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❖ 2018-19 (7)



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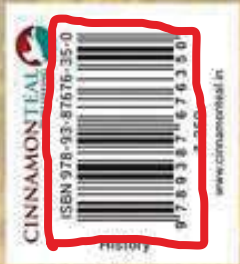
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PUBLIC HISTORY OF GOA
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Edited by Savio Abreu,
Anthony Da Silva, Rinald D'Souza



eISSN: 2213-3585

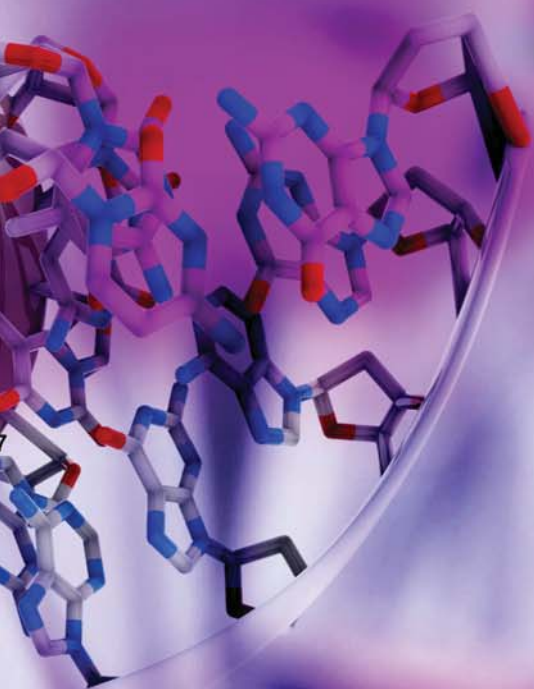
ISSN: 2468-5860

eISBN: 978-1-68108-627-9

ISBN: 978-1-68108-628-6

Volume 7

Topics in **Anti-Cancer Research**



Editors:

Atta-ur-Rahman, *FRS*

Khurshid Zaman

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“Topics in Anti-Cancer Research”

(Volume 7)

Edited by

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&

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Bentham Science Publishers, USA

Topics in Anti-Cancer Research

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Editors: Atta-ur-Rahman, *FRS* and Khurshid Zaman

ISSN (Print): 2468-5860

ISSN (Online): 2213-3585

ISBN (Online): 978-1-68108-627-9

ISBN (Print): 978-1-68108-628-6

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Taxol To Nanotaxol: A Journey Towards Enhanced Drug Delivery

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Abstract: Drug delivery in the field of cancer has undergone a continuous revolution over the past few decades. Development of novel chemotherapeutic agents without the method of delivering them to the tumor site would find no practical application in uprooting the fatal disease of uncontrolled cell proliferation, cancer. This makes the development of drug carriers exceedingly essential for diagnostics and therapy alike. Nanotechnological science has gained impetus in the recent past and has found applications in a plethora of fields. It has managed to create an impact in the field of diagnostics, drug delivery and therapy, equally. Taxol[®], a chemotherapeutic agent that was initially obtained from the bark of *Taxus brevifolia*, moved on to the semi-synthetic approach for its synthesis to address the shortage of its natural source. This drug is partially soluble in water and its initial formulation with Cremophor EL manifested as anaphylactic reactions. To do away with these problems and others such as lower circulation time in blood and non-specificity, nanotechnology is now being looked at as a promising solution. Nanotechnological carriers aim at enhancing target-specificity by functionalization, drug stabilization and preventing its degradation due to physiological conditions, pH, enzymes, etc., demonstrating an Enhanced Permeability and Retention (EPR) effect, prolonged blood circulation and thus better anti-tumor activity, while the side effects being almost negligible. The patents in this chapter aim to highlight how nanotechnology can find practical applications and how one or more than one drugs could be administered *in vivo* in a sustained fashion. The step-wise development in using this potent anticancer drug (Taxol) involved the use of human serum albumin associated compositions (Abraxane[®]), cremophor-free formulations (Capxol[™], Genexol-PM[™]), numerous oil-in-water emulsions, liposomes and micelles, use of graphene quantum dots (GQDs) for bioimaging and drug delivery and the use of single-walled and multi-walled carbon nanotubes. It also allows the readers to explore nanodevices that can be turned on and off as and when the need be for localized drug delivery. Enabling the nanocarriers to modulate the pharmacokinetic and pharmacodynamic properties of the drug is another notable feature that some of these nanocarriers possess.

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Keywords: Abraxane[®], anti-angiogenic, cancer, carbon nanoparticles, Cremophor-free, devices, drug delivery, emulsions, increased tumor specificity, liposomes, micelles, nanocarriers, paclitaxel, prolonged circulation time, protein associated, reduced hypersensitivity, surface-functionalized, Taxol[®], *Taxus brevifolia*, tubulin stabilizing.

1. INTRODUCTION

A normal cell, when developing a neoplastic behaviour, adopts the 6 hallmarks of cancer, turns tumorigenic and may exhibit malignancy. Withstanding cell death signals while sustaining the proliferative ones, eluding growth suppressors, induction of the process of angiogenesis, actuating invasion and promoting metastasis and thus enabling the cells to attain immortal replication ability are the six prominent hallmarks of cancer that the cells adopt [1]. In the developed and the developing countries, cancer is the first and the second leading cause of death, respectively [2]. According to the GLOBOCAN project which is an initiative by The International Agency for Research on Cancer (IARC), the world witnessed 12.7 million cancer cases in the year 2008 [2], while the numbers increased to 14.1 million in the year 2012 [3]. The number of deaths resulting from succumbing to cancer also saw a rise from 7.6 million in the year 2008 [2] to 8.2 million in 2012 [3]. This alarming rate of falling prey to the disease crops up from the present-day sedentary lifestyle, imitation of food and diet fads from the western world and increased tendencies of smoking and alcoholism [2, 4 - 6]. The current modes of treatment available to combat cancer include surgery, employing chemotherapy and radiation therapy in combination or individually, depending on the severity, the type and the stage of cancer [7]. The 1960's witnessed the approval of chemotherapeutic agents like vincristine and vinblastine that were derived from natural sources [8]. The forage for more natural alternatives heightened between the period from 1960-1981, when a collaborative plant screening program was initiated by the National Cancer Institute (NCI) and the U.S. Department of Agriculture (USDA). This program was successful in the collection of about 1,15,000 extracts from 15,000 plant species and their testing which resulted in the identification of a few natural sources for the isolation of molecules that possess potent anticancer activities [9].

Samples from *Taxus brevifolia*, the Pacific yew tree were analyzed by Arthur Barclay, a botanist at USDA. The fruit, needle, twig and bark extracts were tested for their anticancer activity and only the bark extract showed significant cytotoxicity [9, 10]. The bark samples of *Taxus brevifolia* were received in 1964 by two scientists, Mansukh Wani and Monroe Wall, working at the Research Triangle Institute [9, 10]. The bark extract showed potent cytotoxicity against human nasopharynx cancer cell line, 9KB and mouse leukemia cells (*in vitro* cytotoxicity assessment models), while it did not show promising results *in vivo*

[11 - 13]. Following this, attempts to obtain Taxol in its pure crystalline form, begun. In 1966, the active ingredient, that was responsible for the cytotoxic activity, was isolated in its crystalline form. It was named as Taxol in the year 1967 [9, 10], after its source of origin and the presence of hydroxyl groups [9]. Determination of the structure of Taxol required its purified form to be available in large quantities. This was, however, not the case. Twelve kg of stem bark that was air dried could produce only 0.5g of Taxol, the yield being as low as 0.004% [12]. It was also estimated that around 1g of active Taxol could be obtained from three 100-year-old, mature *Taxus brevifolia* trees [11]. With the betterment of the procedures for isolation and purification, the structure of Taxol was elucidated in the year 1971 and reported to be the first compound with a taxane ring possessing antileukemic properties and those capable of tumor inhibition [12, 14]. Although a potential candidate for a chemotherapeutic drug, certain drawbacks of Taxol caused researchers to lose interest in the molecule. Water insolubility of the molecule meant elimination at the formulation stage due to the difficulty in drug delivery [10, 11]. Polyethoxylated castor oil was thus employed for its formulation which leads to various anaphylactic reactions. This was another major cause why the development of Taxol as a chemotherapeutic was looked down at [9]. The inability of total chemical synthesis owing to its complicated structure, complex multistep synthesis procedure, as well as low yields and scarce availability of natural resources for its extraction, further discouraged the drug from reaching advanced development stages [9 - 13, 15]. Also, a low degree of cytotoxicity was identified in P-388 and L-1210 cells and this further dampened the interests [12, 13]. For about a decade, the investigations in this field were at a standstill.

The excellent cytotoxic activity of Taxol against murine B16 melanoma (relatively resistant) and xenografts of human tumors introduced into nude mice when brought to light, furthered its development and it advanced from the preclinical stage to the animal toxicology study stage [10, 12, 13]. Its unique mode of action enthralled the researchers and they were motivated to work towards developing this molecule into a promising chemotherapeutic drug. Taxol promotes the process of microtubule assembly by stabilizing tubulin, thus inhibiting cell division, by preventing the disassembly of the microtubules [9 - 11, 15 - 17]. It does so by causing a shift in the equilibrium towards microtubule assembly by the elimination of the lag period that precedes the process [15, 18]. Taxol interacts with β -tubulin at a specific site (a binding pocket) constituting of β -strands and α -helices [11, 19, 20]. The cells are seen to be arrested in the G2/M phase of the cell cycle, post binding of Taxol to the binding site, not enabling the mitotic spindle to de-construct [11, 15, 18, 20]. Reports on activities of Taxol other than that on microtubules highlight its ability to alter cellular signalling cascades by activation of molecules like Raf-1, nitric oxide synthase and kinases

एक और द्रोणाचार्य एक विश्लेषण



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- संपर्क : 3, नव हिमालय सोसायटी, सुनील नगर, डोंबिवली (पूर्व) 421201
ठाणे, महाराष्ट्र, मोबाइल -77385 46598
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ISBN : 978-93-86579-54-6

प्रथम संस्करण : 2018

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प्रकाशक:

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दूरभाष: 9987478404/9869341047

ई-मेल: vidyapeethprakashan@gmail.com

ISBN 978-81-922913-4-5

मूल्य : 350/-

प्रथम संस्करण : 2018

मुद्रक : नई किताब, नई दिल्ली

सर्वाधिकार : लेखकाधीन

Ek Aur Dronacharya

Edited By : Dr. Santosh Kaul Kak

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'एक और द्रोणाचार्य' नाटक शंकर शेष ने लिखा है। यह एक लघु नाटक है। इसे पूर्वार्ध तथा उत्तरार्ध दो अंको में लिखा गया है। रचना में पौराणिक पात्र द्रोणाचार्य के चरित्र को नवीन संदर्भों में प्रस्तुत किया गया है। साथ ही द्रोणाचार्य के पारिवारिक पात्रों और व्यवस्था से संबंधित अन्य पात्रों का भी नवीन दृष्टिकोण से चित्रांकन किया गया है। अरविंद इस नाटक का प्रमुख पात्र है।

महाभारत में जो स्थान और जो स्थिति द्रोणाचार्य की थी, लगभग ठीक वही स्थान और वही स्थिति इस नाटक के पात्र अरविंद की भी है। अरविंद की मानसिक और पारिवारिक स्थिति द्रोणाचार्य की उन्हीं स्थितियों से मेल खाती है। अरविंद द्रोण से, लीला कृपी से और अनुराधा द्रौपदी से मेल खाती है।

अरविंद एक प्राइवेट कॉलेज में प्रोफेसर है। वह मूल रूप से एक सिद्धांतवादी व्यक्ति है। प्रोफेसर अरविंद सत्य और न्याय का पक्षधर है। परीक्षा के दौरान संस्था के प्रेसिडेंट के पुत्र राजकुमार को नकल करते हुए प्रोफेसर मिश्रा रंगे हाथों पकड़ लेते हैं। प्रेसिडेंट का पुत्र छुरा सामने रखकर नकल कर रहा था। चंदू की रिपोर्ट यूनिवर्सिटी को भेज दी गई क्योंकि उसके पिता प्रेसिडेंट के राजनीतिक प्रतिद्वंदी हैं। चंदू चाहता है कि राजकुमार की रिपोर्ट यूनिवर्सिटी को भेजी जाए। चंदू प्रोफेसर अरविंद के घर जाकर प्रार्थना करता है कि राजकुमार की रिपोर्ट यूनिवर्सिटी भिजवाई जाए। ऐसा न करने पर वह सभी छात्रों के साथ मिलकर धरना प्रदर्शन, आंदोलन, हड़ताल तथा परीक्षा के बहिष्कार की बात करता है। प्रोफेसर अरविंद उसकी बातों से सहमत होकर राजकुमार की रिपोर्ट विश्वविद्यालय भिजवाने की तैयारी करते हैं। अरविंद की पत्नी लीला प्रोफेसर

साहब को ऐसा न करने की सलाह देती है। दरअसल उन्हें अपना परिवार चलाना है।

प्रोफेसर अरविंद का दोस्त 'यदू' भी उनको सलाह देता है कि वह स्वयं अपने प्रिंसिपल बनने का रास्ता साफ करें। कुछ समय बाद प्रेसिडेंट प्रो. अरविंद के घर जाकर उनसे राजकुमार की रिपोर्ट विश्वविद्यालय न भेजने का दबाव डालता है। उधर प्रोफेसर अरविंद अपने फैसले पर अडिग है। प्रेसिडेंट साहब कहते हैं, "जरा सोचिए तो इस घटना से मेरी पब्लिक इमेज को कितना धक्का पहुँचेगा।

चुनाव का टिकट हाथ से जाता रहेगा।"१ ऐसा कहकर प्रेसिडेंट साहब प्रोफेसर अरविंद को प्रिंसिपल के पद का लालच देने लगते हैं, "यू आर ओनली प्रोफेसर तु हूम आई रेस्पेक्ट सो मच। कुछ मामलों में आपसे विरोध हो सकता है परंतु इसका मतलब यह नहीं कि आपकी योग्यता के बारे में मैंने कभी शक किया है।"२

उधर प्रोफेसर अरविंद की पत्नी लीला भी उन्हें बहुत समझाती है कि, "इस बदतमीज लड़के का साथ देकर क्या मिलेगा? प्रेसिडेंट से दुश्मनी ठन जाएगी। किस के भरोसे लड़ोगे? तुम्हारे सहयोगी भी तुम्हारा कहाँ साथ दे रहे हैं।"३ प्रोफेसर अरविंद कहता है, "लेकिन चंदू को दगा देने का मतलब समझती हो? नकल का विरोध करने वाले सैकड़ों विद्यार्थी मेरे खून के प्यासे हो जाएंगे, मुझ पर थूकेंगे।"४ प्रो. अरविंद की पत्नी लीला का चरित्र यहाँ महाभारत के द्रोणाचार्य की पत्नी कृपी की याद दिलाता है। वह कहती है, "प्रेसिडेंट उनसे निपट लेगा। तुम्हें सुरक्षा देगा। प्रिंसिपल बना देगा और यह लड़के तुम्हें सड़कों पर खड़ा कर तमाशा देखेंगे। उनका साथ देने से क्या फायदा।"५ अर्थात् उसे अपना परिवार चलाना है, आदर्श को त्यागकर वह यथार्थ के धरातल पर खड़ी रहकर सोचती है।

प्रो. अरविंद का दोस्त यदू भी उसे समझाते हुए कहता है, "समझने की कोशिश क्यों नहीं करते? पूरे शहर में अफवाह है कि तुमने लड़कों को भड़काया है। पूरा स्टाफ हैरान है तुम्हारी हरकत पर। उधर राजकुमार और उसके साथी भी तुमसे बेहद नाराज हैं। एक तो राजकुमार को पकड़कर तुमने उन्हें चुनौती दी है दूसरे चंदू का साथ देकर तुम उनकी सत्ता ही खत्म कर देना चाहते हो। अगर ये लोग विमलेंदु की हत्या कर सकते हैं तो तुम्हारी क्यों नहीं। हर बात तुम्हारे खिलाफ पड़ रही है। जाओ रिपोर्ट वापस ले लो।"६

इस पर पत्नी लीला को लगता है कि प्रोफेसर अरविंद के प्रिंसिपल बनने में ही भलाई है। इस तरह वह व्यावहारिक दृष्टि से सोचती है। साथ ही यदू का दृष्टिकोण भी

बिल्कुल व्यवहारिक है। वह पुनः कहता है कि, “प्रिंसिपल बन जाओ और वाइस प्रिंसिपल के लिए मेरा रास्ता बनाओ। तुम प्रेसिडेंट का साथ दोगे तो वह भी तुम्हारा साथ देगा। चंदू और उसके साथियों से वह खुद निपट लेगा। लेकिन राजकुमार तुम्हें जिंदा नहीं छोड़ेगा।”^७ इससे पता चलता है कि ईमानदार व्यक्ति को किस प्रकार फँसाया जाता है। इतना ही नहीं प्रोफेसर अरविंद जैसे व्यक्ति को सैंडविच बनाकर दोनों ओर से दबाया जाता है। यदु कहता है, “रिपोर्ट बदलने के अलावा तुम्हारे पास कोई चारा नहीं है। राजकुमार का विरोध करोगे तो हत्या, चंदू का विरोध करोगे तो सामाजिक हत्या। हत्या से तुम बच नहीं सकते।”^८ इस तरह नकलची और प्रभावशाली विद्यार्थियों के बीच एक सिद्धांतवादी ईमानदार प्रोफेसर सैंडविच बन कर रह जाता है।

अंततः प्रेसिडेंट द्वारा प्रोफेसर अरविंद को प्रिंसिपल बना दिया जाता है। प्रोफेसर अरविंद न चाहते हुए भी प्रलोभन का शिकार हो जाता है। प्रिंसिपल बनने के बाद उसे बंगला तथा अनेक सुविधाएँ मिलती हैं। अब वह व्यवस्था के सामने घुटने टेकने पर मजबूर कर दिया जाता है। व्यवस्था द्वारा उसे सुविधाएँ देकर उसका मुँह बंद कर दिया जाता है। इससे पहले विमलेंदु अपनी ईमानदारी के लिए गुंडों द्वारा मरवा दिया जाता है। उसकी आत्मा अरविंद को आगाह करती है कि वह ईमानदार या आदर्शवादी बनने का ढोंग न करें। वह भी विमलेंदु की तरह मारा जाएगा। हमारे समाज में आदर्शवादी, ईमानदार तथा व्यवस्था से पंगा लेने वाले को सिर्फ मौत मिलती है। अच्छा होगा कि तुम जुबान बंद कर चुपचाप नौकरी करो अपने बीवी बच्चों का ख्याल रखो। वरना यूनिवर्सिटी के चेयरमैन की अध्यक्षता में तुम्हारी शोक सभा होगी।

विमलेंदु अरविंद को अपने नाटक के द्रोणाचार्य की याद दिलाता है कि, “जो हाल द्रोणाचार्य का हुआ वही तुम्हारा भी होगा अर्थात् तुम भी छल से ही मारे जाओगे।”^९

प्रिंसिपल बनने के बाद दूसरी बार प्रोफेसर अरविंद को अपने प्रेसिडेंट अर्थात् व्यवस्था से टकराने का अवसर मिलता है। कॉलेज की बीस वर्षीय छात्रा अनुराधा कॉलेज के बगीचे में अपने प्रेमी चंदू का इंतजार कर रही थी। चंदू किसी काम से शहर से बाहर गया हुआ था। अनुराधा को अकेली देखकर प्रेसिडेंट का बेटा राजकुमार अनुराधा पर बलात्कार करने की कोशिश करता है। इस बीच प्रिंसिपल अरविंद वहाँ आ जाते हैं। इस दृश्य को देखकर आश्चर्यचकित हो जाते हैं। उन्हें अपनी आँखों पर विश्वास नहीं होता। अनुराधा घर जाकर अपने माता-पिता को घटना की खबर देती

है तथा राजकुमार को कॉलेज से निकलवाने की बात कहती है। उसके पिताजी कहते हैं कि, हम लोग गरीब हैं रिपोर्ट करने पर हमारी बदनामी होगी। उधर प्रेसिडेंट अनुराधा के पिता को पाँच हजार देकर उसकी जुबान बंद कर देता है।

अगले दिन अनुराधा प्रिंसिपल अरविंद से मिलने आती है। वह राजकुमार को रेस्टीकेट करने की विनती करती है। अरविंद पहले तो उसे समझाते हैं कि रेस्टीकेशन के बाद भी वह तुम्हें परेशान करेगा किंतु अनुराधा नहीं मानती। प्रोफेसर अरविंद अनुराधा का साथ देने के लिए तैयार हो जाते हैं। इतने में प्रेसिडेंट का फोन प्रिंसिपल अरविंद के लिए आता है। वह प्रिंसिपल अरविंद को फोन पर अनुराधा का साथ न देने का आदेश देता है। प्रोफेसर अरविंद के न मानने पर वह १५००० रुपयों के गबन के केस में फँसा देने की धमकी देता है। अपने को घिरा हुआ व ठगा हुआ समझकर अरविंद अनुराधा का साथ नहीं देता।

इस तरह अनुराधा वहाँ से चली जाती है। अगले दिन खबर मिलती है कि अनुराधा ने ट्रक के नीचे आकर आत्महत्या कर ली। प्रिंसिपल अरविंद आत्मग्लानि से भर उठता है। विमलेंदु की आत्मा उससे कहती है कि। “उसकी मौत के लिए केवल तुम जिम्मेदार नहीं हो, बल्कि तीन लोग हैं- प्रेसिडेंट, उसका पिता और तुम।”^{१०} इससे अरविंद का पश्चाताप कुछ कम होता है।

इस प्रकार प्रिंसिपल आदर्शवादी सिद्धांतवादी तथा ईमानदार प्राध्यापक दो बार व्यवस्था के सामने घुटने टेक देता है। पहले जब, प्रेसिडेंट का बेटा छुरा सामने रखकर नकल करते हुए पकड़ा गया था। दूसरी बार तब जब प्रेसिडेंट का बेटा राजकुमार अनुराधा पर बलात्कार करने की कोशिश करता है। प्रिंसिपल अरविंद प्रमुख गवाह होते हुए भी अनुराधा का साथ नहीं दे पाता। अनुराधा ट्रक के नीचे आकर आत्महत्या कर लेती है।

जब प्रिंसिपल को बार-बार समझौता करना पड़ता है। आत्मग्लानि से भरकर कहता है, “मैं समझौते के फंदे पर पच्चीसों बार अपने को लटकाने वाला..... मैं दूसरों के नकाब उतारने की कोशिश में खुद नंगा हो जाने वालामैं.....मुझ पर थूको।”^{११}

निष्कर्ष रूप में यह कहा जा सकता है कि प्रस्तुत नाटक में एक ओर वर्तमान शिक्षण व्यवस्था के खोखलेपन और झूठी समाज सेवा का पर्दाफाश किया गया है। शिक्षण-तंत्र धन एवं जन-बल से प्रतिभा एवं योग्यता को खरीद लेता है। वहीं दूसरी

ओर अपनी आर्थिक व्यवस्था, परिवार तथा मित्रों के दबाव में अरविंद जैसे प्राध्यापक न चाहते हुए भी बार-बार व्यवस्था के समक्ष घुटने टेकने और परिस्थितियों से समझौता करने के लिए मजबूर कर दिए जाते हैं।

एक ओर प्रेसिडेंट जैसे लोग बीसियों शिक्षण संस्थाएँ खोलकर खुलेआम शिक्षण के नाम पर व्यापार कर रहे हैं। सरकार तथा अन्य स्रोतों से आने वाली ग्रांट की धनराशि का उपयोग अपने निजी लाभ के लिए करते हैं। इस पूंजी से अपनी पूंजी को चार-आठ गुना करके वह धन कॉलेज को लौटा कर यह जताने की कोशिश करते हैं कि मानो कॉलेज को अनुदान दे रहे हैं। दूसरी ओर अरविंद जैसे प्राध्यापकों की मजबूरी का लाभ उठा कर उन्हें ब्लैकमेल किया जाता है, कठपुतली की तरह इस्तेमाल किया जाता है।

इस तरह 'एक और द्रोणाचार्य' नाटक के चार प्रमुख उद्देश्य हैं। पहला वर्तमान शिक्षा व्यवस्था का वास्तविक चित्रण। दूसरा वर्तमान शिक्षक/प्रोफेसर की गृहिणियों द्वारा विषम आर्थिक परिस्थितियों में घर चलाने की प्रतिबद्धता को दर्शाना, तीसरा कॉलेज प्रेसिडेंट जैसे संस्था-चालकों के संरक्षण में राजकुमार जैसे खलनायक शिष्यों के निर्माण को रेखांकित करना चौथा छात्रा अनुराधा के माध्यम से स्त्री जीवन की पीड़ा का अंकन करना।

नाटककार ने द्रोणाचार्य को प्रतीक रूप में चित्रित किया है। जिस प्रकार द्रोणाचार्य अपने राजकीय कर्तव्य का पालन करने के लिए व्यवस्था के सामने झुक जाते हैं, वह एकलव्य से कहते हैं कि योग्यता और प्रतिभा से बड़ी चीज व्यवस्था है। व्यवस्था को तोड़ा नहीं जा सकता। यही स्थिति प्रोफेसर अरविंद की भी है। वह दो बार प्रेसिडेंट के बेटे को लेकर व्यवस्था के सामने न चाहते हुए भी हथियार डालने के लिए मजबूर हो जाता है। दरअसल उसके पास इसका कोई दूसरा विकल्प नहीं है।

अतएव, यह कहा जा सकता है कि द्रोणाचार्य हर कालखंड में विवश लाचार ही दिखाई पड़ते हैं। महाभारत काल में राजकीय कर्तव्य के समक्ष जिस प्रकार द्रोणाचार्य ने अपने घुटने टेक दिए, हथियार डाल दिए। ठीक उसी प्रकार प्रोफेसर अरविंद प्रेसिडेंट के समक्ष बार-बार समझौता करने पर मजबूर हो जाता है। कुल मिलाकर एक और द्रोणाचार्य व्यवस्था और व्यक्ति के बीच के द्वंद्व की रचना है।

अंततः व्यवस्था व्यक्ति पर भारी पड़ जाती है। ऐसे में हमारे समाज को चाहिए कि वह एक ऐसे व्यक्ति का निर्माण करे जो व्यवस्था पर भारी पड़ सकता है, परंतु

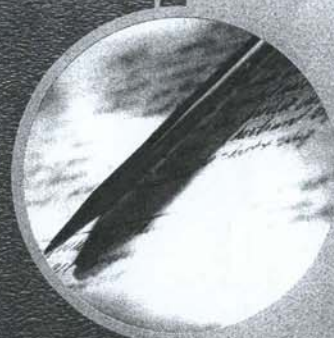
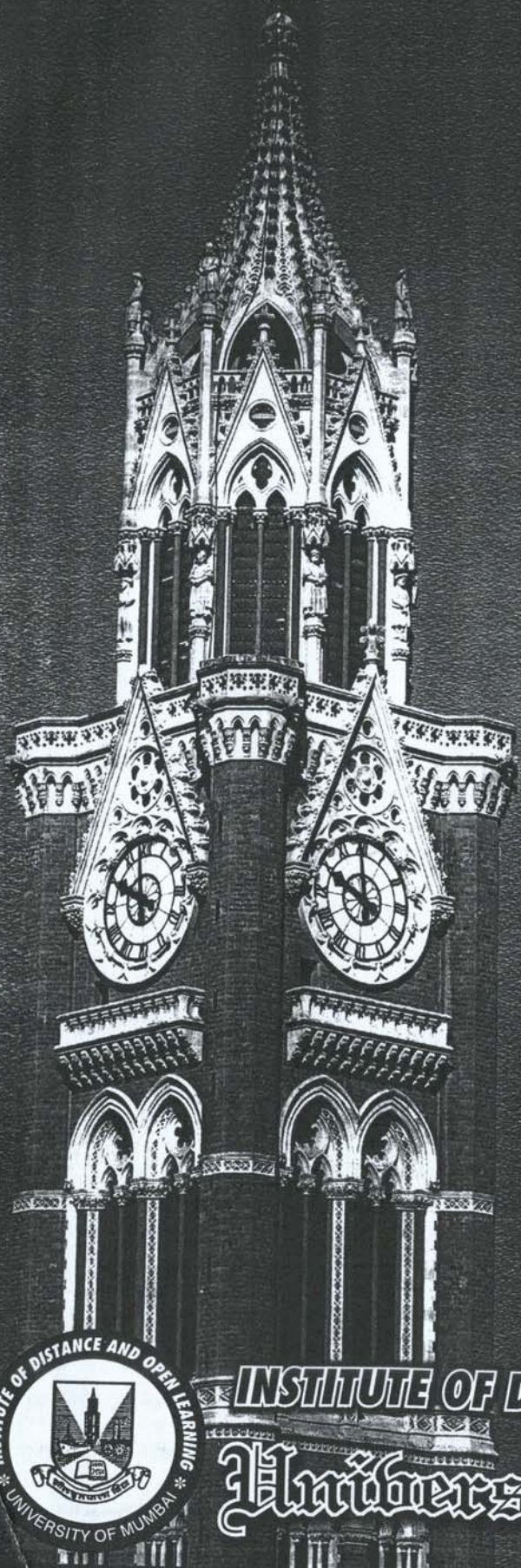
निकट भविष्य में इसकी संभावना कम ही दिखाई पड़ती है क्योंकि जब कुछ दिन पूर्व नालंदा विश्वविद्यालय के चांसलर नोबेल पुरस्कार विजेता प्रोफेसर अमर्त्य सेन ने व्यवस्था के विरुद्ध बयान देने का साहस किया तब उन्हें अपनी कुर्सी छोड़नी पड़ी थी।

संदर्भ

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११. वही

HISTORY OF MODERN INDIA (1857-1947)

48



F.Y.B.A
History
Paper I



INSTITUTE OF DISTANCE AND OPEN LEARNING
University of Mumbai

48



F.Y.B.A.
History Paper-I
History of Modern India
(1857-1947)
(Revised Syllabus)
with effect from 2018-19

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First Edition, December, 2018, F.Y.B.A, History Paper - I,
History of Modern India (1857-1947)

ISBN No. 978-81-929557-0-4

Published by : **Director Incharge**
Institute of Distance and Open Learning,
University of Mumbai,
Vidyanagari, Mumbai - 400 098.

DTP Composed : **Ashwini Arts**
Gurukripa Chawl, M.C. Chagla Marg, Bamanwada,
Vile Parle (E), Mumbai - 400 099.

Printed by : **Print Plus Private Limited**
122, Shah & Nahar Ind. Estate (A-2),
Dhanraj Mill Compound, S.J. Marg, Lower Parel (w),
Mumbai - 400 013. T + 91-22-6661 1017/18/19/20

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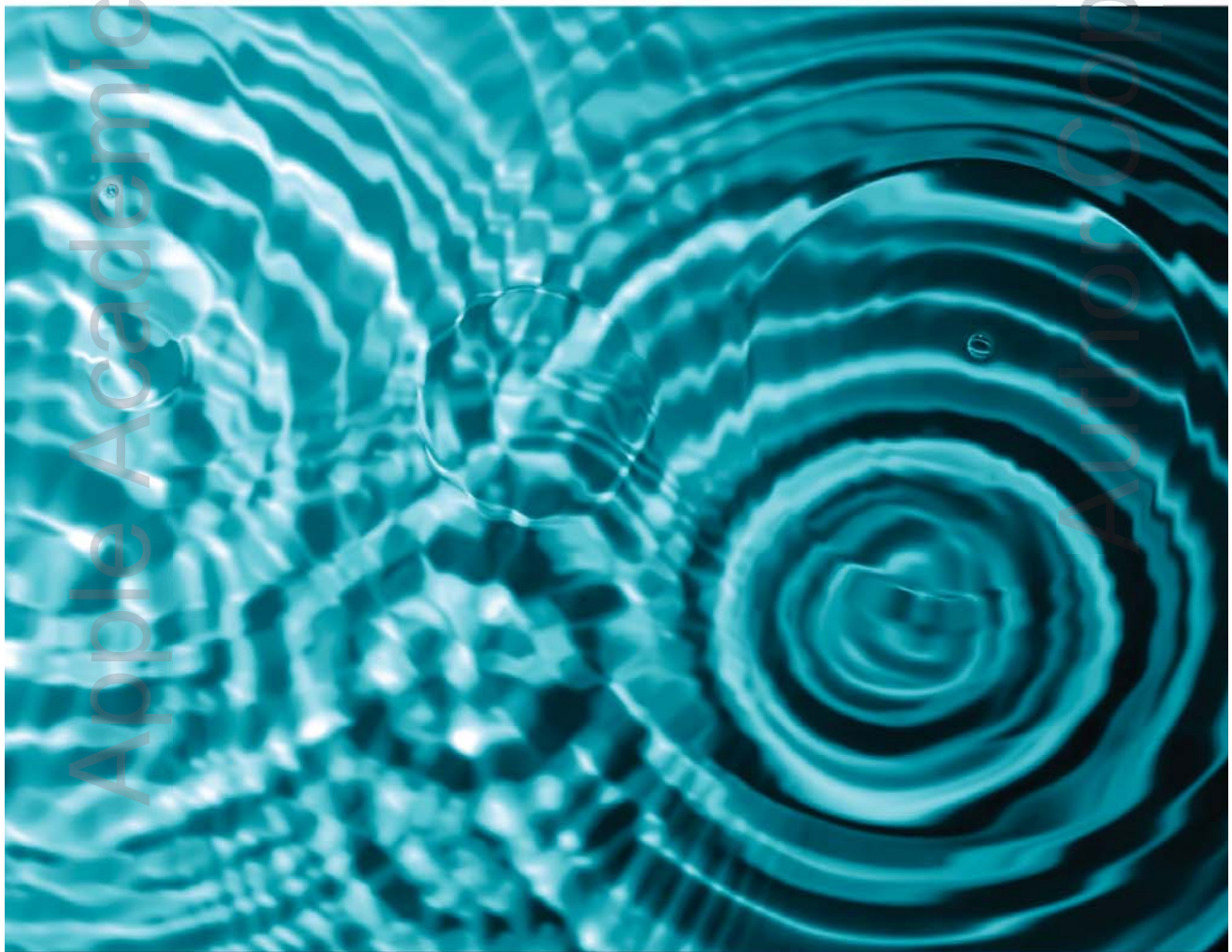




Sonochemistry

An Emerging Green Technology

Editors Suresh C. Ameta • Rakshit Ameta • Garima Ameta



AAP APPLE
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PRESS



CRC Press
Taylor & Francis Group

Apple Academic Press

SONOCHEMISTRY

An Emerging Green Technology

Edited by

Suresh C. Ameta, PhD

Rakshit Ameta, PhD

Garima Ameta, PhD

Author Copy



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Apple Academic Press Inc.
3333 Mistwell Crescent
Oakville, ON L6L 0A2 Canada

Apple Academic Press Inc.
9 Spinnaker Way
Waretown, NJ 08758 USA

© 2018 by Apple Academic Press, Inc.

Exclusive worldwide distribution by CRC Press, a member of Taylor & Francis Group

No claim to original U.S. Government works

International Standard Book Number-13: 978-1-77188-629-1 (Hardcover)

International Standard Book Number-13: 978-1-315-10274-0 (eBook)

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Library and Archives Canada Cataloguing in Publication

Sonochemistry : an emerging green technology / edited by
Suresh C. Ameta, PhD, Rakshit Ameta, PhD, Garima Ameta, PhD.

Includes bibliographical references and index.

Issued in print and electronic formats.

ISBN 978-1-77188-629-1 (hardcover).--ISBN 978-1-315-10274-0 (PDF)

I. Sonochemistry. I. Ameta, Suresh C., editor II. Ameta, Rakshit, editor III. Ameta, Garima, editor

QD801.S66 2018

541'.3

C2018-900505-X

C2018-900506-8

Library of Congress Cataloging-in-Publication Data

Names: Ameta, Suresh C., editor. | Ameta, Rakshit, editor. | Ameta, Garima, editor.

Title: Sonochemistry : an emerging green technology / editors, Suresh C. Ameta, PhD,
Rakshit Ameta, PhD, Garima Ameta, PhD.

Description: Toronto : Apple Academic Press, 2018. | Includes bibliographical references and index.

Identifiers: LCCN 2018002163 (print) | LCCN 2018004391 (ebook) | ISBN 9781315102740
(ebook) | ISBN 9781771886291 (hardcover : alk. paper)

Subjects: LCSH: Sonochemistry. | Chemistry, Physical and theoretical. | Ultrasonic waves--
Physiological effect. | Ultrasonic waves--Industrial applications.

Classification: LCC QD801 (ebook) | LCC QD801 .S65 2018 (print) | DDC 541/.3--dc23

LC record available at <https://lccn.loc.gov/2018002163>

Apple Academic Press also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic format. For information about Apple Academic Press products, visit our website at www.appleacademicpress.com and the CRC Press website at www.crcpress.com

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PREFACE

Nature needs protection from the fast growing chemical pollution. The primary challenge for chemists is to make chemical processes more environmentally benign and sustainable. World has witnessed a tremendous outburst in modifying chemical processes to make them sustainable for making our environment clean and green. One such environmental friendly technique is the use of ultrasound.

Sonochemistry deals with the effect of ultrasonic waves on chemical systems. It has green value because of nonhazardous acoustic radiation and therefore, it is duly recognized as a part of Green Chemistry by synthetic chemists as well as environmentalists. There is no direct interaction of ultrasound with molecular species, but the observed chemical and physical effects of ultrasound are due to the cavitation collapse, which produces drastic conditions of temperature and pressure locally. It induces the formation of various chemical species, which cannot be easily attained under conventional conditions. Sometimes, these species are responsible for driving towards an unusual reactivity in molecular entities.

Exposure to ultrasonic radiation and the resultant sonochemical and/or sonophysical effects have established this technique for driving a particular chemical reaction more efficiently and that too with high yields and selectivity. Sonochemistry utilizes less hazardous starting materials, reagents and solvents. In this process, product selectivity and product yields are increased; in addition, energy consumption is also reduced. This book provides the complete development of sonochemistry starting from introduction, basic concepts of sonochemistry, different types of sonochemical reactions, instrumentation, use of ultrasound in driving particular chemical reactions and its applications in various fields such as polymer synthesis, decontamination of water and waste water, preparation of nanomaterials, food technology, pharmaceutical sciences and so forth.

Apart from this, some fields are also discussed in brief, which do not fall in the actual arena of sonochemistry, but utilize ultrasounds of different frequencies. These are food products and their processing, anaerobic digestion of waste, medical applications such as ultrasonography, sonodynamic

CHAPTER 10

ANAEROBIC DIGESTION

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10.1 INTRODUCTION

Wastewater treatment has become a necessity of the day as the world is in cancerous grip of water pollution and is facing a scarcity of potable water in many developing and undeveloped countries. Many techniques are used for the treatment of wastewater, and biological treatment of wastewater is one of these widely used techniques. Excess sludge production is one

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THE PARSI
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Edited by
Coomi S. Vevaina

The Parsi Contribution to Indian Literature: This book is a compilation of papers presented at the Symposium on The Parsi Contribution to Indian Literature. It is divided into two sections with the first section entitled "In Their Own Words", containing interviews with writers like Adil Jussawala, Keki N. Dauwalla, Thrity Umrigar, Marzban F Shroff and Anosh Irani, and the second, "In Our Words", containing scholarly papers ranging from an overview of Parsi Literature and a visually interesting paper on the way in which literature inspired the archeological excavations in Sanjan, to works of specific writers like Behram Malbari, Dastur Dr. Manekji N. Dhalla, Amal Kiran (K.D. Sethna), Dina Mehta, Gieve Patel, Rohinton Mistry, Cyrus Mistry and Kersi Rustomjee. The explorations are from a wide range of theoretical perspectives with the intention of enabling readers from within the Parsi community to regard themselves from diverse lenses and building bridges of understanding about the Parsis among non-Parsi readers.

Coomi S. Vevaina is an internationally acclaimed critic, writer, teacher trainer and storyteller. Having retired as the Head of the Department of English, University of Mumbai, she is now the Founder Director of *Centre for Connection Education and Management*. She has published 9 books and 58 papers that have appeared in renowned national and international journals and critical anthologies. She has won numerous national and international awards and has been declared as among the ten best Canadian critics in the world by the International Journal of Canadian Studies, Ottawa. Her recent book, *What Children Really Want*, got her recognized by the World Leaders in Education (WLE) as among thirty-five women from across the world who are involved in changing educational paradigms.



SAHITYA AKADEMI

ISBN 978-93-87989-89-4



9 789387 989894

www.sahitya-akademi.gov.in

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The Parsi Contribution to Indian Literature

Edited by
Coomi S. Vevaina



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paper depicts a scene where
guddhodhana the dream of
Below them is seated a scribe
perhaps the earliest available
India.

A.D.

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The Parsi Contribution to Indian Literature: Compilation of papers presented at the symposium on Parsi Contribution to Indian Literature organised by Sahitya Akademi in 2016 at Mumbai. Edited by Coomi S. Vevaina. Sahitya Akademi, 2018. ₹ 170.

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Coomi S. Vevaina: Editor

Genre: Symposium papers

Published by Sahitya Akademi

First published: 2018

ISBN: 978-93-87989-89-4

₹ 170

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Cover design: Geetali Baruah

Typeset and printed by Vikas Computer and Printers, Delhi

Website: <http://www.sahitya-akademi.gov.in>

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Divine Inspiration in Amal Kiran's *The Adventure of the Apocalypse*

Pearl Pastakia

Introductory Note

I was introduced to Shri K. D. Sethna, poet, philosopher and critic of culture, on my first visit to Sri Aurobindo Ashram, Pondicherry in November 1999. It seemed a fortuitous happening spurred by a senior sadhak asking if we would be paying a visit to Shri K. D. Sethna, who like us, was a Parsee. My mother, who accompanied me then, was overjoyed at the prospect of meeting this venerable personality who was at once a fellow Parsee and a senior disciple and so we set off at once to visit K.D. Sethna, or, as Sri Aurobindo called him, Amal Kiran (Sanskrit for 'Serene Ray'), who was then in his nineties. Amal, having sustained a fracture of the hand, was convalescing in the Ashram Nursing Home on the sea-front. He spoke to us patiently and allowed me to click some pictures of him with my mother. On that visit, we picked up several of his works of literary criticism, but not his poems, since they were not stocked in the Ashram bookshops, then as now.

Some years later, when I scoured the library of St. Xavier's College, Mumbai, which was his and my own Alma

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Mater, I found an anthology of his poems, 'The Adventure of the Apocalypse', inscribed in the poet's own hand, 'Affectionately to Freddie from Kekoo'. The inscription is dated: '- 16 / 6 / 49 -' and includes an elaborate Preface by the author.

The Preface is significant for being a personal narrative of the way the poems in the anthology came into being and for the light it throws on some of the techniques of poetic creation in general, a subject of abiding curiosity to readers, critics and aspiring writers. The Ashram poet was also a teacher of poetry and regularly discoursed on what makes a poem work.

Addressing a question frequently put to him by interviewers, forty years after the publication of his anthology, K.D. Sethna, speaking in an interview with Valeria and Sudhakar in August 1988, reflected on the qualities of a poet, the connection between poetry and spirituality and the act of literary creation. He said:

A real poet is one who has the capacity to express himself with intensity of vision, intensity of word and intensity of rhythm. These three intensities in whatever degree are required to make a poem a poem; otherwise it is at best some kind of very efficient verse. But there are various types of poetry, one must admit . . . A true poem can be about anything but in all poetry there is a spiritual force at work; it can work directly and it can work indirectly. Mere belief in God will not do, your every line must move like a god. Then whether you believe in God or do not, it does not matter so far as poetry is concerned. You have to write from some inner source – that is all.

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forte but he maintains the same level of excellence in other sports and
in both Hindi and English. His latest book *Barefoot to Boots—The Many
Lives of Indian Football* was released by the President of FIFA, Gianni
Infantino at Kolkata during the U-17 World Cup in October 2017.

Pearl Pastakia is Head of the Department of English at St Xavier's
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