International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

New Developments in Behavioural Pharmacology

Shreya Anand Dhonde[1], Rahul Sudam Jadhav[2]

[1]Bachelor's Degree in Chemistry, University of Mumbai, Mumbai, Maharashtra, India
Master's Degree in Forensic Science, Vivekananda Global University, Jaipur, Rajasthan, India

[2]Bachelor's Degree in Zoology (Marine Science), University of Mumbai, Mumbai, Maharashtra, India
Bachelor's Degree in Cardiac Perfusion, D. Y. Patil University, Mumbai, Maharashtra, India

Abstract: ***Behavioural pharmacology research has been a keystone in understanding the processes that underlie the behaviour of living organisms and the biological basis of the behavioural and emotional. The findings in this area have helped to explore the potential therapeutic effects of several substances for the treatment of the mentioned disorders. First, we try to put in the context of behavioural pharmacology and its relevance and then show some brief recent examples of how this discipline has developed over the years. Second, we reconsider the concept of a "research model" in preclinical behavioural pharmacology. Third, recent advances use zebra fish as a valuable tool of research. More specific examples are absorbed such as the findings on sleep disorders.***

Keywords: Behavioural Pharmacology, Biological Basis, Therapeutic effects, Research model, Zebrafish, Psychoactive drugs

1. Introduction

Pharmacology is indeed more constantly overlooked. still, without the development of pharmacology as a wisdom grounded on methodical exploration the capacities of medical lores and rectifiers would be veritably limited. Knowledge in pharmacology allows us to understand that theirlive chemical substances with veritably specific structures and parcels which in controlled boluses can interact with the normal physiology of our organism to produce impacts that ameliorate our health known as remedial goods but if the boluses are inadequate or inordinate the goods will be ineffective or dangerous poisonous.

Nowadays, pharmacological exploration has expanded beyond treatments for contagious agents covering conditions related to the differences in the normal functioning of the central nervous system. There are specifics to treat diseases such as depression, anxiety, habitual pain, attention deficiency and hyperactivity complaint, epilepsy, and Parkinson's complaint, and new medicines are desperately sought to stop Alzheimer's complaints. On the other hand, one of the most important current health problems is related to the addicting behaviours touched off by the consumption of certain substances and the side goods of these respiratory and cardiovascular conditions in the case of tobacco, metabolic conditions in the case of drunkenness and addicting consumption of refined sugars, contagious conditions in the case of fitted medicines, and numerous others that aren't mentioned then. Without losing sight of the fact that dependence is itself a complaint of the nervous system with consequences that affect the case's quality of life. Similarly, the use of different substances of abuse such as tobacco and marijuana has increased in the population Also the development of new technologies and products has had a significant impact on internal health as the discovery of Internet dependence and the addicting consumption of refined sugar which impacts the geste of subjects. All these make the nonstop development of behavioural pharmacology to manage the challenges in internal health.

Development of behavioural pharmacology

Behavioural pharmacology is based on methodical exploration with accurate styles for assessing and assaying the goods of chemicals hormones, and medicines on the geste of humans and experimental creatures to establish their eventuality as medicinal agents or pharmacological tools to dissect how the brain functions and the underpinning neurobiological medium of cognition, feelings, and gesture. Behavioural pharmacology must thus be an essential element of numerous Neuroscience exploration programs. The development of behavioural pharmacology includes the development of areas similar to pharmacology and psychology, practical analysis of geste, and lately neuroscience. Still, exploration in behavioural pharmacology can be epitomized in the following points.

1) The development of procedures to screen pharmacological agents for implicit clinical effectiveness.
2) Perfecting behavioural ways to examine the mechanisms of action of behaviourally active medicines and using these chemicals and medicines as tools for the analysis of complex behaviours. thus, medicines aren't only a subject of study, because of their behavioural goods but are also a piece of technology that helps to explain how behaviours are controlled by living organisms.

Year	Research in Behavioural Pharmacology
1972	The first study to administrate Delta - 9 - tetrahydrocannabinol in humans to test the effects on sleep patterns is carried out. The results show a decrease in sleep onset latency. To date, there are controversial results about the positive effects the cannabis on sleep quality
1977	The forced swim test is proposed as a behavioural tool to explore the effects of antidepressant drugs in rats and mice that are exposed to a stressful inescapable condition that triggers despair behaviour
2016	Anxiety - like behaviour is dependent on the post - ovariectomy time frame. At 12 - week post - ovariectomy there is more anxiety - like behaviour than a 3 - week post - ovariectomy

2019	In this study, it was identified that at 3 - week post - ovariectomy appears anxiety likebehaviour, but from 6 - week post - ovariectomy in addition to anxiety - like behaviour, also increases depression - like behaviour in rats, supporting an experimental model of surgical post - menopause

Measuring behaviour

Behaviour is a biological property of organisms, which is remarks the significance of the study of drug - behaviour interactions, a great example of the impact of behaviour beyond psychology is the research by ethologists K. Lorenz, N. Tinbergen, and K. von Frisch, which focused on the analysis of behaviour in several species including fish, insects, and birds, and the importance of which made them worthy of the Nobel price of medicine in 1973.

The first step in all behavioural sciences has been to define what is behaviour; it could seem an easy task, but historically many different definitions of behaviour have been used by scientists over time, the direction of behavioural pharmacology was the development of procedures to screen the effects of pharmacological agents on specific behaviours under the controlled environments. This approach allows scientists to work with operational definitions of specific behaviours, for example, exploration can be measured by scoring ambulation, rearing or nose approaching to an object sexual behaviour can be measured by conditioned place preference, the number of mounts, latency and the number of ejaculations. All these behaviours are normally studied under controlled environments that are designed specifically to the required behavioural display and every feature of the environment the experimental subjects or chemical agents with probes effects on humans have been studied in this environment to establish these manipulations as models of a specific behaviour as spatial learning and memory, or models of specific pathologies behaviourally expressed as is the case of anxiety depression, obsessive - compulsive disorder Parkinson's epilepsy or addictive behaviours and sleep deprivation.

Research Area	Description
Sleep and insomnia	This review describes the efficacy of new drugs in the treatment of insomnia such as melatonin, Remolten, Tasimelteon, and Suvorexant.
Addiction	A review of the most popular behavioural models for the study of addictions such as conditioned place preference and self - administration and new models to study behavioural addictions as gambling and exercise addiction
Sexual dimorphism	This review discusses preclinical and clinical research that show how hormones are involved in the sex differences in some psychiatric disorders like anxiety, and their interactions between fear, stress, and gonadal hormones
Behavioural animal models	This research reviews the relevance of non - mammalian models in behavioural pharmacology with application in the development of biological psychiatry

Behavioural models in zebrafish

While mice and rats are still the most widely used model organisms in behavioural pharmacology zebrafish (Danio rerio Hamilton 1822) comes in an honourable third place quickly swimming into view as a relevant model organism in this field The classical criteria for selecting a model organism in genetics and developmental biology are small size, fast development, easy reproduction, low cost, and genetic tractability present in zebrafish, other advantages are also described by zebra fish researchers' phylogenetic position intermediate complexity in physiology and throughout the availability of tools to study neuro circuitry and to interfere in normal function. The combination of these characteristics suggested that zebrafish could be a suitable model organism in behavioural pharmacology.

Currently, very few true simulations exist in zebrafish, and most behavioural tests that are used to study psychiatric disorders in this species are screening tests or behavioural bioassays. This is a consequence of an extensive focus of research in the field in the last 20 years on developing behavioural tests. This step, of course, was necessary to galvanize research in the field. Notable exceptions exist but as is the case with most initial work on using model organisms to study disorders and investigational treatments these are still limited. However, past research has identified and allowed control factors that affect zebrafish behavioural tests. Now it is clear how chemical properties of the water, illumination, number of fish per tank and routes of administration modify pharmacological effects. For example, administration by immersion is useful for chronic treatments but lacks precise control of the doses absorbed on the other hand intraperitoneal administration ensures the absolute control of doses but is not useful for chronic treatments due to the stress that produces. Oral administration through drugs incorporated in the food is useful for chronic treatments and controlling the doses is easier than immersion however chemical properties of the drug determine their ability to hold into the food until swallowed and oral metabolism must be considered. With the standardization of the proper protocols, these factors can be controlled, and their effects are limited so, behavioural pharmacology research with zebrafish is still a suitable and growing field.

The zebrafish light/dark test and the novel tank test are widely used to test the effects of different drugs on anxiety - like behaviour in this species. These tests rely on natural preferences observed in the wild, and display excellent remission validity—that is, they are sensitive to drugs which affect anxiety in clinical settings, and not sensitive to drugs which do not affect anxiety As a result, these tests were used as screening tests to investigate new drugs, including drugs derived from natural products and plants, for example, These tests have also been used to study the neural mechanisms of anxiety - like behaviour Thus these tests can be used both as screening tests and as behavioural bioassays.

Examples of simulations can be found in the field of neurological disorders an interesting example is the generation of mutants with differences in genes known to be associated with diseases. In humans, mutations in the SCN1A gene, which encodes a voltage - gated sodium channel, cause Dravet syndrome, characterised by severe

intellectual disability, impaired social development, and drug - resistant seizures. The scn1Lab mutant zebra fish displays spontaneous seizure - like electroencephalogram activity, convulsive - like motor patterns, and hyperactivity These mutants have been used to investigate drugs, which could be used to treat Dravet syndrome in human patients; drugs that affect the serotonergic system have been found to ameliorate the symptoms in the mutants and suggest interesting avenues for human patients.

Behavioural pharmacology and sleep disorders

The pharmacological treatment of sleep diseases is still incompletely known and not well understood. Recently expansive pharmacological exploration has concentrated on two sleep diseases insomnia and narcolepsy.

Insomnia is defined as the existent's incapability to fall asleep, manifested by long latency to sleep onset and frequent darkness awakenings endured three times per week or further, for at least 1 month. wakefulness causes emotional disturbances, impairs cognition, and reduces the quality of life utmost epidemiologic studies have set up that about one - third of adults (36 %) report at least one symptom of insomnia like difficulty initiating sleep or maintaining sleep presently, benzodiazepines zopiclone, zolpidem, or zaleplon are the first options to treat wakefulness.

These medicines act as positive allosteric modulators at the GABAA binding point, potentiating GABAergic inhibitory goods still, short - term or long - term treatment with these medicines has undesirable goods similar to cognitive or memory impairment, the rapid - fire development of patience, rebound wakefulness upon termination, auto accidents or falls, and a substantial threat of abuse and dependence which make necessary investigation on new implicit remedial agents.

According to the new substantiation grounded clinical practice guidelines for the treatment of wakefulness, new pharmacology agents for insomnia operation are enforced On the other hand Type 1 wakefulness (wakefulness with hypocretin insufficiency) is a habitual neurodegenerative sleep complaint caused by an insufficiency of hypocretin - producing neurons in the side hypothalamus (LH). Hypocretin neurons are involved in the control of the sleep - wake cycle Treatment of wakefulness is traditionally grounded on amphetamine - suchlike instigations that enhance dopaminergic release to ameliorate narcoleptic symptoms. still, a new group of medicines is emerging as a forthcoming treatment for wakefulness. Pitolisant (Wakix) is an inverse agonist of the histamine H3 bus - receptor that not only blocks the retardation effect of histamine or H3 receptor agonists on endogenous histamine release from depolarized synaptosomes but also enhances histamine release over the rudimentary position in the structures similar as the hypothalamus and cerebral cortex The administration of 20 mg/ kg of Pitolisant promoted insomnia and dropped abnormal direct REM sleep onset in narcoleptic hypocretin knockout mice by enhancing histaminergic and noradrenergic exertion Pitolisant feel a safe remedial option since boluses of 120 mg once a day in the morning, which represent six times the remedial, boluses didn't produce adverse goods and tube situations were reduced at the end of the day, that represents six times the therapeutic, dose did not produce adverse effects and plasma levels reduced at the end of the day, that represent six times the therapeutic, ensuring a lack of waking effect during the night.

New drugs used to insomnia management

Drugs	Site of Action	Therapeutic Effect
Antiparkinsonian ropinirole	Agonist of the dopamine receptor D2	Improvement in efficiency of sleep and total time slept
Antidepressant	Agonists of the serotonin receptor 5 - HT2A and 5 - HT2C	Moderate improvement in subjective sleep Little improvement in sleep efficiency
Suvorexant	Antagonist of the orexin receptor	Improvement of sleep onset and subjective total slept time compared to placebo [
Ramelteon	Dual agonist of both MT1 and MT2 melatonin receptors	Improvement in latency to persistent sleep, total sleep time and sleep efficiency
Diphenhydramine	Agonist of the histaminergic receptors	No clear beneficial impact on sleep

2. Conclusion

The present review paper tried to reflect compactly on the substance of behavioural pharmacology through an anecdotical review of its developments in areas. All findings mentioned above accentuate the significance of the exploration in behavioural pharmacology on the understanding of the neurobiology of different diseases and the medium of action of medicines used to treat similar diseases, and at the same time, give a perspective on the current exploration done in this growing area, which is and will be a foundation in the understanding of mortal geste and internal health.

References

[1] Jacques A, Chaaya N, Beecher K, Ali SA, Belmer A, Bartlett S. The impact of sugar consumption on stress driven, emotional and addictive behaviours. Neuroscience and Biobehavioral Reviews.2019; 103: 178 - 199. DOI: 10.1016/j. neubiorev.2019.05.021

[2] Branch MN. Behavioural pharmacology. In: Lattal EA, Iversen IH, editors. Experimental Analysis of Behavior. Amsterdam: Elsevier; 1991. pp.21 - 70. DOI: 10.1016/j. neubiorev.2019.05.021

[3] Marr MJ. Behavioral pharmacology: Issues of reductionism and causality. In: Barrett JE, Thompson T, Dews P, editors. Advances in Behavioral Pharmacology. Vol.7. Hillsdale: Lawrence Erlbaum; 1990. pp.1 - 12

[4] Pivik RT, Zarcone V, Dement WC, Hollister LE. Delta - 9 - tetrahydrocannabinol and synhexl: Effects on human sleep patterns. Clinical Pharmacology and Therapeutics.1972; 13 (3): 426 - 435. DOI: 10.1002/cpt1972133426
[5] Porsolt RD, Le Pichon M, Jalfre M. Depression: A new animal model sensitive to antidepressant treatment. Nature.1977; 266 (5604): 730 - 732. DOI: 10.1038/266730a0
[6] Kuriyama A, Tabata H. Suvorexant for the treatment of primary insomnia: A systematic review and meta - analysis. Sleep Medicine Reviews.2017; 35: 1 - 7. DOI: 10.1016/j. smrv.2016.09.004
[7] Bourin M. Experimental anxiety model for anxiety disorders: Relevance to drug discovery. In: Kim YK, editor. Anxiety Disorders. Advances in Experimental Medicine and Biology. Singapore: Springer; 2020. pp.169 - 184
[8] Planchez B, Surget A, Belzung C. Animal models of major depression: Drawbacks and challenges. Journal of Neural Transmission.2019; 126 (11): 1383 - 1408. DOI: 10.1016/j. neurol.2015.07.011
[9] Szechtman H, Ahmari SE, Beninger RJ, Eilam D, Harvey BH, Edemann - Callesen H, et al. Obsessivecompulsive disorder: Insights from animal models. Neuroscience and Biobehavioral Reviews.2017; 76: 254 - 279. DOI: 10.1016/j. neubiorev.2016.04.019
[10] Maeng LY, Milad MR. Sex differences in anxiety disorders: Interactions between fear, stress, and gonadal hormones. Hormones and Behavior.2015; 76: 106 - 117. DOI: 10.1016/j. yhbeh.2015.04.002
[11] Belzung C, Lemoine M. Criteria of validity for animal models of psychiatric disorders: Focus on anxiety disorders and depression. Biology of Mood & Anxiety Disorders.2011; 1: 9
[12] Montgomery KC. The relation between fear induced by novel stimulation and exploratory behavior. Journal of Comparative and Physiological Psychology.1955; 47: 254 - 260. DOI: 10.1037/h0043788
[13] Treit D, Menard J, Royan C. Anxiogenic stimuli in the elevated plusmaze. Pharmacology, Biochemistry, and Behavior.1993; 44: 463 - 469. DOI: 10.1016/0091 - 3057 (93) 90492 - c
[14] Bakshi VP, Kalin NH. Animal models and endophenotypes of anxiety and stress disorders. In: Davis KL, Charney D, Coyle JT, Nemeroff C, editors. Neuropsychopharmacology: The Fifth Generation of Progress. New York: American College of Neuropsychopharmacology; 2002. pp.883 - 90
[15] Hånell A, Marklund N. Structured evaluation of rodent behavioral tests used in drug discovery research. Frontiers in Behavioral Neuroscience.2014; 8: 252. DOI: 10.3389/ fnbeh.2014.00252
[16] Griebel G, Holmes A.50 years of hurdles and hope in anxiolytic drug discovery. Nature Reviews. Drug Discovery.2013; 12: 667 - 687. DOI: 10.1038/nrd407
[17] Stewart AM, Ullmann JFP, Norton WHJ, Parker MO, Brennan CH, Gerlai R, et al. Molecular psychiatry of zebrafish. Molecular Psychiatry.2015; 20: 2 - 17. DOI: 10.1038/mp.2014.128
[18] Black MC. Routes of administration for chemical agents. In: Ostrander GK, editor. The Laboratory Fish. San Diego, CA: Academic Press; 2000. pp.529 - 542
[19] De Tolla LJ, Srinivas S, Whitaker BR, Andrews C, Hecker B, Kane AS, et al. Guidelines for the care and use of fish in research. ILAR Journal.1995; 37: 159 - 173. DOI: 10.1093/ilar.37.4.159
[20] Zang L, Morikane D, Shimada Y, Tanaka T, Nishimura N. A novel protocol for the oral administration of test chemicals to adult zebrafish. Zebrafish.2011; 8: 203 - 210. DOI: 10.1089/zeb.2011.0726
[21] Maximino C, De Brito TM, Dias CAGDM, Gouveia A Jr, Morato S. Scototaxis as anxiety - like behavior in fish. Nature Protocols.2010; 5: 209 - 216. DOI: 10.1038/nprot.2009.225
[22] Bencan Z, Sledge D, Levin ED. Buspirone, chlordiazepoxide and diazepam effects in a zebrafish model of anxiety. Pharmacology, Biochemistry, and Behavior.2009; 94: 75 - 80
[23] Maximino C, Benzecry R, Matos KRO, Batista E de JO, Herculano AM, Rosemberg DB, et al. A comparison of the light/dark and novel tank tests in zebrafish. Behaviour.2012; 149: 1099 - 1123. DOI: 10.1163/1568539X - 00003029
[24] do Nascimento JET, de Morais SM, de Lisboa DS, de Oliveira - Sousa M, Santos SAAR, Magalhães FEA, et al. The orofacial antinociceptive effect of Kaempferol - 3 - O - rutinoside, isolated from the plant Ouratea fieldingiana, on adult zebrafish (Danio rerio). Biomedicine & Pharmacotherapy.2018; 107: 1030 - 1036. DOI: 10.1016/j. biopha.2018.08.089
[25] dos Santos Sampaio TI, de Melo NC, de Freitas Paiva BT, da Silva Aleluia GA, da Silva Neto FLP, da Silva HR, et al. Leaves of Spondias mombin L. a traditional anxiolytic and antidepressant: Pharmacological evaluation on zebrafish (Danio rerio). Journal of Ethnopharmacology.2018; 224: 563 - 578. DOI: 10.1016/j. jep.2018.05.037
[26] Maximino C, Puty B, Benzecry R, Araújo J, Gomez - Lima M, de Jesus Oliveira Batista E, et al. Role of serotonin in zebrafish (Danio rerio) anxiety: Relationship with serotonin levels and effect of buspirone, WAY 100635, SB 224289, fluoxetine and parachlorophenylalanine (pCPA) in two behavioral models. Neuropharmacology.2013; 71: 83 - 97. DOI: 10.1016/j. neuropharm.2013.03.006
[27] Braida D, Donzelli A, Martucci R, Capurro V, Busnelli M, Chini B, et al. Neurohypophyseal hormones manipulation modulate social and anxietyrelated behavior in zebrafish. Psychopharmacology.2012; 220: 319 - 330. DOI: 10.1007/s00213 - 011 - 2482 - 2
[28] Amir - Zilberstein L, Blechman J, Sztainberg Y, Norton WHJ, Reuveny A, Borodovsky N, et al. Homeodomain protein Otp and activity - dependent splicing modulate neuronal adaptation to stress. Neuron.2012; 73: 279 - 291. DOI: 10.1016/j. neuron.2011.11.019
[29] Mathuru AS, Jesuthasan S. The medial habenula as a regulator of anxiety in adult zebrafish. Frontiers in Neural Circuits.2013; 7: 99. DOI: 10.3389/fncir.2013.00099

[30] Kokel D, Peterson RT. Chemobehavioural phenomics and behaviour - based psychiatric drug discovery in the zebrafish. Briefings in Functional Genomics.2008; 7 (6): 483 - 490. DOI: 10.1093/bfgp/eln04
[31] Sateia MJ, Buysse DJ, Krystal AD, Neubauer DN, Heald JL. Clinical practice guideline for the pharmacologic treatment of chronic insomnia in adults: An American Academy of Sleep Medicine Clinical Practice guideline. Journal of Clinical Sleep Medicine.2017; 13 (2): 307 - 349. DOI: 10.5664/ jcsm.6470
[32] Zammit GK, Weiner J, Damato N, Sillup GP, McMillan CA. Quality of life in people with insomnia. Sleep.1999; 22 (Suppl.2): S379 - S385
[33] Wickwire EM, Shaya FT, Scharf SM. Health economics of insomnia treatments: The return on investment for a good night's sleep. Sleep Medicine Reviews.2016; 30: 72 - 82. DOI: 10.1016/j. smrv.2015.11.004
[34] Ohayon MM. Epidemiology of insomnia: What we know and what we still need to learn. Sleep Medicine Reviews.2002; 6: 97 - 111. DOI: 10.1053/ smrv.2002.0186
[35] Ashton H. The diagnosis and management of benzodiazepine dependence. Current Opinion in Psychiatry.2005; 18 (3): 249 - 255. DOI: 10.1097/01. yco.0000165594.60434.84
[36] Everitt H, Baldwin DS, Stuart B, Lipinska G, Mayers A, Malizia AL, et al. Antidepressants for insomnia in adults. Cochrane Database Systemic Reviews.2018; 5: CD010753. DOI: 10.1002/14651858. CD010753. pub2
[37] Herring WJ, Connor KM, Ivgy - May N, Snyder E, Liu K, Snavely DB, et al. Suvorexant in patients with insomnia: Results from two 3 - month randomized controlled clinical trials. Biological Psychiatry.2016; 79: 136 - 148. DOI: 10.1016/j. biopsych.2014.10.003
[38] Kuriyama A, Honda M, Hayashino Y. Ramelteon for the treatment of insomnia in adults: A systematic review and meta - analysis. Sleep Medicine.2014; 15: 385 - 392. DOI: 10.1016/j. sleep.2013.11.788
[39] Sys J, Van Cleynenbreugel S, Deschodt M, Van der Linden L, Tournoy J. Efficacy and safety of nonbenzodiazepine and non - Z - drug hypnotic medication for insomnia in older people: A systematic literature review. European Journal of Clinical Pharmacology.2020; 76: 363 - 381. DOI: 10.1007/s00228 - 019 - 02812 -
[40] Leu - Semenescu S, Nittur N, Golmard JL, Arnulf I. Effects of Pitolisant, a histamine H3 inverse agonist, in drug - resistant idiopathic and symptomatic hypersomnia: A chart review. Sleep Medicine.2014; 15 (6): 681 - 687. DOI: 10.1016/j. sleep.2014.01.021
[41] Lin JS, Dauvilliers Y, Arnulf I, Bastuji H, Anaclet C, Parmentier R, et al. An inverse agonist of the histamine H (3) receptor improves wakefulness in narcolepsy: Studies in orexin−/− mice and patients. Neurobiology of Disease.2008; 30 (1): 74 - 83. DOI: 10.1016/j. nbd.2007.12.00
[42] Passani MB, Lin JS, Hancock A, Crochet S, Blandina P. The histamine H3 receptor as a novel therapeutic target for cognitive and sleep disorders. Trends in Pharmacological Sciences.2004; 25 (12): 618 - 625. DOI: 10.1016/j. tips.2004.10.003
[43] Rodríguez - Landa JF, Hernández - López F, Cueto - Escobedo J, Herrera - Huerta EV, RivadeneyraDomínguez E, Bernal - Morales B, et al. Chrysin (5, 7 - dihydroxyflavone) exerts anxiolytic - like effects through GABAA receptors in a surgical menopause model in rats. Biomedicine & Pharmacotherapy.2019; 109: 2387 - 2395. DOI: 10.1016/j. biopha.2018.11.111

Author Profile

Shreya Anand Dhonde, Bachelor's Degree in Chemistry, University of Mumbai, Mumbai. Master's Degree in Forensic Science, Vivekananda Global University, Jaipur.

Rahul Sudam Jadhav, Bachelor's Degree in Zoology (Marine Science), University of Mumbai, Mumbai. Bachelor's Degree in Cardiac Perfusion, D. Y. Patil University, Mumbai.