচন্দ্র রায়ের প্রত্যক্ষ সংস্পর্শে এসে তাঁর স্বাদেশিক বোধ ও চেতনা আরও দৃঢ়মূল হয়। বিজ্ঞানের বহুবিধ শাখায় উপেন্দ্রনাথের স্বচ্ছ¨ গতিবিধি ছিল। উপেন্দ্রনাথ ছিলেন গণিত ও রসায়নের কৃতী ছাত্র ও গবেষক। ভেষজবিদ্যার গবেষণাকর্মেও সক্রিয়ভাবে যুক্ত ছিলেন। কিন্তু জীবনের বেশিরভাগ সময় মূলত শারীরবিদ্যা ও চিকিৎসাবিজ্ঞানের গবেষণায় আত্মনিয়োগ করেছিলেন। এর মূলে ছিল অবশ্যই তাঁর স্বাদেশিক প্রেরণা। অশিক্ষা ও অজ্ঞানতায় আচ্ছন্ন মূঢ়, অসচেতন দেশবাসী, যারা নানা ব্যাধির কবলে পড়ে মুমূর্ষুদশাগ্রস্ত তাদের রোগমুক্তি ঘটিয়ে এক সুস্থ সবল জীবনদান করাই তাঁর কাছে হয়ে উঠেছিল পুণ্যব্রতের মতো।

ব্রিটিশ শাসিত ভারতবর্ষে চিকিৎসাবিজ্ঞানের ছাত্র ও গবেষক হওয়ার তেমন সুযোগ ছিল না ভারতীয় তথা বাঙালি বিজ্ঞানীদের। পরবর্তীকালে উপনিবেশের নানা সংক্রামক ব্যাধি সম্পর্কে ভীত ইংরেজ শাসকেরা চিকিৎসা বিজ্ঞানের ক্ষেত্রটিকে অনেকটাই উন্মুক্ত করে দেয় বাঙালি বিজ্ঞানী ও গবেষকদের জন্য। উপেন্দ্রনাথের সামগ্রিক গবেষণা কর্মের দিকে নিবিষ্টভাবে মনোযোগ দিলে দেখা যায়, মূলত ট্রপিক্যাল ডিজিজের ওপরে গবেষণা করাই ছিল তাঁর প্রধান আগ্রহের বিষয়। রক্ত সম্পর্কিত নানা ধরণের জটিল ও দূর্জ্ঞেয় রোগের কারণ অনুসন্ধানের জন্য গবেষণা করেছেন তিনি আজীবনকাল। তাঁর গবেষণাপত্রের শিরোনাম ছিল 'স্টাডিজ ইন হেমোলাইসিস'।

রক্তবাহিত নানাধরণের সংক্রামক ব্যাধি সম্পর্কে নিরীক্ষা ও গবেষণার সূত্রেই উপেন্দ্রনাথ ব্রহ্মচারী কালাজ্বর সম্পর্কে আগ্রহী হয়ে ওঠেন। এদেশে ম্যালেরিয়ার মতো কালাজ্বরও তখন এক ভীতিপ্রদ সংক্রামক রোগ হিসেবে ত্রাস সৃষ্টি করেছিল সাধারণ মানুষের মধ্যে। এই রোগেরও লক্ষণ অনেকটা ম্যালেরিয়ার মতোই। দীর্ঘমেয়াদি জ্বর, রক্তাল্পতা, যকৃৎ ও প্লীহার বৃদ্ধি, শেষে লোহিত-কণিকার ভাঙন ও অবধারিত মৃত্যু। এদেশের গ্রামীণ গরিব শ্রমজীবী মানুষেরাই ছিল এই রোগের শিকার। মূলত অপুষ্টি, দুর্বলতা ও ভগ্নস্বাস্থ্যের কারণেই এই রোগের জীবাণু সহজেই আক্রমণ করতে পারতো ও দ্রুত বংশবিস্তার করতো মানবশরীরে। তৃতীয় বিশ্বের অনুন্নত দেশের মানুষরাই কালাজ্বরের কবলে পড়ে অসহায়ভাবে আত্মসমর্পণ করতো।

উনিশ শতক থেকে বিশ শতকের মধ্যপর্ব পর্যন্ত (১৮৫৪-১৮৭৩ সাল) গোটা ভারতবর্ষ জুড়ে কালাজ্বরের প্রবল আগ্রাসনে কয়েক লক্ষ মানুষের মৃত্যু হয়েছিল। কালাজ্বর, কালাদুঃখ, দমদম ফিভার— নানা নামে পরিচিত ছিল এই রোগ। বিশিষ্ট ইউরোপীয় বিজ্ঞানী ড. নেপিয়ার, পি.সি. সেনগুপ্ত, রোনাল্ড রসের সঙ্গে উপেন্দ্রনাথ ব্রহ্মচারীও সামিল হন কালাজ্বরের

প্রতিষেধক আবিষ্কারের জন্য। একসময় আবিষ্কার হয় কালাজ্বরের পরজীবী জীবাণু। তারও বহু পরে ১৯২১ সালে ড. উপেন্দ্রনাথ ব্রহ্মচারীর অক্লান্ত গবেষণায় অবশেষে আবিষ্কৃত হল কালাজ্বরের জীবনদায়ী ওষুধ 'ইউরিয়া স্টিবামাইন'। ১৯৪২ সাল পর্যন্ত এই ওষুধের প্রয়োগে কালাজ্বর আক্রান্ত লক্ষ লক্ষ রোগীর প্রাণ বাঁচানো সম্ভব হয়েছিল। বলা যেতে পারে বাঙালির বিজ্ঞানচর্চা ও গবেষণায় ড. উপেন্দ্রনাথ ব্রহ্মচারীর এ এক যুগান্তকারী আবিষ্কার।

এটা ঘটনা যে, আরোগ্য লাভের পরেও ইউরিয়া স্টিবামাইনের পার্শ্ব প্রতিক্রিয়ায় দীর্ঘকাল ধরে অন্যান্য শারীরিক সমস্যায় ভুগতে হয়েছিল কালাজ্বর আক্রান্ত রোগীদের। পার্শ্ব প্রতিক্রিয়া কমিয়ে এই ওষুধকে কিভাবে আরও কার্যকরী ও সফলভাবে প্রয়োগ করা যায় সে বিষয়েও উপেন্দ্রনাথ গবেষণাকর্ম চালিয়ে গেছেন জীবনের অন্তিম প্রহর পর্যন্ত। তাঁর পথ ধরেই পরবর্তীকালে চিকিৎসা-বিজ্ঞানীরা কালাজ্বরের নানা প্রতিষেধক আবিষ্কারে উদ্যোগী ও প্রয়াসী হয়েছিলেন। তবে আক্ষেপের বিষয়, এখনও এদেশে কালাজ্বর থেকে গেছে। ভারতবর্ষে ২০২৩ সালের মধ্যে কালাজ্বর নির্মূলের যে লক্ষ্য ছিল তা সম্পূর্ণ সফল হয়নি।[২]

আগেই বলেছি, বিজ্ঞানের বিবিধ বিষয়ে উপেন্দ্রনাথের আগ্রহ ও সংশ্লিষ্ট বিষয়ে তাঁর প্রজ্ঞাদীপ্ত মননের পরিচয় পাওয়া গেলেও শেষপর্যন্ত এই বিজ্ঞানী -চিকিৎসক চিকিৎসাবিদ্যার গবেষণাতেই নিজেকে সম্পূর্ণ সমর্পণ করেছিলেন। এর অন্তঃস্থিত প্রেরণা ছিল উপেন্দ্রনাথের নিখাদ স্বদেশপ্রেম। চিকিৎসাকে মানবসেবা তথা দেশসেবা হিসেবে গ্রহণ করার অঙ্গীকার করেই ১৮৯৯ সালে স্বাস্থ্যসেবায় সরকারিভাবে নিযুক্ত হয়েছিলেন তিনি। প্রথমে ঢাকা মেডিকেল কলেজ, পরে কলকাতার নীলরতন সরকার মেডিকেল কলেজে একজন নিষ্ঠাবান চিকিৎসক হিসেবে নিরলসভাবে গবেষণা ও চিকিৎসার কাজ করেছেন। ১৯২৭-এ সরকারি কাজ থেকে অবসর নিলেও দেশীয় চিকিৎসাব্যবস্থার উন্নতির জন্য সক্রিয়ভাবে বিভিন্ন বিজ্ঞান-গবেষণা কেন্দ্রের সঙ্গে যুক্ত থেকেছেন। বিজ্ঞান গবেষণার জন্য প্রায় একক প্রচেষ্টায় নির্মাণ করেছেন 'ব্রহ্মচারী রিসার্চ ইন্সটিটিউশন'। তাছাড়াও দেশি ওষুধ তৈরির জন্য প্রকল্প নির্মাণ, ভারতীয় বিজ্ঞান কংগ্রেসের সভাপতি হিসেবে মেধাবী ও তরুণ ভারতীয় বিজ্ঞানীদের গবেষণায় উৎসাহদান প্রভৃতি কাজের মধ্য দিয়েই এই স্বদেশপ্রাণ বাঙালি বিজ্ঞানীর নানা ধরণের কর্মপ্রচেষ্টা চিরস্মরণীয় হয়ে থাকবে।

তৎকালীন ব্রিটিশ সরকার ড. উপেন্দ্রনাথ ব্রহ্মচারীর মতো মেধাবী বাঙালি গবেষক ও চিকিৎসককে নানাভাবে সম্মানিত করেছে। রায়বাহাদুর খেতাব সহ নানা সাম্মানিক পদ ও পুরস্কার তিনি পেয়েছিলেন ব্রিটিশ শাসকদের কাছ থেকে। তবে এই নানাধরণের পুরস্কার ও সম্মানপ্রাপ্তি তাঁকে ব্রিটিশ শাসকদের প্রতি অনুগত করে তুলেছিল একথা মনে হওয়ার কারণ নেই। কারণ ব্রিটিশ প্রভুদের বুদ্ধি বিভাষিত প্রজ্ঞার আড়ালে প্রচ্ছন্ন থাকা হীনস্বার্থপরতা ও চতুর বাণিজ্যবুদ্ধি সম্পর্কে তিনি ছিলেন রীতিমতো সচেতন। কালাজ্বরের প্রতিষেধক হিসেবে আবিষ্কৃত ইউরিয়া স্টিবামাইনের ফর্মূলার সত্ত্ব তিনি ইংরেজদের হাতে তুলে দিতে চাননি। কারণ তাঁর মনে আশঙ্কা ছিল ইংরেজরা তাঁর এই গবেষণালব্ধ আবিষ্কারকে মানবসেবার কাজে ব্যবহার না করে বাণিজ্যিক স্বার্থে কাজে লাগাবে। হয়তো এই কারণেই চিকিৎসাবিজ্ঞানে 'মেডিসিন'-এ নোবেল পুরস্কারের জন্য একাধিকবার তাঁর নাম বিবেচিত হলেও শেষ পর্যন্ত নোবেল পুরস্কার অধরাই থেকে গেল এই কৃতী আপসহীন বাঙালি বিজ্ঞানীর কাছে।

তথ্যসূত্র:

১. বাঙালির বিজ্ঞানচর্চা কিংবা বিজ্ঞানচর্চায় বাঙালি', অরবিন্দ সামন্ত, উনিশ শতকের বাঙালি জীবন ও সংস্কৃতি, স্বপন বসু ও

ও ইন্দ্রজিৎ চৌধুরী সম্পাদিত, পুস্তক বিপণি, প্রথম সংস্করণ, ২০০৩
২. ‘কালাজ্বর : এক মারণ রোগ’, ডা. নিতাই প্রামাণিক, স্বাস্থ্য ও মানুষ, জুলাই-সেপ্টেম্বর, ২০২৪

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

EOQ Model for Deteriorating Drugs with Fuzzy Demand, Deterioration and Backlogging under Carbon Tax Policy

Soumita Kundu

Department of Mathematics, Haldia Government College,
Debhog, Haldia, West Bengal, India 721657
Email: kundu.soumita21@gmail.com

Received : 10:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract: In this study, we propose a continuous-review sustainable inventory model for deteriorating drugs with a time-dependent demand rate under a carbon tax policy. Two key characteristics of many pharmaceuticals—short shelf life and specific storage requirements—pose significant challenges in inventory management. On one hand, inventory levels must be minimized due to the drugs' perishable nature. On the other hand, these drugs require cold storage, which contributes to carbon emissions. Our model allows for shortages within each inventory cycle, which are partially backlogged. The backlogging rate is assumed to be inversely proportional to the waiting time until the next replenishment. To account for uncertainty, the demand rate, deterioration rate and partial backlogging parameter are modeled as fuzzy numbers. The optimal order quantity and maximum total profit are determined by defuzzifying the total profit using the signed distance method. Additionally, a sensitivity analysis is performed to examine how variations in parameter values affect the optimal solution of the fuzzy model.

Keywords: Deterioration, Partial backlogging, Fuzzy inventory model, Signed distance method, Carbon emission

Introduction

In inventory management, product demand plays a crucial role in formulating the Economic Order Quantity (EOQ) model, as it significantly influences inventory behavior. Typically, inventory models assume one of four types of demand: constant, time-dependent, probabilistic, or stock-dependent. Initially, demand was often considered constant; however, in real-world scenarios, demand can vary over time, with price, or even based on the current inventory level.

Another key factor in inventory systems is deterioration, which refers to the degradation, spoilage, obsolescence, or loss of a product's original utility or value. Many real-life items—such as fruits, vegetables, milk, medicines, and photographic film—have a limited shelf life and are thus classified as deteriorating items. Deterioration leads to shortages, potential loss of goodwill, and reduced profits. Consequently, considerable research has been conducted to develop inventory models for deteriorating items, both with and without shortages.

Dave and Patel [1] were pioneers in this area, proposing the first inventory model for deteriorating items with a linearly increasing demand rate over a finite planning horizon and a constant deterioration rate. Sachan [2] extended their work by incorporating shortages. Sahoo et al. [5] developed a model assuming constant deterioration with demand as a function of selling price.

In practice, demand often depends on time. During a product's lifecycle, demand typically increases in the growth phase and declines afterward. For seasonal items like apparel or footwear, demand starts low and rises as the season progresses. Tripathy et al. [7] developed an inventory model with time-dependent Weibull demand and allowed shortages. Manna et al. [8] introduced an EOQ model where demand follows a ramp-type time function, production is finite and proportional to demand, and deterioration increases over time.

Most of these studies assume that all unmet demand is fully backlogged. However, in reality, customer behavior during stockouts varies—some may wait for replenishment

(backordered), while others may turn to alternative sources (lost sales). A more realistic approach considers partial backordering, where the backlogging rate depends on the customer's willingness to wait, which is often influenced by the expected waiting time.

Chang and Dye [9] introduced a model with exponential time-varying demand and partial backlogging, where the backlogging rate decreases with longer waiting times. Dye and Ouyang [10] further explored this by modeling deteriorating items with stock-dependent demand and time-proportional backlogging, deriving conditions for the existence and uniqueness of optimal solutions.

In conventional (crisp) inventory models, all cost parameters are assumed to be known precisely. However, in practice, these parameters may fluctuate slightly, introducing uncertainty. Treating such parameters as *fuzzy variables* offers a more realistic representation. These fuzzy inventory problems are typically defuzzified using suitable techniques before applying standard solution methods.

Hsieh [11] presented a fuzzy inventory model with fuzzy demand and fuzzy lead time, using trapezoidal fuzzy numbers and the Graded Mean Integration Representation method for defuzzification. Mahata and Goswami [3] proposed a fuzzy EOQ model incorporating a fuzzy deterioration rate. Valliathal and Uthayakumar [12] developed a fuzzy inventory model under inflationary conditions, treating cost components as triangular fuzzy numbers and applying the Signed Distance Method for defuzzification. Chiang et al. [13] extended this approach to include fuzzy storage, backorder, ordering, and shortage costs.

Carbon emissions are inevitably generated through various logistical activities within supply chains, such as lighting, heating, air-conditioning, and product deterioration. As living standards continue to rise, the demand for cold chain equipment is expected to increase steadily. Without the implementation of effective energy-saving measures, this growth will lead to a sharp rise in electricity consumption. Among the various components consuming energy in cold storage facilities, the refrigeration system accounts for the majority, as it is essential for maintaining stable conditions necessary for preserving perishable goods such as fresh food, pharmaceuticals, and other temperature-sensitive products.

Industries are making efforts to mitigate these emissions by adopting energy-efficient and environmentally friendly technologies (Mashud et al. [4]). Zhu et al. [6] explored ways to reduce energy consumption and carbon emissions by optimizing control strategies based on the performance of refrigeration systems and the specific needs of cold storage facilities. Similarly, Du et al. [14] conducted a case study evaluating the emissions from eight refrigerated facilities handling fresh fruits. Their findings showed that such facilities are significant sources of greenhouse gas (GHG) emissions.

In response, governments have implemented various strategies to reduce industrial carbon emissions, including imposing a "carbon tax" that charges for each unit of carbon emitted. These emissions contribute to rising environmental temperatures, which in turn have harmful effects on both human health and the environment.

Considering all these factors, we propose a continuous-review inventory model for deteriorating drugs that incorporates time-dependent demand, partial backlogging, and carbon emissions from cold storage within a carbon tax framework. The primary objective is to maximize the system's total profit. To manage uncertainty, the demand rate, deterioration rate, and backlogging parameter are taken as triangular fuzzy numbers, and the Signed Distance Method is employed for defuzzification. Numerical examples are included to demonstrate the effectiveness of the proposed approach.

Notations and assumptions

The following assumption and notation are made 2.1 Notation

I(t) the inventory level at time t, where $t \in [0,T]$

$D(t)$ the demand rate at time t, where $t \in [0,T]$
P_r the selling price per unit
P_c the purchase cost per unit, where $P_c < P_r$
C_e the carbon tax per unit carbon emitted.
ϵ the emission factors thattranslate the energy/fuel consumed to emissions
h_c the holding cost per unit per unit time
O_c the ordering cost per order
d_c the deterioration cost per unit per unit time
S_c the shortage cost per unit per unit time
π_o the opportunity cost due to lost sales per Unit
η the backlogging parameter, where $0 \leq \leq 1$
T the length of replenishment cycle
T_1 the time at which shortage stats, $0 \leq T_1 \leq T$
TP the total inventory profit per unit time

2.2 Assumption

(1) The inventory system considers a singledrug , with instantaneous replenishment and zero lead time.
(2)The demand rate of a drug, D(t) is assumed to be a function of time in a polynomial form:

$$D(t) = \beta t^{\gamma-\alpha}$$

with $\gamma > \alpha$ for increasing demand, $\gamma < \alpha$ for decreasing demand $\gamma = \alpha$ and for constant demand α and β and are positive constants.

(3) The deterioration rate of the on-hand druginventory at any given time t is modeled as a function that varies $\varphi(t) = \theta_1 + \theta_2 t$ with time. where $0 < \theta_1 << 1$ and $0 < \theta_2 << 1$.

(4) Shortages are allowed, and all unsatisfied demand is assumed to be backlogged. However, the rate of backlogging is not constant; rather, it is considered to be a function of the waiting time for the next replenishment. Specifically, the backlogging rate during periods of negative inventory is defined as:

$$D_{backlog}(t) = \frac{1}{1+\eta(T-t)}$$

Where η is backlogging parameter and (T-t) is waiting time $t_1 \leq t \leq T$

Mathematical Formulation

It is assumed that the initial inventory level at time t=0 is Q. Owing to market demand and the deterioration of items, the inventory level gradually decreases over the time interval $[0, T_1)$, ultimately reaching zero at $t= T_1$. Shortages arise during the interval, $[T_1, T]$, and all unsatisfied demand within this period is considered to be backlogged. Furthermore, carbon emissions are generated as a result of unavoidable logistical activities within the supply chain, such as lighting, heating, and air-conditioning. In this study, the energy or fuel consumed for storing perishable products—such as pharmaceuticals—is converted into carbon emissions by applying an emission factor, as suggested by Du et al. [14].

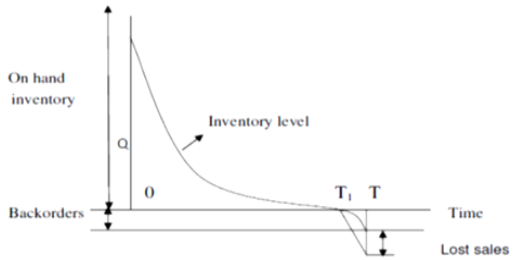


Fig 1. Graphical representation of inventory system

The inventory system developed is depicted by following figure.
The differential equations governing the instantaneous sates of I(t) over the cycle T can be written as follows :

$$\frac{dI(t)}{dt} + (\theta_1 + \theta_2 t)I(t) = -\beta t^{\gamma-\alpha} \quad ; 0 \leq t \leq T_1 \qquad (1)$$

$$\frac{dI(t)}{dt} = \frac{-\beta t^{\gamma-\alpha}}{1+\eta(T-t)} \quad ; T_1 \leq t \leq T \qquad (2)$$

With the conditions
$I(0) = Q, I(T_1) = 0$

The solution of the equation (1)

$$I(t) = \beta\left[\frac{T_1^{\gamma-\alpha+1}}{\gamma-\alpha+1}\left(1-\theta_1 t-\frac{\theta_1 t^2}{2}\right)+\frac{\theta_1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}+\frac{\theta_1}{(\gamma-\alpha+1)(\gamma-\alpha+2)}t^{\gamma-\alpha+2}+\frac{\theta_2}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}+\frac{\theta_2}{(\gamma-\alpha+1)(\gamma-\alpha+3)}t^{\gamma-\alpha+3}-\frac{t^{\gamma-\alpha+1}}{\gamma-\alpha+1}\right]$$

I(0)= Q gives $Q(T_1) = \beta\left[\frac{T_1^{\gamma-\alpha+1}}{\gamma-\alpha+1} + \frac{\theta_1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2} + \frac{\theta_2}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+2}\right]$

The solution of equation (2)

$I(t) = -\beta[\frac{(1-\delta T)}{\gamma-\alpha+1}(t^{\gamma-\alpha+1} - T_1^{\gamma-\alpha+1}) + \frac{\delta}{(\gamma-\alpha+2)}(t^{\gamma-\alpha+2} - T_1^{\gamma-\alpha+2})]$

The holding cost per cycle over the period $[0,T_1]$ is

$HC = h_c \int_0^{T_1} I(t)\,dt$

$= h_c\beta\left[\frac{\theta_1}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3} + \frac{\theta_2}{3(\gamma-\alpha+4)}T_1^{\gamma-\alpha+4} + \frac{1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}\right]$

The deterioration cost per cycle during the period $[0,T_1]$ is

$DC = d_c[Q - \int_0^{T_1}\beta t^{\gamma-\alpha}dt]$

$= d_c\,\beta T_1^{\gamma-\alpha+2}\left[\frac{\theta_1}{\gamma-\alpha+2} + \frac{\theta_2}{2(\gamma-\alpha+3)}T_1\right]$

The purchase cost per cycle PC_1 ,PC_2during the intervals $[0,T_1]$, $[T_1,T]$ respectively are

$PC_1 = P_cQ = P_c\beta\left[\frac{T_1^{\gamma-\alpha+1}}{\gamma-\alpha+1} + \frac{\theta_1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2} + \frac{\theta_2}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+2}\right]$

$PC_2 = P_c \int_{T_1}^{T} \frac{\beta t^{\gamma-\alpha}}{1+\eta(T-t)}\,dt$

$= \frac{P_c\beta}{\gamma-\alpha+1}\left[\left(T^{\gamma-\alpha+1} - T_1^{\gamma-\alpha+1}\right) - \frac{\eta}{\gamma-\alpha+2}T^{\gamma-\alpha+2} + \eta T_1^{\gamma-\alpha+1}\left(T - \frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right)\right]$

The shortage cost per cycle over the period $[T_1,T]$ is

$SC = s_c \int_{T_1}^{T}[-I(t)]\,dt$

$= s_c\beta\left[\frac{(1-\eta T)}{\gamma}\left(\frac{T^{\gamma-\alpha+2}}{\gamma-\alpha+2} - T_1^{\gamma-\alpha+1}T\right) + \frac{\eta}{\gamma-\alpha+2}\left(\frac{T^{\gamma-\alpha+3}}{\gamma-\alpha+3} - T_1^{\gamma-\alpha+2}T\right) + \frac{(1-\eta T)}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2} + \frac{\eta}{\gamma-\alpha+3}T_1^{\gamma-\alpha+3}\right]$

The opportunity cost per cycle due to lost sale over the period $[T_1,T]$ is

$OC = \pi_o \int_{T_1}^{T} \beta t^{\gamma-\alpha}[1 - \frac{1}{1+\eta(T-t)}]\,dt$

$= \pi_o \frac{\beta\eta}{\gamma-\alpha+1}\left[\frac{1}{\gamma-\alpha+2}T^{\gamma-\alpha+2} - T_1^{\gamma-\alpha+1}\left(T - \frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right)\right]$

The sales revenue cost per cycle over the period $[0,T_1]$ is

$SR = P_r[\int_0^{T_1}\beta t^{\gamma-\alpha}\,dt + \int_{T_1}^{T}\frac{\beta t^{\gamma-\alpha}}{1+\delta(T-t)}\,dt]$

$= P_r\frac{\beta}{\gamma-\alpha+1}\left[T^{\gamma-\alpha+1} - \frac{\eta}{\gamma-\alpha+2}T^{\gamma-\alpha+2} + \eta T_1^{\gamma-\alpha+1}\left(T - \frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right)\right]$

The carbon tax paid per cycle due to carbon emission from storing the product over the period $[0,T_1]$ is

$C_{tax} = c_e\epsilon \int_0^{T_1} I(t)dt$

$= c_e\epsilon\beta\left[\frac{\theta_1}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3} + \frac{\theta_2}{3(\gamma-\alpha+4)}T_1^{\gamma-\alpha+4} + \frac{1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}\right]$

Therefore the profit per unit time over the period $[0,T]$ is given by

$TP(T_1,T) = \frac{1}{T}(SR - O_c - HC - DC - PC_1 - PC_2 - SC - OC - C_{tax})$

$= \frac{1}{T}\left[\frac{\beta}{\gamma-\alpha+1}\left((P_r - P_c + \pi_o)\eta + s_c\right)\left[T_1^{\gamma-\alpha+1}\left(T - \frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right) - \frac{1}{\gamma-\alpha+2}T^{\gamma-\alpha+2}\right] + \frac{\beta}{\gamma-\alpha+1}(P_r - P_c)T^{\gamma-\alpha+1} - (d_c + P_c)\beta\left[\frac{\theta_1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2} + \frac{\theta_2}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}\right] - O_c - (h_c + c_e\epsilon)\beta\left[\frac{\theta_1}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3} + \frac{\theta_2}{3(\gamma-\alpha+4)}T_1^{\gamma-\alpha+4} + \frac{1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}\right] - s_c\beta\eta\left[\frac{1}{\gamma-\alpha+1}TT_1^{\gamma-\alpha+1}\left(T - \frac{2(\gamma-\alpha+1)}{\gamma-\alpha+2}T_1\right) + \frac{1}{\gamma-\alpha+3}T_1^{\gamma-\alpha+3} - \frac{2}{(\gamma-\alpha+3)(\gamma-\alpha+2)(\gamma-\alpha+1)}T^{\gamma-\alpha+3}\right]\right](3)$

Fuzzy Continuous Review Model

In the above crisp model, it was assumed that all parameters were fixed or could be predicted with certainty. However, in real-life scenarios, these parameters often deviate slightly from their expected values. Therefore, it is unrealistic to treat them as constant. To address this, we now consider the demand rate, deterioration parameters and backlogging parameter as uncertain and represent them using triangular fuzzy numbers. We represent them by triangular fuzzy numbers as:

$\tilde{\beta}= (\beta-\Delta_1 ,\beta , \beta+\Delta_2)$ where $0 < \Delta_1< \beta$ and $\Delta_2 >0$
$\tilde{\eta} = (\eta-\Delta_3 ,\eta ,\eta+\Delta_4)$where $0 < \Delta_3<\eta$ and $\Delta_4>0$
$\widetilde{\theta_1} =(\theta_1 -\Delta_5 ,\theta_1 , \theta_1 +\Delta_6)$ where $0 < \Delta_5<\theta_1$ and $\Delta_6>0$
$\widetilde{\theta_2} =(\theta_2 -\Delta_7 ,\theta_1 , \theta_1 +\Delta_8)$ where $0 < \Delta_7<\theta_1$ and $\Delta_8>0$

Therefore the total profit per unit time is a fuzzy quantity is given by

$$\widetilde{TP}(T_1,T) = \frac{1}{T}\left[\frac{\tilde{\beta}}{\gamma-\alpha+1}\left((P_r - P_c + \pi_o)\eta + s_c\right)\left[T_1^{\gamma-\alpha+1}\left(T - \frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right) - \frac{1}{\gamma-\alpha+2}T^{\gamma-\alpha+2}\right] + \frac{\tilde{\beta}}{\gamma-\alpha+1}(P_r - P_c)T^{\gamma-\alpha+1} - (d_c + P_c)\tilde{\beta}\left[\frac{\widetilde{\theta_1}}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2} + \frac{\widetilde{\theta_2}}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}\right] - O_c - (h_c + c_e\epsilon)\tilde{\beta}\left[\frac{\widetilde{\theta_1}}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3} + \frac{\widetilde{\theta_2}}{3(\gamma-\alpha+4)}T_1^{\gamma-\alpha+4} + \frac{1}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}\right] - s_c\tilde{\beta}\tilde{\eta}\left[\frac{1}{\gamma-\alpha+1}TT_1^{\gamma-\alpha+1}\left(T - \frac{2(\gamma-\alpha+1)}{\gamma-\alpha+2}T_1\right) + \frac{1}{\gamma-\alpha+3}T_1^{\gamma-\alpha+3} - \frac{2}{(\gamma-\alpha+3)(\gamma-\alpha+2)(\gamma-\alpha+1)}T^{\gamma-\alpha+3}\right]\right] \quad (4)$$

We will use the signed distance method to defuzzify the fuzzy total profit and obtain an estimate of the total profit per unit time in fuzzy sense.

For any δ and $0 \in R$, define the signed distance of a to 0 as $d_0(\delta,0) = \delta$.If $\delta > 0$, implies that δ is on the right-hand side of origin 0 with distance $d_0(\delta,0) = \delta$; and if $\delta < 0$, implies that δ is on the left-hand side of origin 0 with distance $-d_0(\delta,0) = -\delta$. So, we called $d_0(\delta,0) = \delta$ is the signed distance of α to 0.

Let $\sum$ be the family of the fuzzy sets $\widetilde{D}$ on R with which the δ-cut $D(\delta)= \{x|\mu_{\widetilde{D}}(x) \geq \delta\}$ $=[D_L(\alpha) , D_R(\alpha)]$ exists for every $\alpha \in [0, 1]$, where $D_L(\delta)$ and $D_R(\delta)$ are continuous functions on $\delta \in [0, 1]$, then by the Decomposition Principle, for every $\widetilde{D} \in \sum$ we have

$$\widetilde{D} = \bigcup_{0\leq\delta\leq1} [D(\delta), D_R(\alpha)_L ; \delta]$$

For $\widetilde{D} \in \sum$,we have that the signed distance of $D_L(\alpha)$ and $D_R(\alpha)$measured from 0 are $d_0(D_L(\delta), 0) = D_L(\delta)$ and $d_0(D_R(\delta), 0) = D_R(\delta)$, respectively. Therefore, we may define the signed distance of the interval $[D_L(\alpha), D_R(\alpha)]$, which is measured from the origin 0, by $d_0[[D_L(\delta), D_R(\delta)], 0] = \frac{1}{2}[d_0(D_L(\delta), 0) + d_0(D_R(\delta), 0)] = \frac{1}{2}[D_L(\delta) + D_R(\delta)]$.

For each $\alpha \in [0, 1]$, the crisp interval $[D_L(\delta), D_R(\delta)]$ and the level α fuzzy interval $[D_L(\delta), D_R(\delta); \delta]$ are in one to one correspondence. Therefore, we may define the signed distance from $[D_L(\delta), D_R(\delta); \delta]$ to $\tilde{0}$as $d([D_L(\delta), D_R(\delta); \delta], \tilde{0})$ $= d_0([DL(\delta), DR(\delta)], 0) = \frac{1}{2}[D_L(\delta) + D_R(\delta)]$.

Since$\widetilde{D} \in \sum$, $D_L(\alpha)$ and $D_R(\alpha)$ exist and are integrable for $\alpha \in [0, 1]$

So for $\widetilde{D} \in \sum$, we can define the signed distance of $\widetilde{D}$ measured from $\tilde{0}$ as

$d(\widetilde{D}, \tilde{0}) = \frac{1}{2}\int_0^1 [D_L(\delta) + D_R(\delta)]\, d\delta$

For the triangular fuzzy number $\widetilde{D}= (x_1, x_2, x_3)$ the α-cut of $\widetilde{D}$ is $D(\delta)=[D_L(\delta),D_R(\delta)]$,for $\delta \in [0,1]$, where $D_L(\delta)=x_1+(x_2-x_1)\delta$ and $D_R(\delta) = x_3-(x_3-x_2)\delta$, the signed distance of $\widetilde{D}$ to $\tilde{0}$ is $d(\widetilde{D}, \tilde{0}) = \frac{1}{4}(x_1+2x_2+x_3)$

The left and right limit of $\alpha-$ cuts are:

$\beta_L(\delta) = \beta - \Delta_1 + \Delta_1\delta$, $\beta_R(\delta) = \beta + \Delta_2 - \Delta_2\delta$
$\eta_L(\delta) = \eta - \Delta_3 + \Delta_3\delta$, $\eta_R(\alpha) = \eta + \Delta_4 - \Delta_4\delta$
$\theta_{1L}(\delta) = \theta_1 - \Delta_5 + \Delta_5\delta, \theta_{1R}(\delta) = \theta_1 + \Delta_6 - \Delta_6\delta$
$\theta_{2L}(\delta) = \theta_2 - \Delta_7 + \Delta_7\delta, \theta_{2R}(\delta) = \theta_2 + \Delta_8 - \Delta_8\delta$

The signed distance of $\widetilde{TP}(T_1,T)$measured from $\tilde{0}$ is

$$d(\widetilde{TP},\widetilde{0}) =$$
$$\frac{1}{T}\left[d\left(\tilde{\beta},0\right)\left[\frac{((P_r-P_c+\pi_0)\eta+s_c)}{\gamma-\alpha+1}\left[T_1^{\gamma-\alpha+1}\left(T-\frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right)-\frac{1}{\gamma-\alpha+2}T^{\gamma-\alpha+2}\right]+\frac{(P_r-P_c)}{\gamma-\alpha+1}T^{\gamma-\alpha+1}-\right.$$
$$\left.\frac{(h_c+c_e\epsilon)}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}\right]-d\left(\widetilde{\beta\theta}_1,0\right)\left[\frac{d_c+P_c}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}+\frac{(h_c+c_e)}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}\right]-d\left(\widetilde{\beta\theta}_2,0\right)\left[\frac{(d_c+P_c)}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}+\right.$$
$$\left.\frac{h_c+c_e\epsilon}{3(\gamma-\alpha+4)}T_1^{\gamma-\alpha+4}\right]-O_c-s_c d(\widetilde{\beta\eta},0)\left[\frac{1}{\gamma-\alpha+1}TT_1^{\gamma-\alpha+1}\left(T-\frac{2(\gamma-\alpha+1)}{\gamma-\alpha+2}T_1\right)+\frac{1}{\gamma-\alpha+3}T_1^{\gamma-\alpha+3}-\right.$$
$$\left.\frac{2}{(\gamma-\alpha+3)(\gamma-\alpha+2)(\gamma-\alpha+1)}T^{\gamma-\alpha+3}\right]\Bigg] \qquad (5)$$

Now from the definition of the signed distance

$d(\tilde{\beta},\tilde{0}) = \frac{1}{2}\int_0^1[\beta_L(\delta)+\beta_R(\delta)]\,d\delta = \beta + \frac{(\Delta_2-\Delta_1)}{4}$; $\quad d(\tilde{\eta},\tilde{0}) = \frac{1}{2}\int_0^1[\eta_L(\delta)+\eta_R(\delta)]\,d\delta = \eta + \frac{(\Delta_4-\Delta_3)}{4}$.

$d(\widetilde{\theta_1},\tilde{0}) = \frac{1}{2}\int_0^1\left[\theta_{1_L}(\delta)+\theta_{1_R}(\delta)\right]d\delta = \theta_1 + \frac{(\Delta_6-\Delta_5)}{4}$; $d(\widetilde{\theta_2},\tilde{0}) = \frac{1}{2}\int_0^1\left[\theta_{2_L}(\delta)+\theta_{2_R}(\delta)\right]d\delta = \theta_2 + \frac{(\Delta_8-\Delta_7)}{4}$

$$d\left(\widetilde{\beta\eta},\tilde{0}\right) = \frac{1}{2}\int_0^1[(\beta\eta)_L(\delta)+(\beta\eta)_R(\delta)]\,d\delta = \frac{1}{2}\int_0^1[\beta_L(\delta)\eta_L(\delta)+\beta_R(\delta)\eta_R(\delta)]d\delta$$
$$= \frac{1}{12}[12\beta\eta+3\beta(\Delta_4-\Delta_3)+3\eta(\Delta_2-\Delta_1)+2(\Delta_1\Delta_3+\Delta_2\Delta_4)]$$

Similarly

$$d(\widetilde{\beta\theta}_1,0) = \frac{1}{12}[12\beta\theta_1+3\beta(\Delta_6-\Delta_5)+3\theta_1(\Delta_2-\Delta_1)+2(\Delta_1\Delta_5+\Delta_2\Delta_6)]$$
$$d(\widetilde{\beta\theta}_2,0) = \frac{1}{12}[12\beta\theta_2+3\beta(\Delta_8-\Delta_7)+3\theta_2(\Delta_2-\Delta_1)+2(\Delta_1\Delta_7+\Delta_2\Delta_8)]$$

Thus, the defuzzified total profit per unit time is

$$TP(T_1,T) = d\left(\widetilde{TP},\tilde{0}\right) =$$
$$\frac{1}{T}\left[\left[\beta+\frac{(\Delta_2-\Delta_1)}{4}\right]\left[\frac{((P_r-P_c+\pi_0)\eta+s_c)}{\gamma-\alpha+1}\left[T_1^{\gamma-\alpha+1}\left(T-\frac{\gamma-\alpha+1}{\gamma-\alpha+2}T_1\right)-\frac{1}{\gamma-\alpha+2}T^{\gamma-\alpha+2}\right]+\frac{(P_r-P_c)}{\gamma-\alpha+1}T^{\gamma-\alpha+1}-\right.\right.$$
$$\left.\frac{(h_c+c_e)}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}\right]-\frac{1}{12}[12\beta\theta_1+3\beta(\Delta_6-\Delta_5)+3\theta_1(\Delta_2-\Delta_1)+2(\Delta_1\Delta_5+\Delta_2\Delta_6)]\left[\frac{d_c+P_c}{\gamma-\alpha+2}T_1^{\gamma-\alpha+2}+\right.$$
$$\left.\frac{(h_c+c_e\epsilon)}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}\right]-$$
$$\frac{1}{12}[12\beta\theta_2+3\beta(\Delta_8-\Delta_7)+3\theta_2(\Delta_2-\Delta_1)+2(\Delta_1\Delta_7+\Delta_2\Delta_8)]\left[\frac{(d_c+P_c)}{2(\gamma-\alpha+3)}T_1^{\gamma-\alpha+3}+\right.$$
$$\left.\frac{h_c+c_e\epsilon}{3(\gamma-\alpha+4)}T_1^{\gamma-\alpha+4}\right]-O_c-$$
$$s_c\frac{1}{12}[12\beta\eta+3\beta(\Delta_4-\Delta_3)+3\eta(\Delta_2-\Delta_1)+2(\Delta_1\Delta_3+\Delta_2\Delta_4)]\left[\frac{1}{\gamma-\alpha+1}TT_1^{\gamma-\alpha+1}\left(T-\frac{2(\gamma-\alpha+1)}{\gamma-\alpha+2}T_1\right)+\right.$$
$$\left.\left.\frac{1}{\gamma-\alpha+3}T_1^{\gamma-\alpha+3}-\frac{2}{(\gamma-\alpha+3)(\gamma-\alpha+2)(\gamma-\alpha+1)}T^{\gamma-\alpha+3}\right]\right] \qquad (6)$$

The solutions for the optimal values of T_1 and T (say T_1^* and T^*) can be found by solving the following equations simultaneously :

$$\frac{\partial TP(T_1,T)}{\partial T} = 0 \text{ and } \frac{\partial TP(T_1,T)}{\partial T_1} = 0$$

Provided they satisfy the conditions

$\left[\frac{\partial^2 TP(T_1,T)}{\partial T_1^2}\right]$ at $(T_1^*,T^*) < 0$,and

$$\left[\left[\frac{\partial^2 TP(T_1,T)}{\partial T_1^2}\right]\left[\frac{\partial^2 TP(T_1,T)}{\partial T^2}\right]-\left[\frac{\partial^2 TP(T_1,T)}{\partial T_1 \partial T}\right]^2\right] \text{ at } (T_1^*,T^*) > 0$$

5. Numerical Analysis:

Let $\beta = 100, \gamma = 5, \alpha = 1, \eta = 0.3,\ \theta_1 = 0.02, \theta_2 = 0.01, p_c = 2, p_r = 10,\ O = 20, h_c = 0.2,\ d_c = 0.03,\ s_c = 0.03,\ \pi_o = 0.04,\ c_e = 0.04,\ \epsilon = 0.01, \Delta_1 = 1.2, \Delta_2 = 1.5,\ \Delta_3 = .002, \Delta_4 = .004, \Delta_5 = .002, \Delta_6 = .003, \Delta_7 = .002, \Delta_8 = .004$ in appropriate units.

From the figure 2, we observe that the total profit function is strictly concave in T and T_1, Optimal solutions are $Q^* = 8.5 \times 10^7, T^* = 24.38, T_1^* = 19.80$ and the optimality conditions $\left[\frac{\partial^2 TP(T_1,T)}{\partial T_1^2}\right]_{(T_1^*,T^*)} = -1.5 \times 10^6 < 0$ and $\left[\left[\frac{\partial^2 TP(T_1,T)}{\partial T_1^2}\right]\left[\frac{\partial^2 TP(T_1,T)}{\partial T^2}\right] - \left[\frac{\partial^2 TP(T_1,T)}{\partial T_1 \partial T}\right]^2\right]_{(T_1^*,T^*)} = 1.2 \times 10^{12} > 0$ are satisfied.

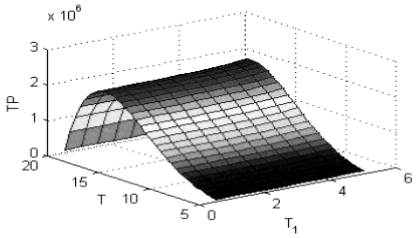
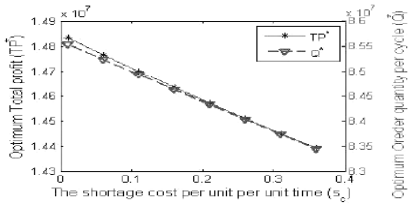
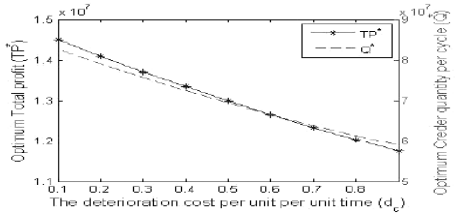
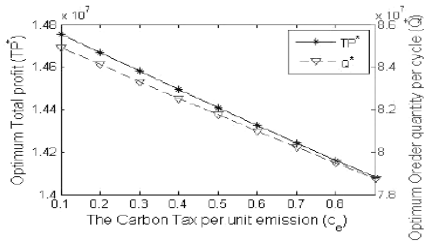


Figure 2: Graphical representation of Total Profit (TP) w.r.t T and T_1

Next, we study the effect of changes in the system parameters c_e, h_c, d_c, s_c on the total profitper unit time (TP^*), and ordered quantity per cycle Q^*.From figure 3, we observe thatTP^* and Q^*alldecreases with increasing values of the parameter c_e, h_c, d_c, s_c.







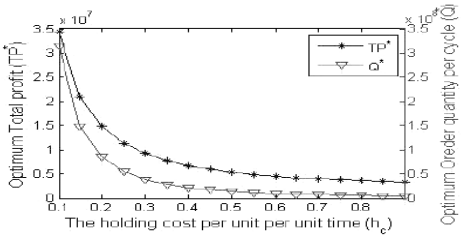


Figure 3 : Effects of d_c, c_e, s_c, h_c on TP^* and Q^*

Conclusion

In this paper ,we studied an EOQ model for a deteriorating drug with time-dependent demand and time dependent partial backlogging under carbon tax policy. To capture the real life situation we have considered that the demand rate, deterioration parameter and partial backlogging parameter are uncertain. The optimum results of fuzzy model isdefuzzified by Signed distance method. Finally, the sensitivity of the solution to changes in the values of different parameter has been discussed.

References

1. Dave, U., & Patel, L. K. (1981). (T, S_i) policy inventory model for deteriorating items with time proportional demand. *Journal of the Operational Research Society, 32*(2), 137–142.
2. Sachan, R. S. (1984). On (T, S_i) inventory policy model for deteriorating items with time proportional demand. *Journal of the Operational Research Society, 35*(10), 1013–1019.
3. Mahata, G. C., & Goswami, A. (2009). Fuzzy EOQ models for deteriorating items with stock dependent demand and nonlinear holding costs. *International Journal of Mathematical and Computer Science, 5*(2), 94–98.
4. Mashud, A. H. M., Pervin, M., Mishra, U., Daryanto, Y., Tseng, M. L., & Lim, M. K. (2021). A sustainable inventory model with controllable carbon emissions in green-warehouse farms. *Journal of Cleaner Production, 298*, 126777. https://doi.org/10.1016/j.jclepro.2021.126777
5. Sahoo, N. K., Sahoo, C. K., & Sahoo, S. K. (2010). An inventory model for constant deteriorating items with price dependent demand and time-varying holding cost. *International Journal of Computer Science & Communication, 1*(1), 267–271.
6. Zhu, Z., Liu, X., Zhao, S., Shan, X., Chen, A., Yu, J., & Liu, B. (2023). Energy saving and carbon emission reduction potential for cold store with new dynamic linkage control strategy. *International Journal of Refrigeration, 154*, 43–55. https://doi.org/10.1016/j.ijrefrig.2023.01.019
7. Tripathy, C. K., & Mishra, U. (2010). An inventory model for Weibull time-dependence demand rate with completely backlogged shortages. *International Mathematical Forum, 5*(54), 2675–2687.
8. Manna, S. K., & Chaudhuri, K. S. (2006). An EOQ model with ramp type demand rate, time dependent deterioration rate, unit production cost and shortages. *European Journal of Operational Research, 171* (2), 557–566.
9. Chang, H. J., & Dye, C. Y. (1999). An EOQ model for deteriorating items with exponential time-varying demand and partial backlogging. *Information and Management Sciences, 10*(1), 1–11.
10. Dye, C. Y., & Ouyang, L. Y. (2005). An EOQ model for perishable items under stock-dependent selling rate and time-dependent partial backlogging. *European Journal of Operational Research, 163* (3), 776–783.
11. Hsieh, C. H. (2004). Optimization of fuzzy inventory models under fuzzy demand and fuzzy lead time. *Tamsui Oxford Journal of Management Sciences, 20*(2), 21–36.
12. Valliathal, M., & Uthayakumar, R. (2010). Fuzzy inventory model for retailer's optimal replenishment policies under inflationary condition. *International Journal of Pure and Applied Sciences and Technology, 1*(1), 46–69.
13. Chiang, J., Yao, J. S., & Lee, H. M. (2005). Fuzzy inventory with backorder defuzzification by signed distance method. *Journal of Information Science and Engineering, 21*, 673–694.
14. du Plessis, M. J., van Eeden, J., &Goedhals-Gerber, L. L. (2022). The carbon footprint of fruit storage: A case study of the energy and emission intensity of cold stores. *Sustainability, 14*(13), 7530. https:// doi.org/10.3390/su14137530

Volume : 12 No. 1 & 2
June, 2025

सुश्रुतः – शल्यचिकित्सायाः पितामहः तस्य सिद्धान्ताश्च

Prosenjit Dutta
Assistant Professor in Sanskrit,
Hooghly Mohsin College, Chinsurah, Hooghly, West Bengal, India.
Email- p123dutta@gmail.com

Received : 20:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

सारांशः (Abstract):

भारतीयचिकित्सायाः इतिहासे सुश्रुतः शल्यचिकित्सायाः पितामहः इति ख्यातः, यः ई.पू. ६०० तमे वर्षे वाराणस्यां नगरे समृद्धिं प्राप्तवान्। तेन विरचितः *सुश्रुतसंहिता* इति महाग्रन्थः आयुर्वेदे शल्यतन्त्रस्य मूलग्रन्थरूपेण प्रसिद्धः। अस्मिन् ग्रन्थे ११२० व्याधयः, ७०० औषधीयवनस्पतयः, ६४ धातुविकृतयः, ५७ प्राणिसम्बन्धिनः योगाः, १२१ शस्त्रयन्त्राणि च सम्यग् विवृणोति ।

सुश्रुतसंहितायां षड्विधानि स्थानानि सूत्रस्थानम्, निदानस्थानम्, शरीरस्थानम्, चिकित्सास्थानम्, कल्पस्थानम्, उत्तरतन्त्रञ्च - यथानुक्रमेण विशदं विवेचितानि। शस्त्रकर्म यथा चेदनम्, भेदनम्, लेखनम्, वेधनम्, एषणम्, आहरणम्, स्रवणम्, सीमनम् इत्येतानि अष्टविधशल्यक्रियाः, नासापुनर्निर्माणम् (नासासंधानम्), अक्षिशल्यचिकित्सा, गर्भविकासः, व्रणोपचारः, रक्तमोक्षणम् (रक्तमोक्षण), अग्निकर्म, स्थिरकरणम् (भङ्गप्रबन्धनम्) च सम्यगनूदितानि। सः मृतदेहविच्छेदनस्य (मृतशरीरच्छेदनस्य) अभ्यासं चिकित्साशिक्षायाम् आवश्यकं मन्यते स्म । शिक्षायां कुम्भकद्रव्यैः, कुष्माण्डफलैः, विकृतांशैः च प्रयोगात्मकं प्रशिक्षणं समाहितम्। यन्त्रशस्त्रविज्ञानम्, मार्मविज्ञानम्, शल्यधर्मः, वैद्यस्य सदाचारः, पूर्वकर्म, प्रधानकर्म, पश्चात्कर्म इत्येते सुश्रुतस्य चिकित्सापद्धतेः प्रमुखाङ्गानि सन्ति। सः रोगिणाम् अनुमतिः (Consent) आवश्यकत्वम् अपि प्रकाशयामास विशेषतः मूत्राश्मरी, मृतगर्भनिष्क्रमणादिके सन्दर्भः ।

सुश्रुतस्य योगदानं भारतात् बहिः यथा ग्रीसदेशं, पारस्यं, यूरोपदेशं च व्याप्य, आधुनिकचिकित्सायामपि प्रेरणास्रोतः अभवत्। सः चिकित्सायाः समग्रदृष्टिः, स्वच्छताम्, नैतिकमूल्यानि च प्रतिपाद्य, अद्यापि आधुनिकचिकित्सायाः मूलस्तम्भरूपेण स्थितः अस्ति ।

कूटशब्दाः (Keywords):

सुश्रुतः, *सुश्रुतसंहिता*, शल्यतन्त्रः, प्राचीनभारतीयचिकित्सा, आयुर्वेदः च ।

भूमिका (Introduction)

आयुर्वेदशास्त्रं स्वयम्भुवा प्रोक्तमिति शास्त्रप्रमाणमस्ति[1] । तदायुर्वेदीयचिकित्सायाः इतिहासे तथा भारतीयचिकित्सायाः इतिहासे सुश्रुतः शल्यचिकित्सायाः पितामहः तथा सौन्दर्यशल्यकर्मणः आद्यप्रवर्तकः इत्युपाधिभ्यां प्रसिद्धिं प्राप्तवान्। तस्य जीवनकालः प्रायः ६०० ई.पू., वा मतान्तरेण १००० ई.पू. काले काशीनगरे (अधुना वाराणसी) स्थितः। सुश्रुतस्य पुराणेषु प्रत्यक्षं उल्लेखो न विद्यते। सुश्रुतसंहिता*यः* कालविचारे पाश्चात्यविद्वानां मध्ये भिन्ना अभिप्रायाः दृश्यन्ते। हैस् (Haas) इति विद्वान् सुश्रुतं च तस्य संहिताञ्च द्वादशे शताब्दे वर्तमानं मन्यते। अपरः पक्षः, यथाः —जोन्स् (Jones), विल्सनः (Wilson) चान्ये च, नवमे वा दशमे शताब्दे तस्य आस्तित्वं स्थापयन्ति। केचन पुनः विद्वांसः सुश्रुतस्य कालं पञ्चमे अथवा चतुर्थे शताब्दे स्थितमिति जल्पन्ति। मेक्डोनल (Macdonell) महाशयो लिखति यत्, *"Suśruta seems to have lived not later than the fourth century A. D., as the Bower manuscript contains passages not only parallel but verbally agreeing with passages in the works of Caraka and Suśruta"*[2]

शिक्षा च वैदिकपरम्परा (Education and the Vedic tradition)

सुश्रुतस्य बाल्यजीवनं पूर्णतया स्पष्टं नास्ति, किन्तु एषः दिवोदासस्य शिष्यत्वेन धन्वन्तरिगुरुकुले शिक्षाम् अलभत इति परम्परया ज्ञायते। धन्वन्तरिः आयुर्वेदस्य अधिदैवतम् इति ख्यातः। सुश्रुतः विश्वामित्रऋषेः वैदिकपरम्परायामपि गण्यते।

तस्य शिक्षायाः पद्धतिः गुरुशिष्यपरम्परा इत्याख्यया ख्याता आसीत्, यत्र मौखिकमार्गेण ज्ञानस्य संप्रेषणं क्रियते स्म। आयुर्वेदे शरीरस्य, मनसः, च आत्मनः सम्यग्व्यवस्थायाः मेलनं प्रमुखं मन्यते। सुश्रुतेन शल्यकर्म, भेषजविज्ञानं, ओषधिपरिज्ञानञ्च बाल्ये एव अवगतम्। सोऽचिन्तयत् यत् शल्यकर्म न केवलं अन्तिमसाधनम्, अपि तु चिकित्सायाः मौलिकसाधनमिति।

गुरोः शिक्षया प्रेरितः सुश्रुतः मृतदेहविच्छेदनस्य महत्त्वं प्रतिपाद्य शरीररचनायाः सूक्ष्मज्ञानं प्राप्तवान्। अस्मिन् कृत्ये धार्मिकप्रतिबन्धाः आसन्, तथापि सः व्यतिक्रम्य वैज्ञानिकदृष्ट्या समर्पितः आसीत्। तस्य मते, शल्यचिकित्सायां केवलं कर्मकौशलं न पर्याप्तम्, अपि तु रोगिणः समग्रस्वास्थ्यस्य ज्ञानं, तदनुगुणः उपचारः च अपेक्षितौ। आयुर्वेदीयदृष्ट्या चिकित्सायाः त्रैविध्यम्- पूर्वकर्म, मुख्यकर्म, पश्चात्कर्म - सर्वत्र सः सम्यक् दृष्टिं दत्तवान्। सुश्रुतः एकस्मिन् शास्त्रे एव निष्ठां त्यक्त्वा सर्वेषां आनसङ्गिकानां विज्ञानानाम् अध्ययनम् आवश्यकं मन्यते।

सामाजिकधार्मिकविघ्नाः (Socio-religious obstacles)

स सामाजिकधार्मिकविघ्नेन पीडितः आसीत्। तस्य समये मृतशरीरस्य विच्छेदनं अपवित्रतायाः कारणं मन्यतम्, यत् कारणात् धार्मिकसमाजेन प्रतिषेधः अपि कृतः। तथापि सुश्रुतः दृढनिश्चयेन वैज्ञानिकपद्धतिम् अनुवर्त्य शल्यचिकित्सायाः मूलाधारमुपस्थापयत्। तेन समाजपरम्परायाः विरुद्धं गत्वा शास्त्रस्य हिताय साहसम् आचरितम्।

***सुश्रुतसंहिता*-ग्रन्थपरिचयः (An Introduction to the Suśruta Saṃhitā)**

सुश्रुतस्य साहित्यिककृतेः मूर्तस्वरूपं *सुश्रुतसंहिता* इति ग्रन्थे दृश्यते। ग्रन्थेऽयं शल्यचिकित्सायाः[3] प्राचीनतमः आधारभूतश्च ग्रन्थः इति गण्यते। आयुर्वेदे[4] त्रयः मुख्यग्रन्थाः *चरकसंहिता, सुश्रुतसंहिता, अष्टाङ्गहृदयम्*-'बृहत्त्रयी' इत्याख्यया प्रथिता। *सुश्रुतसंहिता* शल्यतन्त्रे विशेषं प्रकाश्य आयुर्वेदचिकित्सायाः मुखस्तम्भरूपेण गण्यते। अस्य ग्रन्थस्य आशयः धन्वन्तरिसम्प्रदायेन सम्बद्धः[5] इति मन्यते। अयं ग्रन्थः शल्यकर्मणः तात्त्विकं च व्यावहारिकं च विवेचनं ददाति, यत् आधुनिकचिकित्सायाः प्रेरकस्रोतः इति प्रतिपद्यते।

ग्रन्थस्य अध्यायविन्यासः (The chapter layout of the text)

सुश्रुतसंहितायां विविधविषयेषु विस्तृतं विवरणं दृश्यते, एष ग्रन्थः शल्यचिकित्सायाः प्राचीनतमः स्रोतः इति प्रसिद्धिरस्ति।

ग्रन्थेऽस्मिन् -

- प्रायः १८६ अध्यायाः सन्ति, अन्यस्मिन् प्रमाणे १८४ अध्यायाः उल्लिख्यन्ते।
- ११२० व्याधीनां वर्णनानि समाहितानि।
- ७०० औषधीयवृक्षाः उल्लिखिताः।
- ६४ खनिजस्रोतजन्याः योगाः निर्दिष्टाः।
- ५७ प्राणिजद्रव्यम् आधारिकृत्य औषधप्रयोगाः दर्शिताः।

शरीररचनायाः सूक्ष्मं विवरणं अप्यत्र प्राप्तम्।

षट्स्थानात्मकं वर्गीकरणम् (Classification based on six sections)

सुश्रुतसंहिता षट्स्थानेषु विभागीकृता अस्ति, यत् वर्गीकरणं तस्य चिकित्साविज्ञानस्य वैज्ञानिकताम् अधिकं पुष्णाति -

1. सूत्रस्थानम्- अत्र शल्यचिकित्सायाः सामान्यसिद्धान्ताः निरूपिताः सन्ति। शल्यविज्ञानस्य मौलिकतत्त्वानि, उपायाः च विवृतानि सन्ति।

2. निदानस्थानम्- अस्मिन् स्थाने व्याधीनां निदानानि, हेतुप्रक्रिया, लक्षणानि च विशेषेण निरूप्यन्ते। वातरोगेभ्यः आरभ्य अश्मरी (मूत्राश्मरी), भगन्दरः (गुददृष्टिः) इत्यादयः रोगाः अत्र वर्णिताः। एषः विभागः १६ अध्यायान्वितः अस्ति।

3. शरीरस्थानम् - शरीररचना, गर्भविज्ञानं, आनुवंशिकरोगाश्चात्र सुस्पष्टतया विवृताः। गर्भविकासस्य अवस्थाः, मातृस्वास्थ्यस्य महत्त्वं च अत्र प्रतिपादितम्। अयं भागः शरीरविज्ञाने श्रेष्ठतमः ग्रन्थरूपेण स्वीकृतः ।

4. चिकित्सास्थानम्- अत्र चिकित्साविधीनां विस्तारः दृश्यते। व्रणरोपणम् (क्षतोपचारः), नासासन्धानम् (नासिकापुनर्निर्माणम्), भङ्गचिकित्सा (अस्थिभङ्गोपचारः) इत्यादयः शल्यप्रक्रियाः अत्र सम्यक् निरूपिताः।

5. कल्पस्थानम् - विषविज्ञानस्य निरूपणम् अत्र क्रियते। विषप्रकाराः, लक्षणानि, निष्कासनविधयः च विवृताः।

6. उत्तरतन्त्रम् - अयं भागः ६६-अध्यायविशिष्टः अस्ति। कायचिकित्सा (आन्तरिकोपचारः), बालरोगोपचारः, गृहोपचारः, नेत्ररोगविज्ञानं च अत्र विस्तरतः समाहितम्।

शल्यविद्यायाः मूलानीतयः सुश्रुतप्रवर्तिताः नूतनविधयश्च (The foundational principles of surgery established by Suśruta and the modern advancements)

सुश्रुतस्य योगदानं चिकित्साविज्ञाने क्रान्तिकरं मन्यते। सः नेत्रतिमिरचिकित्सायाम्, नासासन्धानकर्मणि, अस्थिभङ्गोपचारे च अद्वितीयः प्रवर्तकः आसीत्। तेन सूत्रबन्धनकौशलम् आरब्धं, यत्र अश्वकेशा, वनस्पतितन्तवः च सूत्रद्रव्यरूपेण उपयुज्यमानाः आसन्। प्रत्येकं शस्त्रक्रियायाः विधिम्, उपकरणानि, च उपशल्यचिकित्सायाः (postoperative care) नियमं च तेन सूक्ष्मतया लिपिबद्धम्। तस्याभिप्रायेन शल्यक्रियायां युक्तिः, निर्मलता, सुरक्षा चैते शल्यकर्मणि मानदण्डाः इति समीकृताः ।

सुश्रुतसंहितायाम् उल्लिखिताः प्रमुखा नूतनविधयः एवं प्रयोगाः -

१. मृतशरीरविच्छेदनविज्ञानम् (Cadaveric anatomy)

सुश्रुतस्य मृतशरीरविच्छेदनस्य पक्षे स्थितिः तस्य समये अपूर्वं कृत्यम् आसीत्। धर्मसमाजस्य प्रतिरोधे अपि, सः प्रत्यक्षदर्शनेन शरीररचनायाः बोधः अनिवार्यः इति निश्चिन्त्य, नवपद्धतिम् अन्वयत्। मृतशरीरं प्रवहणनद्यां निमज्य सप्तरात्रपर्यन्तं विसृज्य, ततः चर्मादीनि परिशुद्धीकृत्य क्रमशः विवेचनं क्रियताम् इति। तत्र निर्दिष्टं यत् यः शरीरः विश्लेषणाय उपयुक्तः, सः रोगरहितः, विषसेवनरहितः, शतवर्षात् न वृद्धः च भवेत्। एषः अभ्यासः मानवशरीरविज्ञानस्य तात्त्विकं व्यावहारिकं च बोधं विशेषतया संवर्धितवान्। तेन शरीरविन्यासाः अवयवपरस्परसम्बन्धाश्च स्पष्टरूपेण निरूपिताः वर्गीकृताश्च।

२. व्यावहारिकशिक्षणम् प्रायोगिकप्रशिक्षणम् वा (Applied learning or practice-based training)

सुश्रुतस्य शिक्षणपद्धतिः अद्वितीया आसीत्। तेन शिक्षार्थिनां कृते मत्स्यचर्म, तैलमक्षिकामिश्रितं घृतं च, मृत्तिकां प्रयुञ्जानः कृत्रिमशरीरस्य निर्माणेन शिक्षायाः प्रयोगात्मकदिशां समारब्धवान्। शस्त्रकर्मणां पूर्वाभ्यासाय सः कुष्माण्डः, आलाबु , त्रपुस इत्यादीनां फलानां प्रयोगः, अपि च जलपूरितकुप्यां वा मृत्तिकासंचितपात्रे च छेदन-भेदनाभ्यासं अनुशंसितवान्। शल्यविद्यायां सिद्धिः केवलं शास्त्रज्ञानतः न सिध्यति इति सः विशदं निर्दिशति। तेनोक्तं- *'अधिगतसर्वशास्त्रार्थमपि शिष्यं योग्यां कारयेत् । स्नेहादिषु छेद्यादिषु च कर्मपथमुपदिशेत् । सुबहुश्रुतोप्यकृतयोग्यः कर्मस्वयोग्यो भवति*[6] । एवं सः सैद्धान्तिकं व्यावहारिकं च ज्ञानं अवलम्ब्य चिकित्सायाः परिपूर्णतां उद्घाटितवान्।

शल्योपकरणानि (Surgical instruments)

शल्यविद्यायाम् अस्य अनुपमेयं योगदानं तस्य रचितेषु विविधेषु उपकरणेषु प्रकटं दृश्यते। सुश्रुतेन १२१ प्रकाराणि शल्योपकरणानि निर्दिष्टानि, च तानि यथाविधि नामकृतानि, स्वकार्ये निर्देशितानि च। १०१ यन्त्राणि (मृदूपकरणानि), २० शस्त्राणि (तीक्ष्णोपकरणानि) च समुल्लिख्य कुलतः १२१ प्रकारान् वर्णयन्ति। सुश्रुतः सर्वप्रथमं शल्योपयोग्योपकरणानां वर्गीकरणं, विवेचनं च कृतवान् इति अभिप्रायः सन्दृश्यते। सः 'हस्तं' सर्वाधिकं महत्त्वपूर्णम् उपकरणम् इति मन्यते।

१. यन्त्राणि (मृदूपकरणानि) [Yantras (non-sharp instruments)]

यन्त्राणां संख्या १०१ (वा १००) दृश्यते। तानि रूपविन्यासेन च कार्यविशेषेण च षट्सु भेदेषु वर्गीकृतानि-

- **स्वस्तिकयन्त्राणि (क्रूशस्वरूपाणि)** २४ प्रकाराः। पशुपक्षिणां वक्त्ररूपाणि। अस्थिषु प्रविष्टान् परवस्तूनां निष्कर्षणार्थं प्रयुज्यन्ते।

- **सन्दंशयन्त्राणि (प्लासप्रायाणि)** २ प्रकारौ, तालेन च विना च। चर्म, पेशी, रक्तवाहिनीषु, स्नायुषु च प्रविष्टान् पदार्थानां निष्कर्षणाय प्रयुक्तम्।

- **तालयन्त्राणि (चषकाकृतीनि)** प्रविष्टवस्तूनां निष्कर्षणाय। २ प्रकारौ। कर्णे, नासायां वा नासाशोथे दृश्यन्ते मत्स्यशकलसदृशानि चिन्हानि ।

- **नाडीयन्त्राणि (नलिका-सदृशोपकरणानि)** २० प्रकाराः। गुदादिद्वारेषु परिशीलनं, चिकित्सायाः च कार्याय। अर्शः (पाइल्स्), भगन्दरः (फिस्टुला), योनिव्रणदर्शनम् इत्यादिषु उपयुज्यमानानि।

- **शलाकायन्त्राणि (दण्डाकारम्)** उपयोगाय विविधानां च कार्याणां कृते। २८ प्रकाराः। विभिन्नविस्तारविषये प्रयुक्तानि ।

- **उपयन्त्राणि (सहायोपकरणानि)** २५ प्रकाराः। सूत्रम्, पट्टिकाः, चमरपट्टाः, तन्तवः, एवं शरीरभागाः अपि- अङ्गुलिः, जिह्वा, दन्ताः, नखाः च उपकरणरूपेण निर्दिष्टाः।

२. शस्त्राणि (तीक्ष्णोपकरणानि) [Śastras (Sharp surgical instruments)]

शस्त्राणां विंशतिः संख्या दृष्टा। सुश्रुतः अनुशंसेत् यथैतानि शस्त्राणि इतः अपि सूक्ष्माणि भविष्यन्ति, येन ते केशविभेदनक्षमाणि स्युः। एतानि आयसादिभ्यः धातुभ्यः निर्मितानि, स्वच्छता, तीक्ष्णता च मुख्यगुणरूपेण विवक्षितानि। तेन शस्त्राणि नियमितरूपेण तीक्ष्णीकर्तव्यानि, यथाकालं शुद्धीकर्तव्यानि च इत्यादेशः अनिवार्यतया प्रदत्तः। एषः दृष्टिकोणः आधुनिकशल्य-चिकित्सायामपि स्वीक्रियते। सर्वं यन्त्रशस्त्रनिर्माणं तेन कर्मविशिष्टतया, सूक्ष्मतया, तथा 'शारीरिकसुखोपयोगिता' (ergonomics) इत्येतदपि मनसि कृत्वा कल्पितम्।

सुश्रुतस्य शस्त्रकर्मविधयः (Surgical Techniques)

सुश्रुतः अष्टविधं शस्त्रकर्म निर्दिष्टवान्-

1. छेदनम् (Excision)- दोषयुक्तभागस्य अपसारणम्। ग्रन्थि-भगन्दर-अर्बुदादिषु प्रयोगः[7]। उपकरणानि मण्डलाग्रः, कर्पत्रः। भिन्नप्रदेशे विविधरूपच्छेदाः तिर्यक्, चन्द्रमण्डलः, अर्धचन्द्राकृतिः।

2. भेदनम्[8] (Incision)- शून्यभागस्य उद्घाटनं, पाकोद्भवस्य द्रवस्य निष्कर्षणाय। उपद्रवव्रणेषु, स्फीतिषु प्रयोगः। उपकरणानि वृद्धिपत्रः, नखशस्त्रः। पयोऽभिव्यक्तेः पर्यन्तं भेदनं कर्तव्यम्।

3. लेखनम्[9] (Scraping)- रोमपातदिशायां कर्णिकादिभ्यः स्कन्धविश्लेषणम्। पिडका, उपजिह्निका, अर्शः, कुष्ठ इत्यादिषु प्रयोगः। उपकरणानि - मण्डलाग्रः, कर्पत्रः।

4. वेदनम्[10] (Puncturing)- सुषिररूपेण छेदनम्, द्रवदोषस्य निष्कर्षणाय। कूथारिका, शूचिः इत्यादीनि उपकरणानि। अधिकव्रणजनकप्रयत्नं त्याज्यम्।

5. एषणा[11] (Probe) -व्रणेषु गवेषणकर्म, शल्यम् अन्वेष्टुं वा। उपकरणम् एषणी। नाडीव्रण-उन्मार्गिव्रणादिषु उपयोगः।

6. आहरणम्[12] (Extraction) - शल्यम्, दोषम् वा निष्कर्षणम्। दन्तजदोषेषु बडिशः, दन्तशङ्कुः, अश्मरिः इत्येतानि उपकरणानि प्रयोगं यान्ति।

7. विस्रवणम्[13] (Drainage) -दोषद्रवस्य संयमितः निष्कासनः क्रियते, यः विद्रधि-दन्तदोष-कुष्ठादिषु विशेषतः उपयोगी भवति। शूचिः, कुशपत्रम् - उपकरणानि। जलेपोपयोगोऽपि निर्दिष्टः।

स्त्रीरोगप्रसवचिकित्सायां[22] सुश्रुतः प्रमुखः योगदानकरः। क्षारसूत्रविधिः स्त्रीप्रजननरोगेषु प्रचलितः। मूढगर्भस्य विषमस्थितौ शल्यं (सिजेरियन-सेक्शन) अपि निर्दिष्टम्। स्तनव्रणरोगस्य[23] च उपचारः वर्णयते ।

७. गर्भविज्ञानम् तथा आनुवंशिकरोगाः (Embryology and Genetic Diseases)

गर्भविकासस्य[24] विविधाः अवस्थाः, मातृस्वास्थ्यस्य महत्त्वं च सुश्रुतेन वर्णितम्। आनुवंशिकरूपेण रोगाणां प्रभावः तथा मातृशिशोः आरोग्ये चेतनम्।

८. अग्निकर्म तथा रक्तमोक्षणम् (Cauterization and Bloodletting)

तापोपचाररूपे अग्निकर्म प्रयोगः विशेषतः व्याधिजव्रणेषु क्रियते। एषः उपचारः संप्रेषणरोगनिवारणे, रक्तप्रवाहनिरोधे, चिकित्सायां च सहायकः। तद्वत्, रक्तमोक्षणस्य माध्यमेन त्रिदोषाणां सम्यक्संतुलनं साध्यते।

९. गुदशल्यचिकित्सा (Anorectal Surgeries)

अर्शः, भगन्दरः, परिकार्तिकश्च — एषां रोगाणां शस्त्रकर्म सुश्रुतादिभिः सूक्ष्मतया विवृत्तम्। अर्शरोगस्य सन्दर्भे अन्तिमोपायतया शल्यक्रिया निर्दिष्टा। भगन्दरस्य तु कटिप्रकारेषु सन्धिकरणं, तथा फिस्टुलानां विच्छेदनं विशेषोपचाररूपेण निर्दिष्टम्।

१०. उदरशल्यचिकित्सा (Abdominal Surgeries)

बद्धगुदोदरः, छिद्रोदरः, दाकोदरादिरोगेषु शल्यकर्मणा उपचारे वर्णनम् दृश्यते। वृद्धिः (हर्निया), निरुद्धप्रकाशः (फिमोसिस्) अपि चर्चिताः। तीव्रं वेदनायुक्तं च उदररोगं प्रति शस्त्रक्रियाविधयः — यथा लपरोटोमी, अन्तरशल्यः, सूत्रपचनं च — चिकित्सायाः मुख्योपायाः रूपेण निर्दिष्टाः कृष्णकृमिशिरसूत्रीकरणं च उल्लिखितम्। सुश्रुतेन अष्चविधोदररोगानामुल्लेखः कृतः , यथा-अनाहः (गुदमार्गे विघ्नः, मलविघातः, आन्तरवातश् च),पार्श्वोदरम् (उदरस्य एकस्मिन्भागे शोफः),बद्धगोदरम् (मलमूत्रयोः सङ्गः),आस्रावोदरम् (उदरे दीर्घकालपर्यन्तं पूयस्रावः),प्लीहोदरम् (प्लीहानो वृद्धिः),यकृतोदरम् (यकृत्तस्य शोफः वा वृद्धिः),पित्तोदरम् (उदरे पित्तदोषस्य प्रकोपः),जलोदरम् (उदरे जलसञ्चयः, उदरश्लेष्मा वा)।

११. व्रणसिद्धान्तः (Concept of Vraṇa - Ulcer/Wound)

व्रणस्य महत्त्वं सुश्रुतः विशेषतया प्रकटयति[25]। व्रणं शरीरधातूनां भङ्गरूपं, त्वचामांसरक्तवाहिनीनां च विनाशः। सुश्रुतसंहितायां साद्यव्रणानां षड्विधाः प्रकाराः निर्दिष्टाः — छिन्नं छुर्यादिना छेदनेन जातं, भिन्नं विदारणकर्मणा, विद्धं वेधोपघातेन, क्षतं मांसादिपातनपूर्वकं, पिच्छितं दन्तादिपीडनजन्यं, घृष्टं भुजप्रहारजन्यं स्पन्दहीनं वा व्रणम् चेत्यादयः[26] । शुद्धव्रणदुष्टव्रणं च वर्गीकृतम्। षष्टिरूपेण उपचारविधानानि। दग्धव्रणवर्णनम् अपि दृश्यते।

१२. मरमतत्त्वम् (Concept of Marmas - Vital Points)

शरीरे १०७ मर्माणि, तानि स्फोटयित्वा मृत्यु वा विकृतिः स्यात्। सुश्रुतसमीहते मर्मविज्ञानं शल्यतन्त्रस्य अर्धज्ञानम् इति। सुश्रुतः मर्मविज्ञानं शरीरशास्त्रस्य अत्यावश्यकं अङ्गं मन्यते। मर्मस्थानानां यथायोग्यं ज्ञानाभावात् तेषां भेदेन यो मृत्युप्रवणतायुक्तः परिणामः दृश्यते, सः अन्यत्र दुर्लभः — अयं मृत्युदरः अद्वितीय एव शल्यकर्तृणां मर्मरक्षणं अनिवार्यम्।

शल्यचिकित्सायाः सिद्धान्ताः (Principles of Surgical Practice)

सुश्रुतेन त्रिविधकर्माणि[27] शल्यचिकित्सायाः मुख्यविभागरूपेण व्यवस्थितानि। तानि त्रयाणि कर्माणि-पूर्वकर्म, प्रधानकर्म, पश्चात्कर्म-इत्येतानि ।

१. पूर्वकर्म (Pre-operative Phase):

सुश्रुतः पूर्वकर्मणि शस्त्रकर्मगृहस्य आयोजनं, रोगिणः सिद्धिकरणं च निर्दिष्टवान्। शस्त्रचिकित्सापूर्वं यथाविधि उपकरणानां व्यवस्थापनं, यन्त्राणां च सज्जीकरणं कर्तव्यमित्यपि तेन सूचितम्। आधुनिकशल्यचिकित्सायां यथारूपेण शल्यदोलायाः सिद्धिकरणं दृश्यते, तथैव सुश्रुतः तस्य उल्लेखं करोति। रोगिणां हेतुना लघु आहारः प्रदेयः, परं तु विशेषशस्त्रकर्मणि यथा भ्रूणविपरीतस्थितिः, उदरवृद्धिः, अर्शः, अश्मरी, भगन्दरः, मुखरोगश्च -रोगिणः निराहारः स्थापनीयः इति तेन निर्दिष्टम्।

स्त्रीरोगप्रसवचिकित्सायां[22] सुश्रुतः प्रमुखः योगदानकरः। क्षारसूत्रविधिः स्त्रीप्रजननरोगेषु प्रचलितः। मूढगर्भस्य विषमस्थितौ शल्यं (सिजेरियन-सेक्शन) अपि निर्दिष्टम्। स्तनव्रणरोगस्य[23] च उपचारः वर्णयते ।

७. गर्भविज्ञानम् तथा आनुवंशिकरोगाः (Embryology and Genetic Diseases)

गर्भविकासस्य[24] विविधाः अवस्थाः, मातृस्वास्थ्यस्य महत्त्वं च सुश्रुतेन वर्णितम्। आनुवंशिकरूपेण रोगाणां प्रभावः तथा मातृशिशोः आरोग्ये चेतनम्।

८. अग्निकर्म तथा रक्तमोक्षणम् (Cauterization and Bloodletting)

तापोपचाररूपे अग्निकर्म प्रयोगः विशेषतः व्याधिजव्रणेषु क्रियते। एषः उपचारः संप्रेषणरोगनिवारणे, रक्तप्रवाहनिरोधे, चिकित्सायां च सहायकः। तद्वत्, रक्तमोक्षणस्य माध्यमेन त्रिदोषाणां सम्यक्संतुलनं साध्यते।

९. गुदशल्यचिकित्सा (Anorectal Surgeries)

अर्शः, भगन्दरः, परिकार्तिकश्च — एषां रोगाणां शस्त्रकर्म सुश्रुतादिभिः सूक्ष्मतया विवृत्तम्। अर्शरोगस्य सन्दर्भे अन्तिमोपायतया शल्यक्रिया निर्दिष्टा। भगन्दरस्य तु कटिप्रकारेषु सन्धिकरणं, तथा फिस्टुलानां विच्छेदनं विशेषोपचाररूपेण निर्दिष्टम्।

१०. उदरशल्यचिकित्सा (Abdominal Surgeries)

बद्धगुदोदरः, छिद्रोदरः, दाकोदरादिरोगेषु शल्यकर्मणा उपचारे वर्णनम् दृश्यते। वृद्धिः (हर्निया), निरुद्धप्रकाशः (फिमोसिस्) अपि चर्चिताः। तीव्रं वेदनायुक्तं च उदररोगं प्रति शस्त्रक्रियाविधयः — यथा लपरोटोमी, अन्तरशल्यः, सूत्रपचनं च — चिकित्सायाः मुख्योपायाः रूपेण निर्दिष्टाः कृष्णकृमिशिरसूत्रीकरणं च उल्लिखितम्। सुश्रुतेन अष्टविधोदररोगानामुल्लेखः कृतः , यथा-अनाहः (गुदमार्गे विघ्नः, मलविघातः, आन्तरवातश् च),पार्श्वोदरम् (उदरस्य एकस्मिन्भागे शोफः),बद्धगोदरम् (मलमूत्रयोः सङ्गः),आस्रावोदरम् (उदरे दीर्घकालपर्यन्तं पूयस्रावः),प्लीहोदरम् (प्लीहानो वृद्धिः),यकृतोदरम् (यकृत्तस्य शोफः वा वृद्धिः),पित्तोदरम् (उदरे पित्तदोषस्य प्रकोपः),जलोदरम् (उदरे जलसञ्चयः, उदरश्लेष्मा वा)।

११. व्रणसिद्धान्तः (Concept of Vraṇa - Ulcer/Wound)

व्रणस्य महत्त्वं सुश्रुतः विशेषतया प्रकटयति[25]। व्रणं शरीरधातूनां भङ्गरूपं, त्वचामांसरक्तवाहिनीनां च विनाशः। सुश्रुतसंहितायां साद्यव्रणानां षड्विधाः प्रकाराः निर्दिष्टाः — छिन्नं छुर्यादिना छेदनेन जातं, भिन्नं विदारणकर्मणा, विद्धं वेधोपघातेन, क्षतं मांसादिपातनपूर्वकं, पिच्छितं दन्तादिपीडनजन्यं, घुष्टं भुजप्रहारजन्यं स्पन्दहीनं वा व्रणम् चेत्यादयः[26] । शुद्धव्रणदुष्टव्रणं च वर्गीकृतम्। षष्टिरूपेण उपचारविधानानि। दग्धव्रणवर्णनम् अपि दृश्यते।

१२. मरमतत्त्वम् (Concept of Marmas - Vital Points)

शरीरे १०७ मर्माणि, तानि स्फोटयित्वा मृत्यु वा विकृतिः स्यात्। सुश्रुतसमीहते मर्मविज्ञानं शल्यतन्त्रस्य अर्धज्ञानम् इति। सुश्रुतः मर्मविज्ञानं शरीरशास्त्रस्य अत्यावश्यकं अङ्गं मन्यते। मर्मस्थानानां यथायोग्यं ज्ञानाभावात् तेषां भेदेन यो मृत्युप्रवणतायुक्तः परिणामः दृश्यते, सः अन्यत्र दुर्लभः — अयं मृत्युदरः अद्वितीय एव शल्यकर्तृणां मर्मरक्षणं अनिवार्यम्।

शल्यचिकित्सायाः सिद्धान्ताः (Principles of Surgical Practice)

सुश्रुतेन त्रिविधकर्माणि[27] शल्यचिकित्सायाः मुख्यविभागरूपेण व्यवस्थितानि। तानि त्रयाणि कर्माणि-पूर्वकर्म, प्रधानकर्म, पश्चात्कर्म-इत्येतानि ।

१. पूर्वकर्म (Pre-operative Phase):

सुश्रुतः पूर्वकर्मणि शस्त्रकर्मगृहस्य आयोजनं, रोगिणः सिद्धिकरणं च निर्दिष्टवान्। शस्त्रचिकित्सापूर्वं यथाविधि उपकरणानां व्यवस्थापनं, यन्त्राणां च सज्जीकरणं कर्तव्यमित्यपि तेन सूचितम्। आधुनिकशल्यचिकित्सायां यथारूपेण शल्यदोलायाः सिद्धिकरणं दृश्यते, तथैव सुश्रुतः तस्य उल्लेखं करोति। रोगिणां हेतुना लघु आहारः प्रदेयः, परं तु विशेषशस्त्रकर्मणि यथा भ्रूणविपरीतस्थितिः, उदरवृद्धिः, अर्शः, अश्मरी, भगन्दरः, मुखरोगश्च -रोगिणः निराहारः स्थापनीयः इति तेन निर्दिष्टम्।

वेदनाशमनाय औषधीयसुरामादीनामुपयोगः, औषधयुक्तानां वनस्पतीनां वा प्रयोगः निर्दिष्टः। विशिष्टेषु अपायकरूपेषु क्रियासु यथा अश्मरीचिकित्सा, भ्रूणविपरीतस्थितेः निवारणं च सुश्रुतः रोगिणः अथवा अधिकृतानां सम्मतिः आवश्यकेति निर्दिशति। शल्यक्रियापूर्वं रोगिणं तस्य स्वजनं च गभीररोगाणां अनिष्टपरिणामं सूचयित्वा यथासम्भवमुपशममवलम्बनीयमिति निर्दिष्टम्।

२. प्रधानकर्म (Operative Phase):

एषा शस्त्रकर्मस्य मुख्यावस्था। अत्र अष्टविधशस्त्रकर्माणि प्रतिपादितानि। तेषु सुश्रुतः सूक्ष्मतया विधिपूर्वकं शस्त्रकर्मणां सम्पादनम् उपदिशति,- *"तच्च शस्त्रकर्माष्टविधं, तद्यथा - छेद्यं, भेद्यं, लेख्यं, वेध्यम्, एष्यम्, आहार्यं, विस्राव्यं, सीव्यमिति।"*[28]

३. पश्चात्कर्म (Post-operative Phase):

शल्यकर्मोत्तरं चिकीर्षितं परिहरणं सुश्रुतेन विस्तारतः प्रतिपादितम्। अत्र शीतोदकविसर्पणम्, मृदपरिसंशोषणं, कषायैः प्रक्षालनं, सूत्रवस्त्रैः शोषणं, लवणप्रयोगः, लेपनं, पट्टनं च निर्दिष्टम्। रोगी तदनन्तरं विश्रान्तिगृहे स्थापनीयः, आचारविधानं च अनुसर्तव्यम्। शस्त्रकर्मगृहस्य, प्रसवगृहस्य, च शल्योत्तरगृहस्य धूपनं (धूपनकर्म) अपि सुश्रुतेन निर्देशितम्। किटाणुनाशनसमर्थैः वनस्पतीधूपैः वायुमण्डलविशोधनं कर्तव्यं इति सुश्रुतेन सूत्ररूपेण निरूपितम्, यतः रोगोत्पादकजीवीनां दुष्प्रभावज्ञानं तस्यासीत्।तेनोक्तम्,- *"अतोऽन्यतमं कर्म चिकीर्षता वैद्येन पूर्वमेवोपकल्पयितव्यानि भवन्ति तद्यथा - यन्त्रशस्त्रक्षाराग्निशलाकाश्टङ्गजलौकालाबूजाम्बवौ-ष्ठपिचुप्रो तसूत्रपत्र-पट्टमधुघृतवसापयस्तेलत र्पणकषायालेपनक-ल्कव्यजनशीतोष्णोदककटाहादीनि, परिकर्मिणश्च स्निग्धाः स्थिरा बलवन्तश्च"*[29]।

शल्यनीतिः च शल्यविशेषज्ञस्य गुणाः (Surgical Ethics and Qualities of a Surgeon)

सुश्रुतः शल्यचिकित्सायाः आचारसंहितां प्रतिपादयत्। तेन शस्त्रचिकित्सायां कुत्सिताचारस्य (quackery) विरोधः कृतः। यस्य चिकित्सकस्य आचार्योपदिष्टं शिक्षणं, व्यावहारिकं प्रशिक्षणं च अस्ति सः एव वैद्यः, अन्यथा पुनः शस्त्रकुशलवञ्चकः इति तेन उक्तम्,-

"एकं शास्त्रमधीयानो न विद्याच्छास्त्रनिश्चयम् । तस्माद्बहुश्रुतः शास्त्रं विजानीयाच्चिकित्सकः ॥

शास्त्रं गुरुमुखोद्गीर्णमादायोपास्य चासकृत् । यः कर्म कुरुते वैद्यः स वैद्योऽन्ये तु तस्कराः ॥"[30]

सः सतताध्ययनस्य, नित्याभ्यासस्य च आवश्यकता सूचयति। चिकित्सकः विनयी, शुचिः, हृष्टचित्तः, मधुरभाषी, सत्यवादी च भवेत्। सश्रुतेन कुशलशल्यविशेषज्ञस्य निम्नलिखितगुणाः निर्दिष्टाः-धैर्यम्, सौक्ष्म्यहस्तता, अकम्पनम्, अस्वेदनम्, तीक्ष्णशस्त्रसज्जता, आत्मविश्वासः, आत्मनिग्रहः च।

उपसंहारः (Conclusion)

शल्यचिकित्सायाः जनकः इति समादृतः सुश्रुतः, प्राचीनभारतीयचिकित्सायाम् अद्वितीयं स्थानं अलभत। सुश्रुतसंहिता नाम ग्रन्थः न केवलं शस्त्रचिकित्सायाम् एव सीमितः, अपि तु समग्रचिकित्साशास्त्रस्य व्याप्तिं दर्शयति। तेन रोगिणां पूर्वशल्यचिकित्साकालीनम्, शल्यचिकित्सासमयानम्, च पश्चात्कालीनम् परिचरणं यथासम्भवम् अवलम्ब्य, शास्त्रीयपद्धत्या सम्यक् निरूपितम्।

यद्यपि तस्य काले वेदनानिवारकस्य (anesthesia) उपयोगः अनुपलब्धः आसीत्, तथापि सः अपूर्वकौशलसम्पन्नः चिकित्सकः आसीत्। नासिकायाः पुनर्निर्माणम्, कृत्रिमदृष्टिस्थापनम्, अस्थिसन्धानं च सुश्रुतेन याः क्रियाः विकसिताः, ताः न केवलं तस्य समये क्रान्तिकारी आसन्, किन्तु आज्ञापि आधुनिकचिकित्सायाम् तेषां प्रभावः विद्यमानः सुश्रुतस्य शरीररचनाविज्ञानस्य (anatomy) सूक्ष्मतया अवगमनं, स्वच्छताया च विशिष्टम् आग्रहः, आज्ञावान् चिकित्सा-नैतिकताया च प्रतिमानम् निर्मितवान्।

तस्य योगदानं केवलं प्राचीनशल्यचिकित्सायां न सीमितम्, अपि तु तेन स्थापिताः मानदण्डाः अद्यापि व्यावहारिकचिकित्सायाम् उपयुज्यन्ते। अतः सुश्रुतस्य योगदानं शल्यचिकित्सायाः विकासे विशेषमहत्त्वं वहति। तेन स्थापिता परम्परा अस्माभिः पठनीया, ग्रहीतव्या च, यथा एषा शाखा निरन्तरं उन्नतिं गच्छेत्।

पयरिशेषे तियारी तथा शुक्लामहोदयानां भाषया वक्तुं शक्यते यत्, "It gives me great pleasure in summarizing the achievements of one of the finest teachers' in our surgical heritage: Sushruta - who is proudly known as the 'Father of Indian surgery."[31]

Endnote:

---

[1] *सुश्रुतसंहिता*, सूत्रस्थानम्,३/४१,पृ.२३४/०१२५२
"स्वयम्भुवा प्रोक्तमिदं सनातनं पठेद्धि यः काशिप्रतिप्रकाशितम् । स पुण्यकर्मा भुवि पूजितो नृपैरसुक्षये शक्रसलोकतां व्रजेत् ॥"
[2] A history of Sanskrit Literature, p.436
[3] *सुश्रुतसंहिता*, सूत्रस्थानम्,१/७,पृ.२३०/१२५२
"तत्र, शल्यं नाम विविधतृणकाष्ठपाषाणपांशुलो हलोष्टास्थिबालन-
खपूयास्स्रावदुष्टव्रणान्तर्गर्भशल्योद्धरणार्थं, यन्त्रशस्त्रक्षाराग्निप्रणिधा-नव्रणविनिश्चयार्थं च"
[4] तत्रैव, सूत्रस्थानम्,१/१५,पृ.२३१/१२५२
'आयुरस्मिन् विद्यते, अनेन वाऽऽयुर्विन्दन्ति' इत्यायुर्वेदः' ।
[5] तत्रैव, सूत्रस्थानम्, १/३,पृ.२२९/१२५२.
'अथ खलु भगवन्तममरवरमृषिगणपरिवृतमाश्रमस्थं काशिराजं दिवोदासं
धन्वन्तरिमौपधेनववैतरणौरभ्रपौष्कलावतकरवीर्य (र) गो-पुररक्षितसुश्रुतप्रभृतय ऊचुः' ।
[6] तत्रैव, सूत्रस्थानम्,९/३,पृ.२५८/१२५२
[7] तत्रैव, सूत्रस्थानम्,२५/३,पृ. ३१९/१२५२
"छेद्या भगन्दरा ग्रन्थिः श्लेष्मिकस्तिलकालकः। व्रणवर्मार्बुदान्यर्शश्चर्म कीलोऽस्थिमांसगम् ॥"
[8] तत्रैव, सूत्रस्थानम्,२५/५,पृ. ३१९/१२५२
"अनुषश्चोपदंशाश्च मांसकन्द्यधिमांसकः । भेद्यो विद्रधयोऽन्यत्र सर्वजाहून्थयस्त्रयः ॥"
[9] तत्रैव, सूत्रस्थानम्,२५/९,पृ. ३२०/१२५२
"लेख्यौश्चतस्त्रो रोहिण्यः किलासमुपजिह्विका । मेदोजो दन्तवैदर्भी ग्रन्थिर्वर्त्माधिजिह्विका ॥"
[10] तत्रैव, सूत्रस्थानम्,२५/१०,पृ. ३२०/१२५२
"अर्शांसि मण्डलं मांसकन्दी मांसोन्नतिस्तथा । वेध्या सिरा बहुविधा मूत्रवृद्धिर्दकोदरम् ॥"
[11] तत्रैव, सूत्रस्थानम्,२५/११,पृ. ३२०/१२५२
"एष्या नाड्यः सशल्याश्च व्रणा उन्मार्गिणश्च ये । औहार्याः शर्करास्तिस्त्रो दन्तकर्णमलोऽश्मरी ॥"
[12] तदेव
[13] तत्रैव, सूत्रस्थानम्,२५/१२-१५,पृ. ३२०/१२५२
[14] तत्रैव, सूत्रस्थानम्,२५/१६,पृ. ३२१/१२५२
"पित्तासृक्कफजाश्श्वोष्ठ्याः क्षुद्ररोगाश्च भूयशः । सीव्या मेदःसमुत्थाश्च भिन्नाः सुलिखिता गदाः ॥"
[15] तत्रैव, सूत्रस्थानम्,१६/२७-३१,पृ. २८८/१२५२
"विश्लेषितायास्त्वथ नासिकाया वक्ष्यामि सन्धानविधि यथावत् । नासाप्रमाणं पृथिवीरुहाणां पत्रं गृहीत्वा स्ववलम्बि तस्य ॥

तेन प्रमाणेन हि गण्डपार्श्वदुत्कृत्य बद्धं त्वथ नासिकाग्रम् । विलिख्य चाशु प्रतिसंदधीत तत् साधुबन्धैर्भिषगप्रमत्तः ॥

सुसंहितं सम्यगतो यथावन्नाडीद्वयेनाभिसमीक्ष्य बद्धा । प्रोन्नम्य चैनामवचूर्णयेत्तु पतङ्गयष्टीमधुकाञ्जनैश्च ॥

संछाद्य सम्यक् पिचुना सितेन तैलेन सिञ्श्वेदसकृत्तिलानाम् । धृतं च पाथ्यः स नरः सुजीर्णे स्निग्धो विरेच्यः स यथोपदेशम् ॥

रूढं च सन्धानमुपागतं स्यात्तदर्धशेषं तु पुनर्निकृन्तेत् । हीनां पुनर्वर्धयितुं यतेत समां च कुर्यादतिबुद्धमांसाम् ॥"

[16] तत्रैव, चिकित्सितस्थानम्,३/३,पृ.६९९/१२५२

"अल्पाशिनोऽनात्मवतो अन्तोर्वातात्मकस्य च । उपद्रवैर्वा जुष्टस्य भग्नं कृच्छ्रेण सिध्यति।।"

[17] तत्रैव, चिकित्सितस्थानम्,३/७,पृ.६९९/१२५२

"लेपनार्थं मञ्जिष्ठां मधुकं रक्तचन्दनम् । शतधौतघृतोन्मिश्र शालिपिष्टं च संहरेत् ॥"

[18] तत्रैव, चिकित्सितस्थानम्,३/४,पृ.६९९/१२५२

[19] तत्रैव, चिकित्सितस्थानम्,३/८,पृ.६९९/१२५२

"सप्ताहादथ सप्ताहात् सौम्येष्वृतुषु बन्धनम् । साधारणेषु कर्तव्यं पञ्चमे पञ्चमेऽहनि ॥"

[20] तत्रैव, चिकित्सितस्थानम्,३/१६,पृ.७००/१२५२

"प्रथमे वयसि त्वेवं मासात् सन्धिः स्थिरो भवेत् । मध्यमे द्विगुणात् कालादुत्तरे त्रिगुणात् स्मृतः ॥"

[21] तत्रैव, उत्तरतन्तरम्,१७/५५-६९,पृ.१०१०-१०११/१२५२

[22] तत्रैव, उत्तरतन्तरम्,३८/५-७,पृ.१०१०-१०६३

"विंशतिर्व्यापदो योनेर्निर्दिष्टा रोगसंग्रहे । मिथ्याचारेण या स्त्रीणां प्रदुष्टेनातेवेन च ॥
जायन्ते बीजदोषाच्च दैवाच्च शृणु ताः पृथक् । उदावर्ता तथा वन्ध्या विप्लुता च परिश्रुता ॥
वातला चेति वौतोत्थाः पित्तोत्था रुधिरक्षरा । वामिनी स्रंसिनी चौपि पुत्रघ्नी पित्तला च या ॥"

[23] तत्रैव, सूत्रस्थानम्,२५/१४,पृ. ३२०/१२५२

"अर्बुदानि विसर्पाश्च ग्रन्थयश्चादितश्च ते । त्रयस्त्रयश्चोपदंशाः स्तनरोगा विदारिका ॥"

[24] तत्रैव, निदानस्थानम्,८/८,पृ.५२९/१२५२

"एवं कालप्रकर्षेण मुक्तो नाडीनिबन्धनात् । गर्भाशयस्थो 'यो गर्भो जननाय प्रपद्यते ॥ "

[25] तत्रैव, सूत्रस्थानम्,२२/३,पृ.३१०/१२५२.

[26] तत्रैव, चिकित्सितस्थानम्,२/९,पृ.६८९/१२५२

"समासतो लक्षणतः षड्विधः परिकीर्तितः । छिन्नं भिन्नं तथा विद्धं क्षतं पिच्चितमेव च ॥"

[27] तत्रैव, सूत्रस्थानम्,५/३,पृ.२५३/१२५२

'त्रिविधं कर्म-पूर्वकर्म, प्रधानकर्म, पश्चात्कर्मेति; तद्व्याधिं प्रति उपदेक्ष्यामः।'

[28] तत्रैव, सूत्रस्थानम्,५/५,पृ.२५३/१२५२

[29] तत्रैव, सूत्रस्थानम्,५/६,पृ.२५३/१२५२

[30] तत्रैव, सूत्रस्थानम्,४/७-८,पृ.२४२/१२५२

[31] *Indian Journal of Surgery, 67*(4), p.229.

Select Bibliography:

1. Suśruta. (1945). *Suśrutasaṃhitā* (Nārāyaṇa Rāma Ācārya, Ed. & Rev.). Mumbai: Niryṇayasāgara Mudraṇayantrālaya. . (pdf-archieve.org).
2. Macdonell, A. A. (1900). *A history of Sanskrit literature*. D. Appleton and Company. (pdf-archieve.org).

Journals:

1. Kumar A, Kumar BN (2020) The Principles of Surgical Practice: *Sushruta Samhita* and its Importance to Present Day Surgery. J. Surg Open Access 6(2): dx.doi.org/10.16966/2470-0991.207
2. Satheesh, V. D., Sharada, B. S., Sharma, V., Shailaja, S. V., & Mishra, B. (2014). Surgical procedures in *Sushruta Samhita* and its relevance in modern surgery. *AYUSHDHARA, 1*(1), 32–37.
3. Tewari, M., & Shukla, H. S. (2005). Sushruta: The father of Indian surgery. *Indian Journal of Surgery, 67*(4), 229.

Websites:

1. **উইকিপিডিয়া**. (n.d.). ***সুশ্রুত সংহিতা***. Bengali Wikipedia. Retrieved May 19, 2025, from https://bn.m.wikipedia.org/wiki/%E0%A6%B8%E0%A7%81%E0%A6%B6%E0%A7%8D%E0%A6%B0%E0%A7%81%E0%A6%A4_%E0%A6%B8%E0%A6%82%E0%A6%B9%E0%A6%BF%E0%A6%A4%E0%A6%BE
2. Wikipedia contributors. (n.d.). *Sushruta Samhita*. Wikipedia. Retrieved May 19, 2025, from https://en.wikipedia.org/wiki/Sushruta_Samhita

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

Socio-Economic Determinants of Anaemia Among Indian Women: Some Insights from NFHS-5 In Legacy of the Social Perspective of Sir U.N. Brahmachari

Tanusree Mishra

Assistant Professor of Economics, Department of Economics
Sister Nibedita Govt. General Degree College for Girls
Email: tanushree.mishra84@gmail.com

Received : 20:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract : The problem of anaemia is persistent among Indian women of reproductive age for decades. Exploration of NFHS-5 data (2019-21) reveals that around 54 percentages of women of age group 18-45 are anaemic. Apart from food habits and iron deficiency we have explored the socio-economic determinants influencing the incidence of anaemia among Indian women. Descriptive statistics reveals that the likelihood of anaemia is greater among poor, rural people and if she is underweight, if she is from schedule caste or schedule tribe category rather than from any other caste and if she is a mother. The incidence of anaemia is higher for women having prolonged pregnancy. However the likelihood of being anaemic is lower among women who is educated and reads newspaper daily. Since NFHS-5 data were collected during the pandemic phase, so we have also foundthat the post COVID states have reported less incidence of anaemia among women. This may be due to the fact of less reporting of anaemic cases as the spike of COVID related health issues taken over the attention.

Keywords: NFHS, anaemia, COVID, socio-economic

Introduction:

A non-pregnant woman of reproductive age is considered to be anaemic if her haemoglobin is less than 12g/dl according to WHO (World Health Organisation,2008) [1]. Persistent anaemia causes several types of health risks. Women develops several types of infection, postpartum haemorrhage, low physical and mental capabilities and maternal mortality [2,3,4].The primary cause of Anaemia is nutritional deficiency, such as iron, vitamin B12, vitamin C, folic acid etc [5,6]. However, iron deficiency related anaemia is the most prevalent indeveloping nations. South Asian countries ranked highest in number of anaemic women due to the persistent cases of malnutrition [7,8]. In case of India, apart from inadequate dietary intake, women remainat high risk of being anaemic due to gender discrimination and disempowered in decision making for health, food and education[9,10]. Socio economic inequality breeds anaemia in India [11,7]. Religion, race, ethnicity and poor sanitary and drinking facility are one of the key determinants influencing anaemia prevalence in India [10].Several researchers have investigated the causes of anaemia among women in India. Sharif et al.(2023)[6] explored the level and trend of anaemia prevalence among the socially disadvantaged group (SC&ST, OBC) of women and observed that multiple socio-demographic factors ranging from poor economic and educational status, rural residence to higher childbearing of women are responsible for predicting anaemia levels among the social groups of women in India. Let et al.(2024)[5]analysed both NFHS-4 and NFHS-5 data and found a significant increase in anaemia among women of reproductive age from aspirational districts of India. Mangla and Singla (2016) [12]observed various socio demographic factors that contribute to high prevalence of anaemia among pregnant females from their longitudinal study conducted in the general hospital of Gohana town in district of Sonipat of rural India.Maji et al.(2023)[13] found that NFHS-5 data indicates a surge in anaemia incidences significantly across women of all age groups

over the last five year. Sharma et al.(2018) [14] observes that women in India are not only suffering from economic inequalities but also inequalities in terms of food and malnutrition which causes high prevalence of anaemia among them. Das et al.(2023)[15] observed from their analysis, it was clear that nutritional status and anaemia has an impact on COVID-19 cases over the hotspot states of India. Based on the literatures on anaemia, the present study tries explore the details of the socio economic and socio demographic determinants of anaemia among non-pregnant women in India. The study also highlighted the effect of higher education and mass media exposures on anaemia, and lastly we focused on the effect of COVID pandemic on the incidence of anaemia among women using NFHS-5 data.

Data:

The National Family Health Survey (NFHS) is a large-scale, multi-round survey conducted in a representative sample of households throughout India.NFHS-5(2019-21) survey was conducted when India was suffering from the waves of COVID-19 pandemic. A total of

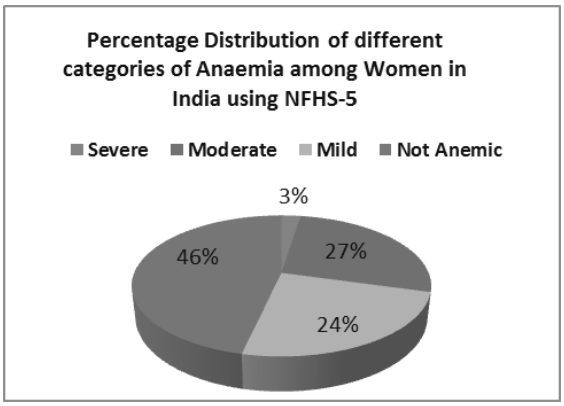
Anaemia Category	% of women respondents in NFHS-5 (2019-21)
Severe	2.62
Moderate	27.64
Mild	24.41
Not Anaemic	45.33
Total	100

45,739 women respondents are included in the present study and all of them are married and at age category of 15-49 years.

Table1: Percentages of different categories anaemia among women in India in NFHS-5 Source:Author's own calculation

From the above table we observe that around a total 54.67% of women are anaemic, among them 27.64% are moderately and 24.41% are mildly anaemic.

Figure1:



Variables:

Incidence of anaemia:

In this analysis we have considered the women respondent of age group 15-45 years as anaemic if the haemoglobin level is lesser than 12 g/dl and it is coded as 1 and 0 for haemoglobin level greater equal to 12 g/dl.

Socio economic and bio demographic variables:

Based on the existing literature we have considered the following control variables[13, 16] we have included wealth status of the respondent, type of residence, religion and caste category of the respondent, highest level of educational attainment of the respondent and also frequency of reading newspaper. For bio demographic determinants on the incidence of anaemia we have included Body Mass Index of the respondent, frequency of eating pulses or beans, frequency of eating milk or curd, whether she uses contraceptive or not and lastly the impact of COVID pandemic on the incidence of anaemia.

Methodology:

A detailed descriptive summary statistics is presented using the NFHS-5 data. Percentages along with mean and S.D is calculated using "summarize" command of STATA. The percentages for all the determinants are calculated only for anaemic women.

Result and Discussion:

Variables	Level	%	Mean ± S.D
Anaemia	No (<12g/dl) Yes (>=12g/ dl)	54.67	0.510±0.500
Wealth status	Poor	45.95	0.428±0.495
	Middle income	19.75	0.205±0.403
	Rich	34.31	0.367±0.482
Contracep-tive Use	Yes	67.24	0.680±0.466
COVID phase	Phase 1	48.42	0.474±0.499
	Phase 2	51.58	1.526±0.499
Frequency of eating pulses or beansdaily	Yes No	48.30 51.70	1.601±0.642
Highest level of Education	No edu-cation	29.59	0.278±0.448
	Primary	14.28	0.138±0.345
	Second-ary	45.62	0.464±0.499
	Higher	10.51	0.120±0.325
Frequency of taking milk or curd	Daily	44.99	0.469±0.499
	Weekly	22.93	0.227±0.419
	Occa-sionally	24.91	0.236±0.425
Body Mass Index	. Under-weight	16.16	0.130±0.337
	Healthy Weight	59.62	0.578±0.494
	Over-weight	17.89	0.198±0.399
	Obesity	6.33	0.093±0.290
Frequency of reading newspaper or magazine	Yes	25.99	0.395±0.683
Religion	Hindu	78.97	0.754±0.431
	Muslim	10.90	0.116±0.320
	Other	10.12	0.130±0.337
Caste category	General	22.77	0.238±0.426
	ST	25.58	0.251±0.434
	OBC	51.65	0.511±0.500
Type of Residence	Rural	77.84	
	Urban	22.16	0.245±0.430

Source: Authors calculation based on NFHS-5 Data

From the above table we observe that the percentage of anaemic women among the poor respondents is more (45.95%) than who belong to middle income class. The percentage of anaemia increases for women who do not use any type of contraceptive (32.76%). The likelihood of anaemia is found to be lesser in post COVID dataset(51.58%). The result may be due to anaemia is the contributory factor for various respiratory diseases such as COVID-19 [15]. Respondents who consume pulses or beans and who consume milk or curd may be daily (44.99%) or occasionally than those who do not or never consume these food items are more likely to have anaemia. The percentage of anaemia increases for women who are overweight or obese than women who are underweight. Next we observe that women who are highly educated reported lesser incidence (10.51%) of being anaemic and Further, women who reads newspaper daily (25.99%) the odds are less for being anaemic than who do not (74.01%) and The percentage of being anaemic for respondents are lesser for Muslim (10.90%) or any other religion (10.12%) than the reference category Hindu (78.97%).The percentage of anaemic women is more among the OBC (51.65%) and schedule tribe (25.58%) than general caste (22.77%) category following observations of Sharif et al.(2023)[6]. The odds for being anaemic are greater for women from rural (77.84%) area than women from urban area. All the findings are in line with Mog et al. (2023)[10].

Conclusion:

The increase in percentage of anaemic women in India is a major concern. The present study observes that poor, less educated, rural women with less exposure to mass media and women from OBC caste are more prone to be anaemic. Further we observe that more percentages of women become anaemic who has poor dietary intake and who are overweight or obese[17]. Anaemic women are more inclined to get affected with respiratory diseases like COVID 19. Several policies have been formulated to combat the persistent increase in anaemia among women.

Govt.of India launched Anaemia Mukt Bharat program in 2018 to reduce anaemia prevalence among reproductive women. National Nutritional Anaemia Prophylaxis Programme (NNAPP)launched in 1970 to reduce the iron deficiency of women and children. However the success is too far away from reality. Awareness campaign for women in rural area should be arranged to spread benefits of healthy food consumption and higher education. Efforts should be given to the betterment of socially backward classes by providing better economic infrastructure along with public health campaign.

References

[1]https://www.who.int/docs/default-source/gho-documents/world-health-statistic-reports/en-whs08-full.pdf
[2]https://www.who.int/campaigns/world-health-day/2020
[3] Das M, Verma M, Barman P, Behera DK. Prevalence of anaemia among married women with recent birth history and high-risk fertility behaviour: secondary data analysis of the National Family Health Survey -India (2019–21). BMJ open. 2024 Jan 1;14(1):e073395.
[4] Rush D. Nutrition and maternal mortality in the developing world. The American journal of clinical nutrition. 2000 Jul 1;72(1):212S-40S.
[5] Let S, Tiwari S, Singh A, Chakrabarty M. Prevalence and determinants of anaemia among women of reproductive age in Aspirational Districts of India: an analysis of NFHS 4 and NFHS 5 data. BMC Public Health. 2024 Feb 12;24(1):437.
[6] Sharif N, Das B, Alam A. Prevalence of anemia among reproductive women in different social group in India: cross-sectional study using nationally representative data. Plos one. 2023 Feb 2;18(2):e0281015.
[7]https://www.who.int/publications/i/item/9789241565486
[8] Bentley ME, Griffiths PL. The burden of anemia among women in India.European journal of clinical nutrition. 2003 Jan;57(1):52-60.
[9] Das PP, Kapoor M, Mishra A, Malviya A, Buragohain D, Goswami D. Anemia profile and iron deficiency in patients with heart failure: a hospital-based study in Northeast India. Heart Failure Journal of India. 2023 Sep 1;1(3):189-94.
[10] Mog M, Neogi D, Bharadwaz MP, Panda BK, Sil A. Prevalence and factors associated with Anaemia in Married Women of Reproductive age group: Evidence from North East India. Journal of Biosocial Science. 2023 May;55(3):425-37.
[11]https://www.who.int/news/item/15-05-2014-world-health-statistics-2014
[12] Mangla M, Singla D. Prevalence of anaemia among pregnant women in rural India: a longitudinal observational study. Int J ReprodContraceptObstet Gynecol. 2016 Dec 15;5(10):3500-5.
[13] Maji I, Randhawa JK, Bakshi D, Gautam D, Mishra SS. Status of Anaemia amongst women in India: trend analysis of NFHS data. Indian Journal of Community Health. 2023 Sep 30;35(3):354-8.
[14] Sharma H, Singh SK, Srivastava S. Major Correlates of Anemia among women (Age 15–49) in India and spatial variation, evidence from National Family Health Survey-4. J Women's Health Care. 2018;7 (440):2167.
[15] Das A, Das M, Ghosh S. Impact of nutritional status and anemia on COVID-19: Is it a public health concern? Evidence from National Family Health Survey-4 (2015–2016), India.Public Health. 2020 Jun 9;185:93.
[16] Bharati P, Shome S, Chakrabarty S, Bharati S, Pal M. Burden of anemia and its socioeconomic determinants among adolescent girls in India. Food and Nutrition Bulletin. 2009 Sep;30(3):217-26.
[17] Datta BK, Haider MR. The double burden of overweight or obesity and anemia among women married as children in India: A case of the Simpson's paradox. Obesity Research & Clinical Practice. 2022 Sep 1;16 (5):364-72.

AJHMC
ISSN : 0973-6212

Volume : 12 No. 1 & 2
June, 2025

Title: Dr. U.N. Brahmachari: Nationalism, Self-Reliance, and Medical Autonomy

Piku Das Gupta

Associate Professor, PG Dept. of Political Science,
Hooghly Mohsin College

Received : 26:05:2025 Accepted : 27:05:2025 Published : 07:06:2025

Abstract: Dr. Upendranath Brahmachari (1873–1946) was a pioneering Indian physician whose groundbreaking discovery of Urea-Stibamine revolutionized the treatment of kala-azar, a fatal tropical disease. His innovative research combined rigorous scientific methodology with a nationalist drive for self-reliance, challenging colonial -era dominance in medical advancements. Brahmachari's synthesis of Urea-Stibamine significantly reduced mortality rates, affirming the potential of indigenous medical research. His advocacy for scientific autonomy was deeply intertwined with the Swadeshi movement, reinforcing the need for locally driven healthcare solutions. Moreover, he championed institution-building, including the establishment of India's first blood bank, fostering a resilient medical infrastructure that prioritized domestic talent and public health reforms. Despite his monumental contributions, global recognition - such as a Nobel Prize - eluded him, highlighting the systemic biases in international scientific appraisal. His work not only reshaped Indian healthcare policy but also set a precedent for decentralized, grassroots medical innovation. Brahmachari's legacy continues to influence contemporary health policies and research paradigms, underscoring the enduring impact of indigenous scientific excellence.

Keywords: Urea-Stibamine, Kala-azar treatment, Scientific self-reliance, Colonial healthcare challenges, Indigenous medical innovation.

Introduction: Dr. Upendranath Brahmachari (1873–1946) was a pioneering Indian physician whose groundbreaking discovery of Urea-Stibamine revolutionized the treatment of kala-azar, a form of visceral *leishmaniasis*, during a time of intense colonial domination (Chen, 1949). His innovative work was not only a significant medical breakthrough but also an assertion of indigenous scientific prowess at a time when Western methodologies were privileged. Devoted to addressing India's unique public health challenges, Brahmachari developed life-saving treatments that alleviated the suffering of countless individuals, marking a decisive step towards decentralized, locally relevant

[1] Urea stibamine, synthesized by Upendranath Brahmachari in 1922, was a significant treatment for kala-azar (visceral leishmaniasis). It's a brownish amorphous powder, water-soluble, and forms a reddish solution. Brahmachari's discovery earned him Nobel Prize nominations and saved numerous lives in countries like India, France, Greece, and China.

[2] Kala azar, also known as visceral leishmaniasis, is a severe parasitic disease primarily found in India and its neighboring countries. It's caused by the protozoan parasite Leishmania donovani and transmitted through the bite of infected sandflies. If left untreated, kala azar is almost always fatal.

[3] Visceral leishmaniasis (VL), also known as kala-azar or "black fever", is a serious and potentially fatal parasitic disease caused by Leishmania parasites transmitted by sandflies. It's characterized by irregular bouts of fever, weight loss, and enlargement of the spleen and liver. If left untreated, VL can be fatal, with over 95% of cases resulting in death.

healthcare. His research uniquely combined rigorous scientific inquiry with a deep commitment to social justice, serving as both a clinical innovation and a potent symbol of nationalist self-reliance. The roots of the nationalist ethos can be traced back to the early movements against colonial rule. Leaders and thinkers envisioned a nation that would reclaim its heritage and build entirely upon its own resources. This vision gave birth to initiatives that encouraged the revival of native arts, industries, and scientific research. The famed Swadeshi Movement, for example, promoted indigenous products and laid the groundwork for the broader idea of "Atma Nirbhar Bharat" or self-reliant India—a concept that has seen significant resurgence in contemporary discourse. This introduction sets the stage for a detailed exploration of his contributions: from his medical innovations to his resistance against colonial constraints, his efforts in institutional development, and the enduring legacy he carved in modern Indian healthcare. The sections that follow will further elucidate the confluence of science, nationalism, and self-determination characterizing his work.

Medical Innovation and the Discovery of Urea-Stibamine

In the early decades of the twentieth century, kala-azar emerged as a significant public health challenge in colonial India, particularly among impoverished rural communities. Official records clearly indicate that British India was severely affected by epidemics and contagious diseases. Despite being aware of these health crises, the colonial government refrained from implementing preventive or curative measures for nearly a century (Mund, 2021). The British colonial power in India exhibited lack of concern for the remedial measures towards the treatment of tropical diseases and subsequent research. Dr. Upendranath Brahmachari, driven by acute awareness of these health crises, embarked on a meticulous inquiry into the pathology of kala-azar. His persistent research led to the synthesis of Urea-Stibamine, a novel therapeutic agent that dramatically reduced mortality rates and improved patient outcomes. Brahmachari's rigorous laboratory experiments and methodical clinical trials demonstrated how indigenous research, even under resource-constrained conditions, could produce life-saving advancements. By 1925, the use of Urea-Stibamine had successfully reduced the mortality rate of Kala-azar to 10%, achieving a remarkable cure rate of 95%. This drug was widely utilized for treating Kala-azar not only in India but also in Greece, France, and China for several years (Saha, Chaudhury, & Maji, 2021).

Urea-Stibamine was far more than a pharmaceutical breakthrough; it symbolized a broader commitment to self-reliance in medical science. By relying on local expertise and scientific acumen, Brahmachari's work decisively challenged prevailing assumptions that Western medicine was the sole source of effective treatment. This innovation not only alleviated the severe burden of kala-azar among affected populations but also served as an assertion of national intellectual sovereignty. His success galvanized further local research into tropical diseases, paving the way for a renewed framework of autonomous and context-specific medical investigation in India.

Moreover, the development of Urea-Stibamine redefined the role of indigenous research within a colonially dominated scientific milieu. By overcoming immense institutional and resource barriers, Brahmachari's discovery underscores the potential for locally driven scientific breakthroughs to confront and transcend external domination. His pioneering work remains a landmark achievement in global health, testifying to the transformative power of homegrown innovation in tackling region-specific medical challenges.

Colonial Challenges and Advocacy for Scientific Self-Reliance

British colonial rule justified its authority through a developmentalist perspective that portrayed the colonized population as underdeveloped and fragmented. The portrayal of colonial subjects as "underdeveloped" framed the Indian population as incapable of self-

governance, effectively postponing their sovereignty to an uncertain future (Sultan, 2020). Even after 150 years of British rule, Western medical practices continued to face significant challenges in gaining widespread acceptance among the Indian population (Arnold, 1993, p.3). Under British colonial rule, Indian scientists operated within a framework intentionally designed to subdue indigenous research. The prevailing policies favoured Western methodologies and institutions, thereby restricting funding, modern laboratory access, and institutional support for native scholars. Such systemic barriers were instrumental in maintaining the colonial hierarchy by marginalizing local expertise and innovation.

Despite these formidable challenges, Dr. Upendranath Brahmachari transformed adversity into an opportunity for pioneering public health advancements. Confronted with the dual burden of tropical diseases and colonial neglect, he channelled his efforts into developing effective treatments that could be produced locally. His synthesis of Urea-Stibamine not only provided a breakthrough cure for kala-azar but also emerged as a potent symbol of scientific self-reliance. By relying on indigenous knowledge and resourcefulness, Brahmachari's work challenged the notion that Western science was the sole harbinger of medical progress.

Brahmachari's advocacy extended beyond the laboratory. It was rather closely intertwined with the broader Swadeshi movement**,** advocating for all encompassing self-reliance**.** Indian nationalism is an intricate fabric shaped by centuries of intellectual, cultural, and political struggles, ultimately converging into a unified aspiration for self-sufficiency. Central to this movement is the principle of self-reliance—not just a demand for political autonomy from colonial rule, but a resolute call to revive and utilize indigenous strengths in pursuit of a sovereign and self-sustaining future. He argued that the health of a nation could only be secured through an internally sustained research ecosystem that was attuned to local challenges. In doing so, he not only countered the global dominance of Eurocentric scientific discourse but also laid the groundwork for an autonomous framework of medical research in India. His work inspired subsequent generations of Indian researchers to pursue solutions tailored to the unique healthcare needs of their communities, reinforcing the ideal that true progress emanates from self-determination and local expertise.

Institution-Building and Grassroots Healthcare Reforms

Dr. Upendranath Brahmachari understood that the transformative potential of his scientific breakthroughs could be amplified only through robust institutional support and locally grounded healthcare reforms. One of his most notable contributions was the establishment of India's first blood bank, a pioneering venture that revolutionized emergency medical care by ensuring the rapid availability of lifesaving blood supplies for patients in critical need.

Brahmachari's vision extended well beyond a single institution. He was instrumental in founding hospitals and research centers that served as incubators for local scientific talent. His hospital in Kolkata, for instance, not only provided high-quality clinical care to underserved communities but also fostered an environment where indigenous practitioners could receive advanced training and engage in collaborative research. This dual approach, combining patient care with scientific inquiry, significantly advanced the domestic capacity for addressing region-specific health challenges.

Moreover, Brahmachari's institution-building efforts were imbued with a strong commitment to social justice. He believed that accessible healthcare was a cornerstone of national self-determination and that the empowerment of local communities was essential for overcoming the vestiges of colonial dependency. By integrating grassroots engagement with high-caliber medical research, he laid the foundation for a decentralized healthcare model that continues to inform public policy in modern India. His legacy in institutional reform not only fortified the nation's scientific infrastructure

but also served as a catalyst for future innovations driven by local resources and expertise.

Recognition, Controversies, and Global Scientific Biases

Dr. Upendranath Brahmachari's development of Urea-Stibamine for kala-azar treatment, stands as a monumental achievement in Indian medical science that, paradoxically, received limited international recognition. Despite clear evidence of his treatment's efficacy and transformative impact on reducing mortality among afflicted populations, Brahmachari was notably overlooked by major global awards such as the Nobel Prize (Saha, Chaudhury, & Maji, 2021). This omission has prompted extensive scholarly debate regarding the structural biases inherent in the global scientific community, biases that have historically prioritized research emerging from western institutions over that conducted within colonial contexts.

The controversy surrounding Brahmachari's unrecognized achievements underscores deeper issues of exclusion and marginalization. His pioneering efforts, which not only advanced clinical practice but also symbolized a broader nationalist assertion of scientific autonomy, challenged prevailing Eurocentric narratives of medical progress. Critics contend that his case exemplifies how political dynamics and systemic prejudice under colonial rule contributed to the undervaluation of indigenous scholarship. Such oversight inadvertently reinforced a cycle in which non-Western scientific contributions remained perpetually on the periphery of international acclaim.

Moreover, Brahmachari's experience illustrates the broader consequences when exceptional local innovations are sidelined. The failure to acknowledge his work not only diminished his personal legacy but also impeded the momentum for an indigenous research paradigm tailored to the unique challenges of tropical medicine. This historical oversight serves as a call for re-examining the criteria by which scientific merit is judged and recognized. Contemporary scholars advocate for a more inclusive evaluative framework—one that values scientific ingenuity regardless of geographical or political origin, thereby ensuring equitable acknowledgment of breakthroughs that have the potential to reshape global health outcomes.

Legacy and Impact on India's Healthcare Policies

Dr. Upendranath Brahmachari's enduring legacy has profoundly shaped the contours of India's healthcare landscape and pharmaceutical policies long after colonial rule ended. His groundbreaking innovation -the development of Urea-Stibamine for kala-azar was more than a medical breakthrough; it was a clarion call for scientific self-reliance that challenged the era's dominant Western paradigms. By demonstrating that locally driven research could decisively combat region-specific diseases, Brahmachari not only saved countless lives but also inspired a transformational reorientation in public health priorities.

In the post-independence India, Brahmachari's methods became a cornerstone for the nation's evolving healthcare strategies. His relentless pursuit of institution-building, exemplified by the establishment of the country's first blood bank and other medical research facilities, set in motion a ripple effect across the healthcare sector. These institutions provided the necessary infrastructure for rigorous scientific inquiry and advanced clinical care, effectively bolstering the nation's ability to manage endemic diseases with indigenous expertise[2]. Brahmachari's model integrated research with grassroots healthcare delivery, a dual approach that has since been enshrined in national policy reforms aimed at decentralizing medical services and fostering local innovation.

Furthermore, his work significantly contributed to the growth of a resilient domestic pharmaceutical industry. By advocating for policies that prioritized local resources, technology transfer, and capacity building, Brahmachari established a

framework within which subsequent researchers could develop region-specific therapeutic solutions. This strategic emphasis on self-sustaining research ecosystems has continued to influence health policy, ensuring that modern initiatives remain closely aligned with the unique needs of the Indian populace. Today, Brahmachari is celebrated not only for his clinical achievements but also for his visionary role in shaping a healthcare system rooted in indigenous strengths and social equity. His lifetime of contributions continues to inspire policymakers and researchers who strive to create an inclusive and responsive healthcare landscape in India. There remains much to learn from his life, encapsulated in the four guiding principles—Discipline, Devotion, Dedication, and Diligence (Bharati, 2024).

Conclusion

Dr. Upendranath Brahmachari's enduring contributions have indelibly shaped the trajectory of Indian medical science and policy. The legacy is interwoven with the broader tapestry of Indian nationalism. His work stands as a testament to how self-reliance in science contributed to the nation's overall struggle for identity and autonomy. In a time when the colonial regime sought to control every facet of Indian life, independent research and indigenous innovation became acts of defiance and symbols of resistance. Such groundbreaking contributions reinforced the belief that for India to be truly free, it needed to cultivate strength in every domain-political, economic, cultural, and scientific. Ultimately, Brahmachari's integrated vision of medical innovation, institution-building, and national pride offers enduring lessons for global health policy. His contributions remind us that sustainable progress in healthcare is most achievable when science is firmly rooted in the realities of its community and when national efforts are acknowledged, valued, and given importance, particularly in relation to international collaborations.

Today, the call for self-reliance continues to echo in modern policies and initiatives that aim to enhance local production, innovation, and economic sustainability. As India moves forward into the global sphere, it does so by paying homage to the legacy of visionaries like Dr. U.N. Brahmachari, whose spirit of innovation and commitment towards the nation continues to inspire. In essence, the synergy between Indian nationalism, self-reliance, and the pioneering work of Dr. U.N. Brahmachari illustrates a fundamental truth: a nation's true strength lies in its ability to harness and celebrate its potential.

References

- Arnold, D. (1993). *Colonizing the body: State medicine and epidemic disease in nineteenth-century India*. University of California Press.
- Bharati, K. (2024). Sir U.N. Brahmachari: His life & his science. *Indian Journal of Physiology and Allied Sciences, 76*(2), 3–7.
- Chen, T. T. (1949). Rapid Treatment of Chinese Kala-Azar with Urea Stibamine: A Report of Twelve Cases. *Annals of Tropical Medicine & Parasitology*, *43*(2), 174–181. https://doi.org/10.1080/00034983.1949.11685403
- Mund, S. (2021). Colonialism and the politics of epidemiology: The rise of radical nationalism in India. *Miroirs: Revue des civilisations anglophone, ibérique et ibéro-américaine*, *6*, 42–65. https://ffhal-03350204
- Saha, P., Chaudhury, A., & Maji, A. K. (2021). Sir U.N. Brahmachari and his battle against Kala-Azar. *Tropical Parasitology, 11*(2), 89–91. https://doi.org/10.4103/tp.tp_48_21
- Sultan, N. S. (2020). Self-rule and the problem of peoplehood in colonial India. *American Political Science Review, 114*(1), 81–94. https://doi.org/10.1017/S0003055419000601

Guidelines for Authors

The academic Journal of Hooghly Mohsin College is a peer reviewed, multidisciplinary, multilingual Journal. AJHMC welcomes the submission of original research articles, review papers, case studies, and other scholarly contributions relevant to the scope of the journal. All submissions must adhere to the following guidelines to be considered for peer review and publication.

1.Scope and Aims Manuscripts must align with the aims and scope of the journal. Submissions that fall outside the thematic focus may be rejected without external review.

2. Manuscript Preparation

General Format

Language: All manuscripts must be submitted in English (UK/US consistency required). File Type: Submit in Microsoft Word (.doc or .docx). Font: Times New Roman, 12-point, double-spaced. Margins: 1 inch (2.54 cm) on all sides. Line Numbers: Include line numbers for ease of review. Structure
The manuscript should typically include the following sections: Title Page (title, authors, affiliations, corresponding author contact)

Abstract (150–250 words), Keywords (4–6 words) Introduction, Methods, Results, Discussion, Conclusion Acknowledgements (if any), References

Tables and Figures: Include tables and figures at the end of the manuscript or in a separate file. Each must be numbered consecutively and cited in the text. Provide descriptive captions.

3. Referencing Style: Use the [insert preferred citation style, e.g., APA 7th, Chicago, Vancouver] referencing style. Ensure consistency throughout the manuscript.

4. Ethical Considerations: Authors must confirm that the manuscript is original and has not been published elsewhere.

All authors must have made a significant contribution to the work.

Research involving human participants or animals must include appropriate ethical approval and informed consent statements.

5. Peer Review : All manuscripts undergo peer review process.

6. Conflict of Interest : Authors must disclose any financial or personal relationships that may bias the work.

7. Contact Information

For further inquiries, please contact the editorial office at:

unbarticle@gmail.com, hooghlymohsincollege@gmail.com