

Raj Kumar, PhD
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Educational Qualification:

1. **Ph. D.** (Chemistry, Major-Biochemistry), 2012, University of Massachusetts, Lowell, MA, U.S.A. **Dissertation title:** Folding and Flexibility of Botulinum Neurotoxin Light Chain.
2. **M.S** (Chemistry, Major- Biochemistry), 2009, University of Massachusetts, Dartmouth, USA (2009).
3. **M.Sc.** (Chemistry, Major- Analytical Chemistry), 2001, Banaras Hindu University, Varanasi, India.
4. **B.Sc. (H)** (Physics, Chemistry, and Mathematics; Major- Chemistry), 1999, Banaras Hindu University, Varanasi, India.

Position Held:

1. **Kuruom School of Advanced Sciences (KSAS), Lucknow, INDIA (December 2021 – Present):** Director
Establish KSAS as non-profit company and taken all the necessary permissions from local and central government. Built a state-of-art facility in INDIA and managing (both scientific and administrative), hired several people, and designed complete program as per KSAS mission and vision. Also designed another facility at Indore for KSAS which is currently under construction.
2. **Institute of Advanced Sciences, Dartmouth (January 2021 – Present):** Associate Professor.
Responsibilities are similar to Assistant professor. In addition, responsibilities for this position includes development of accredited and non-accredited certificate and degree program, internship programs, development of online teaching platform for the institute, establishment of research facilities, private and governmental collaborations, educational and research outreach etc.
3. **Institute of Advanced Sciences, Dartmouth (September 2018 – Present):** Director of Academic Advisement and Research Program
Responsible for development of teaching courses, workshops, research and publications, develop research portfolio for the institute, intellectual property, research collaborations and joint research projects.

4. Institute of Advanced Sciences, Dartmouth (March 2014 – December 2020): Assistant Professor.

Responsibilities include Research and development in the area of protein chemistry, diagnostics, drug screening, drug delivery, cell culture, nanoparticles and biotechnology through conducting a variety of specialized laboratory procedures and research. Specifically, isolation and purification of native and recombinant proteins, biochemical and biophysical characterization, structural analysis using UV/VIS spectrophotometry, fluorescence spectroscopy, circular dichroism, fluorescence microscopy, etc., development of antidotes against botulinum neurotoxins, extraction of bioactive compounds from plants, screening of synthetic and natural compounds against enzymatic activity of Botulinum neurotoxins, culture and testing of neuroblastoma cells and enteric neurons for testing neuroactive compounds, development of enzyme linked immunosorbent assay (ELISA) against pathogenic compounds, characterization and testing of vaccine candidates against tetanus and botulinum toxins; coordinate research with collaborators at federal and corporation labs, organize and maintain research data and perform data analysis using lab information management system, writing grant proposals and submit to various agencies, including NIH and DOD, report to Director of Research and Development, and CEO on issues related to project progresses and potential problems or difficulties in the projects. Member of IACUC (Institutional Animal Care and Use committee) and IBC (Institutional Biosafety Committee).

5. Chemistry and Biochemistry Department, UMASS Dartmouth (January 2012 -December 2014): As a part-time lecturer.

6. Centre of Indic Studies, UMASS DARTMOUTH (February 2012 - May 2014): Research Associate, responsible for writing grant proposals, experimentation, presentation, and assisting graduate and undergraduate students.

7. Botulinum Research Center (January 2012 - August 2013): Research Associate, responsible for writing grant proposals, experimentation, presentation, and assisting graduate and undergraduate students.

8. Botulinum Research Center, UMASS DARTMOUTH (September 2007 - December 2011): As a graduate student pursued my PhD work.

9. Advinus Therapeutics, Pune, INDIA (A member of TATA group) (February 2006 - July 2007): Worked as an analytical scientist in drug discovery department. Responsible for the purification of organic compound using mass-based purification technique, qualitative/quantitative analysis and characterization of compounds.

10. Regent Drugs Limited, INDIA (A member of TEVA group) (January 2004 - February 2006): In charge of three different projects. Responsible for the whole project; from literature search till validation of analytical methods and stability of final products. Also responsible for daily planning of team members. Presentation and communication of the group work in various internal and external meetings.

11. LUPIN Research Park, Pune, INDIA (June 2001 - January 2004): Started as trainee in analytical research and development department. Responsible for routine analysis. After first year promoted as Assistant research Scientist (E-I), responsible for routine analysis, analytical method development, qualitative and quantitative analysis. Next year promoted as research scientist (E-II), responsible for routine analysis, analytical method development, validation and stability. Responsible for planning of my team and project report preparation and communication to the other concerned department. Also responsible for transferring the analytical methods to QC and successfully performed various pilot projects.

Scholarships, Awards and Positions:

1. Best participant award in Chemistry Quiz held at Mrs. K.M.P.M School, Jamshedpur, India, 1995.
2. Successfully completed summer internship at Tata Steel, Jamshedpur, India, 2000.
3. Second Prize in Quiz held at Advinus Therapeutics (A Member of TATA group), 2006.
4. Graduate Assistant, Botulinum Research Center, UMASS, Dartmouth, September - December 2007.
5. Shaukat Ali Memorial Scholarship, 2008, UMASS, Dartmouth.
6. Research Assistant, Botulinum Research Centre, UMASS, Dartmouth, January 2008 - December 2009, August - December 2010.
7. Teaching Assistant, Chemistry and Biochemistry Department, UMASS, Dartmouth, January-May 2010.
8. Teaching Assistant, Chemistry and Biochemistry Department, UMASS, Dartmouth from Jan. 2011 to May 2011.
9. Teaching Fellow at Chemistry and Biochemistry Department, UMASS, Dartmouth from Sept. 2011 to Dec. 2011.
10. Awarded Dissertation Writing Support Grant from UMASS, Dartmouth, Fall 2011.
11. Chair, IBSC (Institutional Biosafety Committee), Gufic Biosciences, Jan 2019 - Present
12. Selected for NIH (National Institute of Health, USA) – ECR program, May 2021 – Present

Research projects

In all the listed projects, currently I am working as a Principal Investigator.

1. *Structure and Function of Protein*: I am working on several projects related to structure and function of proteins. Our model molecule is Botulinum Neurotoxin and its different domains. I used both conventional (UV, Fluorescence and CD) and advanced (SAXS and Computational) techniques to study the folding, flexibility and function of the protein. I collaborated Dr. Valeri Barsegov (University of Massachusetts, Lowell), an expert in computational techniques for this project. This also involve a project in which I am trying to solve problems such as a) why one protein is kinetically better than the other, b) reason behind the stability of a protein, and c) role of structural intermediates on the function of a protein.
2. *Cellular Projects*: Development of protocol for differentiating stem cells to neurons. Developing a technology to increase the bioavailability of therapeutic molecules through intestinal adsorption. This also involve developing a cell-based potency assay of botulinum toxin.
3. *Targeted drug delivery*: I am working on three major delivery projects; a) topical delivery, b) neuronal delivery, and c) specific delivery to cancerous cells.
4. *Protein purification, stability and functional studies*: This involves projects to understand the translocation mechanism, purification of chimeric proteins, stability of BoNT/A toxin in various formulations, recombinant P80 purification, mammalian transfection and expression, and purification of native protein. Also, testing the efficacy M-complex of BoNT/E in *in vitro* and *in vivo* models.
5. *Neuronal regeneration project*: I am working on two different sets of experiments. First one is related to axonal regeneration and the second one is related to improvement of synaptic plasticity. Part of this project is funded by NIH.
6. *Oncology project*: I am working on understanding the mechanism and finding a holistic treatment for neural crest cell derived tumors. This involves reprogramming of the tumor epigenome as an option for the treatment. In this project, I am trying to establish an alternative to the current paradigm of one drug-one target to a multipronged approach to counter several mechanistic aspects of cancer by a single treatment. Collaborated with Dr. Chandra Sekhar Mayanil of North Western University on this project. Extending this project to other cancerous model.
Working on developing another cellular engineering method for development of treatment for cancer.
7. *Inhibitor Designing*: Involved in a project related to inhibitor of botulinum toxin using conventional screening, MD simulation and ex-vivo methods. Project was funded by Department of Defense, USA and Infinity foundation, USA.

8. *Biosensor development*: Involved in designing and model preparation of a detection instrument based on anisotropy.
9. *Alternate theory of evolution*: Working on devising an alternative theory of evolution which will be based on molecular characteristics. Published several theoretical works.
10. *Immune response project*: This project is in the hypothesis stage in which BoNT/A may affect CD4+ and CD8+ T-cells. I was part of INADS collaboration with Dr. Manoj Bhasin, Beth Israel Deaconess Medical Center, Boston, MA, USA.
11. *Development of pain model*: Based on engineered 3D microfluidic device, this project involves development of tripartite model of brain. I was involved in optimization of BoNT/A acetylcholine release assay and treatment of the developed model with BoNT/A.
12. *BoNT/A product development projects*: In this project, I was involved in initial discussion, planning, project management, protocol development and execution for developing several products based on botulinum toxin. I attended several meetings and prepared several documents which was shared with several interested organizations.
13. *Topical formulation of BoNT/A*: Developed a few formulations for topical delivery. Developed protocol and trained personnel for the toe-spread assay experiment. Animal testing done with very encouraging results at four different concentrations; 100, 50, 25 and 10 units. Developed protocol for hyperhidrosis experiment. Soon experiment will be started.
14. *TC2 vaccine*: Designed mammalian construct of TC2 vaccine. Developed and optimized protocol for expression and purification of TC2 vaccine. Technology is developed and the developed stable clone for cost effective production. Prepared documents for various filing requirements.
15. *Oral Insulin*: Developed formulation and protocol for animal assay. Project is in developmental stage.
16. *Dengue Vaccine*: Prepared the strategy and detailed plan for dengue vaccine. Designed three mammalian constructs of multi-epitope dengue vaccine. Developed and optimized protocol for expression and purification of dengue vaccine. Prepared tech transfer document and got it signed. Protocol for stable cell production. Involved in the preparation of a few documents for DCGI submission. Developing animal assay protocol.
17. *HCG project*: Designed the constructs for HCG production using CHO cells. Currently working on optimization of the production and purification.
18. *Original CHO cell line development*: First set of experiment completed. Working on different strategies.

19. *Therapeutic antibody*: Working on both bacterial and mammalian vector. Developed the strategies for vector design, required fragments and primer design. Two vectors are developed for the production of antibodies. Working on the development of

Journal Reviewer

1. Peptides
2. Biochemistry and Biophysics Reports
3. Journal of Biochemical and Molecular Toxicology
4. Annals of Neurology
5. Chemical Methodologies
6. Computational and Structural Biotechnology
7. Environmental Toxicology and Pharmacology
8. Marine Drugs
9. Toxins
10. Antibiotics
11. Bulletin of Environmental Contamination and Toxicology
12. Molecules.
13. Biology
14. Infection
15. International Journal of Molecular Sciences
16. Proteomes
17. Bioengineering
18. Frontiers in Neuroimaging
19. Biomedicines

Invited Seminar/Symposium Speaker:

1. Advinus Therapeutics, Pune, India, 7th March 2007.
Topic: CETP (Cholesterol Ester Transferase Protein) as potential target for lowering LDL level.
2. WAVES conference, University of Massachusetts, Dartmouth, 13-15th July 2012.
Topic: Neurological Link between Diet and Mind.
3. Botulinum Research Symposium, University of Massachusetts, Dartmouth, 16-17th August 2012.
Topic: Comparative functional folding of BoNT endopeptidase.
4. Youth Camp, University of Massachusetts, Dartmouth, 31st July 2013.
Topic: Chemistry: Our Life Our Future.
5. Botulinum Research Symposium, UMASS Dartmouth, 14-16th August 2013.
Topic: Differential Role of Molten Globule and Protein Folding in Distinguishing Unique Features of Botulinum Neurotoxin Endopeptidase.

6. One of the panelists in Panel Discussion 4, Vedanta Conference, 14th July 2013.
Topic: Vedanta in Academia, Business, Health, and Society.
7. Department of Chemistry and Biochemistry, UMASS Lowell, 7th November 2013.
Topic: Uniqueness of Botulinum Toxin.
8. Amity University, Gurgaon, 2nd May 2016.
Topic: Unique Structural and Functional Features of Botulinum Toxin.
9. Botulinum Research Symposium, Institute of Advanced Sciences, 17-19th August 2016.
Topic: Solution structure of BoNT/A light chain A.
10. Inter Botulinum Research Coordination Committee Conference, 23-26th October 2016.
Topic: Solution structure of BoNT/A light chain A and its implication in inhibitor design.
11. Mini-Symposium: Modern Relevance of Ancient Indian Education Pedagogy, 29th April, 2017.
Topic: Characteristics and Relevance of Ancient Educational System.
12. Botulinum Research Symposium, Institute of Advanced Sciences, 16-18th August 2017.
Topic: Paracellular vs. Transcellular absorption of botulinum neurotoxins.
13. Vedanta Conference, 2017. 13th August, 2017.
Topic: Vedic Perspectives of Origin of the Universe and Life.
14. Inter Botulinum Research Coordination Committee Conference, 22-25th October 2017.
Topic: Intestinal absorption of Botulinum Neurotoxin: Paracellular or Transcellular, or Both?
15. Educational Symposium 2018: Creating Standards for Ancient Education Pedagogy, 12th May 2018.
Topic: Role of Ancient Indian Education Systems in Creating Standards.
16. Anubhav 2018: 16th June 2018.
Topic: Paradigm Shift in the treatment of disease.
17. Anubhav 2018: 16th June 2018.
Topic: Evolutionary Theory of Veda.
18. 3rd Integrative Medicine Conference: 23rd June 2018, Harvard Medical School.
Topic: Ocimum Sanctum: A Source of Holistic Treatment for Neurofibromas.
19. Botulinum Research Symposium, Institute of Advanced Sciences, 15-17th August 2018.
Topic: Crystal vs Solution Structure: Are we dealing with the right structure of BoNT/A LC?

20. Inter Botulinum Research Coordination Committee Conference, 21-24th October 2018.
Topic: Why is crystalline not right in solution for botulinum neurotoxin endopeptidase structure?
21. Department of Chemistry and Biochemistry, UMASS Lowell, 30th November 2018.
Topic: Botulinum Toxin: A molecule to redefine biochemistry.
22. Botulinum Research Symposium, Institute of Advanced Sciences, 14-16th August 2018.
Topic: Preliminary investigation on botulinum neurotoxin-based delivery vehicle for axonal regeneration.
23. Inter Botulinum Research Coordination Committee Conference, 21 – 24th October 2019.
Topic: A novel method for axonal regeneration using botulinum neurotoxin.
24. Botulinum Research Symposium, Institute of Advanced Sciences, 19th August 2020.
Topic: Botulinum neurotoxin-based delivery vehicle for axonal regeneration.
25. International e-seminar on Global Pandemic and Mental Health. Host: Government Hamidia Arts and Commerce College, Bhopal, Madhya Pradesh, India. 13th September 2020.
Topic: COVID-19 and mental health.
26. Botulinum Research Symposium, Institute of Advanced Sciences, 19th August 2021.
Topic: Conformational dynamics of botulinum toxin and its implication on evolution.
27. Vedanta Conference, 30th October 2021.
Topic: Vedic Theories of Creation.
28. Botulinum Research Symposium, Institute of Advanced Sciences, 17 - 18th August 2022.
Topic: Evolution of Botulinum Neurotoxins and Their Commercial Uses.
29. Inter Botulinum Research Coordination Committee Conference, 17 – 18th October 2022.
Topic: Redefining Evolution using Bacterial Toxins.
30. Mutual Sensibilities of Dharma, Mazahab and Religion, 3rd January 2023.
Topic: Scientific perspectives of spirituality.
31. Mutual Sensibilities of Dharma, Mazahab and Religion, 24th January 2023.
Panel discussion: Scientific and Spiritual Perspectives.
32. Botulinum Research Symposium, Institute of Advanced Sciences, 19th – 21st July 2023.
Topic: Novel and effective nano emulsion for topical administration of Botulinum Neurotoxin A.

Teaching Experience:

1. Teaching Assistant at Chemistry and Biochemistry Department, University of Massachusetts, Dartmouth from January 2010 to May 2010 (Freshman chemistry lab).
2. Teaching Assistant at Chemistry and Biochemistry Department, University of Massachusetts, Dartmouth from January 2011 to May 2011 (Biochemistry lab).
3. Teaching Fellow at Chemistry and Biochemistry Department, University of Massachusetts, Dartmouth from September 2011 to December. 2011 (Freshman chemistry instructor for chemistry majors/non-majors).
4. Part-time Lecturer at Chemistry and Biochemistry Department, UMASS, Dartmouth from January 2012 – December 2013 (Freshman chemistry lecture/labs for chemistry majors/non-majors, supervised chemistry lab for seniors).
5. Taught chemistry theory/lab to the students of American Vivekanand Academy, New Hampshire, Fall 2012.
6. Taught a few classes as a visiting lecture. Introduction to Neuroscience, Science of Kriyayoga. University of Massachusetts, Dartmouth. Spring 2014.

Undergraduate Teaching:

CHM 151, General Chemistry I (3 semesters)
CHM 152, General Chemistry II (3 semesters)
CHM 161, General Chemistry Laboratory I (3 semesters)
CHM 101, General Chemistry (1 semester)
CHM 162, Chemistry Laboratory II (1 semester)
CHM 163, Chemistry Laboratory I (For Chemistry Major, 1 semester)
CHM 414, Biochemistry Laboratory (1 semester as Teaching Assistant)
IST 111, Science of Kriya Yoga (As a visiting faculty)

Graduate Teaching:

CHM 529, Physical Biochemistry (one three-hour class about Protein Folding)

Student Advisement:

Post-Doc: 1) Soniya Balli
2) Pratyusha Macha Krishna
3) Abhinandan Mani Tripathi
4) Pankaj Soni

- Graduate Students:** 1) Tom Feltrup (UMASS Dartmouth, USA)
2) Harkiran Preet Kaur Dhaliwal (UMASS Dartmouth, USA)
3) Gowri Chellapan (UMASS Dartmouth, USA)
4) Pavithra Janardhanan (UMASS Dartmouth, USA)
5) Niraj Ramsamooj (UMASS Dartmouth, USA)
6) Avinash Tiwari (Lucknow University, India)

- Undergraduate Students:** 1) Sara Sabet (Cedars-Sinai, LA, USA)
2) Aisha Furey (Binghamton University, NY, USA)

- High School Students:** 1) Brooke Spencer (Dartmouth High School, MA)
2) Lindsey Foster (Dartmouth High School, MA)
3) Fardeen Rashid (Dartmouth High School, MA)
4) Zachary Young (Bishop Connelly High School, MA)
5) Pedro de Souza (BMC Durfee High School, MA)
6) Leilani Rockwell (Rock Canyon High School, CO)
7) Alice Wong (Taunton High School)
8) Andrew Zhu (Dartmouth High School)
9) Sofia Levitt (Dartmouth High School)
10) Camron Vaillancourt (Dartmouth High School)

Research Interest:

Bio-Molecular spectroscopy, Protein folding and dynamics, Cellular biology, Molecular Dynamics Simulation, Protein NMR and Neurobiochemistry.

Organized Symposiums and Seminars

- 1) Education Symposium 2016, Attelboro, MA
- 2) Education Symposium 2017, Fall River, MA
- 3) BRC Symposium 2014 – 2022, New Bedford, MA
- 4) Mini-Symposium 2021, Virtual symposium

Publications:

1. **Kumar, R.**, Zhou, Y., Ghosal, K., Cai, S., and Singh, B. R. (2012) Anti-apoptotic activity of hemagglutinin-33 and botulinum neurotoxin and its implication to therapeutic and countermeasure issues. *Biochemical and Biophysical Research Communication*, 417, 726-731.

2. Singh, B. R., and **Kumar, R.** (2012) Modern scientific view of Ayurveda. *Light on Ayurveda Journal*, XI, 16-22.
3. Singh, B. R., **Kumar, R.**, and Cai, S. (2013) Molecular mechanism and effects of Clostridial neurotoxins. In *Handbook of Neurotoxicity* (Editor: Kostrzewa, Richard M, Springer), Springer Publication, New York, 513 - 551.
4. **Kumar, R.**, Kukreja, R. V., Li, L., Zhmurov, A., Kononova, O., Cai, S., Ahmed, S. A., Barsegov, V., and Singh, B. R. (2014) Botulinum neurotoxin: unique folding of enzyme domain of the most-poisonous poison. *Journal of Biomolecular Structure and Dynamics*, 32, 804-815.
5. **Kumar, R.**, Chang, T. W., and Singh, B. R. (2013) Evolutionary traits of toxins. *Handbook of Toxinology* (Editor: P. Gopalakrishnakone, Springer): Biological Toxins and Bioterrorism, Springer Dordrecht Heidelberg New York London, Vol 1, chapter 23, 527 - 557.
6. **Kumar, R.**, Kukreja, R., Cai, S. and Singh, B. R. (2014) Differential Role of Molten Globule and Protein Folding in Distinguishing Unique Features of Botulinum Neurotoxin. *Biochimica et Biophysica Acta – Proteins and Proteomics*, 1844, 1145-1152.
7. Chellappan, G., **Kumar, R.**, Cai, S., and Singh, B. R. (2014) Role of neurotoxin associated proteins in the Low pH induced structural changes in the botulinum neurotoxin complex. *The Protein Journal*, 33, 557 - 564.
8. **Kumar, R.**, Cai, S., and Singh, B. R. (2015) Resolution of sub-nano second motion in BoNT/A LC: Evidence of internal flexibility. *Biochimica et Biophysica Acta – Proteins and Proteomics*, 1854, 321- 326.
9. Chellapan, G., **Kumar, R.**, Goyal, D., Cai S., and Singh, B. R. (2015) Structural and functional analysis of botulinum neurotoxin subunits for pH-dependent membrane channel formation and translocation. *Biochemical et Biophysica Acta — Proteins and Proteomics*, 1854, 1510 – 1516.
10. **Kumar, R.**, Dhaliwal, H. P. K., Kukreja, R. V., and Singh, B. R. (2016). Botulinum toxins: Molecular structure and mechanisms of action in motor and sensory systems. *Seminars of Neurology*. 36, 10 -19.
11. Feltrup, T., Patel, K., **Kumar, R.**, Cai, S., and Singh, B. R. (2018) Differential structural and functional features of full length and truncated Light chain of Botulinum Toxin A. *Scientific Reports*.
12. **Kumar R.** (2018) A Review on Therapeutic use of Botulinum Toxin in Pain Treatment. *Neuronal Signalling*, NS20180058; **DOI:** 10.1042/NS20180058.
13. Dhaliwal, H. P. K., Thiruvanakarassu, N., **Kumar, R.**, Patel, K., Ambrin, G., Cai, S., and Singh, B. R. (2018). High Yield Preparation of Functionally Active Catalytic-Translocation

Domain Module of Botulinum Neurotoxin Type A That Exhibits Uniquely Different Enzyme Kinetics. *The Protein Journal*, 36, 486 – 491.

14. Ambrin, G., **Kumar, R.**, and Singh, B. R. (2018). Differential endopeptidase activity of different forms of type A botulinum neurotoxin: A unique relationship between the size of the substrate and activity of the enzyme. *Toxicon*, 144, 34 – 41.

15. **Kumar, R.**, Feltrup, T. M., Kukreja, R. V., Patel, K. B., Cai, S., and Singh, B. R. (2019). Evolutionary features in the structure and function of bacterial toxins. *Toxins*, 11, 1 - 23.

16. Monik, S., Mohanty, V., Khan, M., Yerneni, G., **Kumar, R.**, Cantu, J., Ichi, S., Xi, G., Singh, B. R., Tomita, T., and Mayanil, C. S. (2019). A phenotypic switch of differentiated glial cells to dedifferentiated cells is regulated by folate receptor a. *Stem Cells*, <http://dx.doi.org/0.1002/stem.3067>.

17. **Kumar, R.**, Maksudov, F., Kononova, O., Marx, K. A., Barsegov, V., Singh, B. R. (2020). Botulinum Endopeptidase: SAXS experiments and MD simulation reveal extended solution structures that accounts for its biochemical properties. *Journal of Physical Chemistry B*, 124, 5801-5812.

18. **Kumar, R.** (2021). Vedic Perspectives on Origin of Universe and Life. *Proceedings of Vedanta Conference 2017*.

19. Patel, K. B., Kononova, O., Cai, S., Barsegov, V., Parmar, V., **Kumar, R.**, and Singh, B. R. (2021). Botulinum neurotoxin inhibitor binding dynamics and kinetics relevant for drug design. *BBA – General Subject*, 1865, 129993.

20. Ambrin, G., Wang, L., **Kumar, R.**, and Singh, B. R. (2021). Neurodegenerative mechanistic Pathways with focus on Ayurveda point of view and applications of Nutraceuticals. (Chapter 7 inbook *Nutraceuticals for Aging and Anti-Aging: Basic Understanding and Clinical Evidence*, edited by Dr. Yashwant Pathak).

21. **Kumar, R.** (2021). Vedic theories of creation (part-I). *Proceedings of Vedanta Conference 2021*.

21. Cai, S., **Kumar, R.**, and Singh, B. R. (2021). Clostridial Neurotoxins: Structure, Function, and Implications to Other Bacterial Toxins. *Microorganisms*, 9, 2206 -2238.

22. **Kumar, R.** (2021). Vedic Theory of Creation (part-II). *Proceedings of Vedanta Conference*, Oct. 22-31, 2021 (Accepted).

23. **Kumar, R.**, and Singh, B. R. (2022). *Animal (Pashu)*. Dhol, Gawar, Shudra, Pashu, Nari (Edited by B. R. Singh). (Accepted after review).

Manuscripts (in preparation):

1. **Kumar, R.** (2021). Microglia and Schwann cells: an alternative target for neuropathic pain. (Under review; Neuronal Signaling).
2. Dhaliwal, H. P. K., **Kumar, R.**, Cai, S., Singh, B. R., and Thirunavukkarasu, N. Identification of channel-forming motifs in botulinum neurotoxins and characterization of ion-channel deficient mutation in type A toxin (*in preparation: to be submitted soon*).
3. Dhaliwal, H. P. K., Thirunavukkarasu, N., **Kumar, R.**, Ghoshal, K., Cai S., and Singh, B. R. Botulinum Neurotoxin Type A Light Chain Host-Cell Mediated Phosphorylation Mechanisms in M17 Neuroblastoma Cells (*in preparation: to be submitted soon*).
4. **Kumar, R.**, and Singh, B. R. Botulinum Toxin Mechanism of Action (To be submitted soon).

Published Book

1. **Protein Toxins in Modeling Biochemistry (Authors: Raj Kumar and Bal Ram Singh)** Published in Springer Brief, ISBN 978-3-319-43538-1, 978-3-319-43540-4 (ebook).
2. **Principles Techniques in Molecular Biotechnology (Authors: Raj Kumar and Bal Ram Singh)** Cambridge University Press, ISBN 978-1-108-48640-8.

Book and Book Chapters in process of submission:

1. Bal Ram Singh, **Raj Kumar.** Redefining evolution (*in preparation*).

Peer-reviewed Blogs:

1. Scientific Significance of OM (published on Feb 3, 2016 in a peer reviewed blog).
2. Characteristics of ancient Indian educational system (published on Sep 24, 2016 in a peer reviewed blog).
3. How to integrate the ancient educational system with the modern educational system (published on Oct 1, 2016 in a peer reviewed blog).
4. Vibration: The cause of our existence and its connection with Vedic philosophy (Part-I) (published on Oct 11, 2017 in a peer reviewed blog).
5. Vibration: The cause of our existence and its connection with Vedic philosophy (Part-II) (published on Oct 13, 2017 in a peer reviewed blog).
6. India: A concept of nationhood (Part-I) published on Jan 26, 2018 in a peer reviewed blog).
7. India: A concept of nationhood (Part-II) published on Jan 27, 2018 in a peer reviewed blog).

Patents:

- 1) Composition of Oral or Nasal Delivery of Tetanus, Diphtheria, and Pertussis Vaccine alone or in combination using Neurotoxin Associated Proteins. Weiping Yang, **Raj Kumar**, Paul Lindo, Bal Ram Singh. (Application no.: USPTO 15/064,651) (in review).
- 2) Novel Universal Substrate for the Detection of Botulinum Toxins. Weiping Yang, **Raj Kumar**, Bal Ram Singh. (Application no: USPTO 15/418,810) (in review).
- 3) A Pharmaceutical composition comprising P80 protein. Bal Ram Singh, Sirisha Mukkawali, **Raj Kumar**, Paul Lindo (Application no: USPTO62570742) (in review).
- 4) A pharmaceutical preparation for increasing stability and bioavailability of botulinum Toxin A and its complex. **Raj Kumar**, and Bal Ram Singh (Application no: USPTO 62/623,711) (abandoned).
- 5) Treatment of malignant neurofibroma with *Ocimum Sanctum* hydrophilic fraction-1 (OSHP-1) (Application no: USPTO62/690369). C.S.K. Mayanil, **Raj Kumar**, Bal Ram Singh, Tadanori Tomita (awarded).
- 6) A complex of botulinum neurotoxin E and its binding protein as a formulation with enhanced potency. **Raj Kumar**, Bal Ram Singh (Application no: USPTO17200822) (in review).
- 7) Topical formulation of botulinum neurotoxin. **Raj Kumar**, Bal Ram Singh (submitted to USPTO).
- 8) Tetanus vaccine platform for embedding Covid-19 vaccine. Bal Ram Singh, Kruti Patel and **Raj Kumar**. PCT application to 21 countries. USPTO separately (in review).
- 9) A protein-based vaccine and production method thereof for SARS COV-2. **Raj Kumar**, Bal Ram Singh (to be submitted to USPTO).
- 10) Multiepitope vaccine platform for Dengue. **Raj Kumar**, Bal Ram Singh. (submitted to USPTO).

Poster Presentations

1. **Raj Kumar**, Shuowei Cai, and Bal Ram Singh (2008) Protein flexibility through hydrogen exchange, 14th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 29-30, 2008.

2. **Raj Kumar**, Yu Zhou, Koyel Ghosal, Shuowei Cai, Bal Ram Singh (2008) Anti-apoptotic property of Hn-33. Second Annual Botulinum Research Symposium, UMASS Dartmouth, August 20-21, 2008.
3. **Raj Kumar**, Li Li, Roshan Kukreja, Shuowei Cai, Bal Ram Singh (2009) A biologically active intermediate of urea denaturation in botulinum neurotoxin endopeptidase. Inter Botulinum Research Coordination Committee Conference (2009) in Alexandria, VA; 15th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 28-29, 2009, and Third Annual Botulinum Research Symposium, UMASS Dartmouth, August 20-21, 2009.
4. **Raj Kumar**, Silvi Agarwal, Artem Zhumarov, Valerie Bargesov, Bal Ram Singh (2010). MD simulation of BoNT/A LC. 16th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 28-29, 2010, and in Fourth Annual Botulinum Research Symposium, August 19-20, 2010.
5. **Raj Kumar**, R. Kukreja, Li Li, Shuowei Cai, Syed A. Ahmed, and Bal Ram Singh (2011) A unique urea denaturation pattern of botulinum neurotoxin A endopeptidase. 17th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 2011, and in Fifth Annual Botulinum Research Symposium, August 18-19, 2011.
6. **Raj Kumar**, Emmanuel Ojadi, Shuowei Cai and Bal Ram Singh (2011) Resolution of sub-nanosecond motion of BoNT/A endopeptidase: An evidence of internal flexibility. Fifth Annual Botulinum Research Symposium, August 18-19, 2011, and Eight Annual Botulinum Research Symposium, August 13-15, 2014
7. **Raj Kumar**, Mario J. Oliveira, Shuowei Cai, and Bal Ram Singh (2012) Dynamics of BoNT/A endopeptidase during catalysis. 18th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 30, 2012.
8. **Raj Kumar**, Jordan Burke, Marco Tonelli, Milo Westler, Shuowei Cai, and Bal Ram Singh (2013) SAXS and NMR analyses of active conformational states of BoNT/A endopeptidase. 19th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 23-24, 2013, Sigma XI, and Sixth Annual Botulinum Research Symposium, August 15-16, 2011.
9. **Raj Kumar**, Shuowei Cai, and Bal Ram Singh (2013) Effect of Digested peptides from dietary proteins on regulation of natural health. 19th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 23-24, 2013; National Ayurvedic Medical Association, April 14 - 16, 2016, Warwick, Rhode Island, USA.
10. Thomas Feltrup, **Raj Kumar**, Shuowei Cai, and Bal Ram Singh (2013) Differential activity of BoNT/A and BoNT/E with respect to substrate length demonstrates the involvement of exosite binding in endopeptidase activity. 19th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 23-24, 2013, and in Seventh Annual Botulinum Research Symposium, August 15-16, 2013.

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12. Harkiranpreet Dhaliwal, Nagarajan Thirunavukkarasu, **Raj Kumar**, Paul K. Kinker, Easwaran Ravichandran, Alan Fikelstein, Shuowei Cai and Bal Ram Singh (2013) Identification of ion-channel forming structural determinants in botulinum neurotoxins. 19th Annual Sigma Xi Research Exhibit, University of Massachusetts Dartmouth, North Dartmouth, MA, April 23-24, 2013; Seventh Annual Botulinum Research Symposium, August 15-16, 2013, and in Inter Botulinum Research Coordination Committee, Maryland, October 21-25, 2013.
13. **Raj Kumar**, Jordon Burke, and Bal Ram Singh (2014) Active Conformational States of Botulinum Endopeptidase as Determined by SAXS. Eight Annual Botulinum Research Symposium, August 13-15, 2014.
14. Brook Spencer, Lindsey Foster, Sara Sabet, **Raj Kumar**, Kodumudi Venkat Venkateshwaran, Shuowei Cai, and Bal Ram Singh (2014) A Combination of Isoelectric and Ammonium Sulfate Precipitation Enhances Detection of BoNT/A in a Monoclonal Antibody based Sandwich ELISA. Eight Annual Botulinum Research Symposium, August 13-15, 2014. Ninth Annual Botulinum Research Symposium, August 12-14, 2015.
15. **Raj Kumar**, Olga Kononova, Shuowei Cai, Valeri Barsegov, and Bal Ram Singh (2014). Dynamic Solution Structure of BoNT/A Light Chain Critical for Binding to Potential inhibitors. Inter Botulinum Research Coordination Committee Conference in Philadelphia, October 26-29, 2014.
16. **Raj Kumar**, and Bal Ram Singh (2015). Virtual Screening of small molecule inhibitor against BoNT/A LC. Ninth Annual Botulinum Research Symposium, August 12-14, 2014.
17. **Raj Kumar**, Kruti Patel, Shuowei Cai and Bal Ram Singh (2015 and 2016). Virtual Screening and ADMET analysis of endopeptidase inhibitors. Inter Botulinum Research Coordination Committee Conference in Philadelphia, October 25-28, 2015. and Bio-Science Meeting, Baltimore, June 7, 2016.
18. **Raj Kumar**, Wei Ping Yang, Thomas Feltrup, Guncha Ambrin, Tzuu Wang Chang, Paul Lindo, Shuowei Cai, and Bal Ram Singh (2015). Size and structures of SNAP-25 substrates and botulinum neurotoxin endopeptidase influence enzyme assays. Inter Botulinum Research Coordination Committee Conference in Philadelphia, October 25-28, 2015; Botulinum Research Symposium, August 17 - 19, Institute of Advanced Sciences, New Bedford, 2016.
19. Bal Ram Singh, Sirisha Mukkavalli, and **Raj Kumar** (2015). Vedantic Foundations of Ayurvedic Science and Technology. Vedanta Conference at Jawaharlal Nehru University, India, December 27 - 30, 2015.

20. Easwaran Ravichandran, Jenny Davis, Lei Wang, Kruti Patel, **Raj Kumar** and Bal Ram Singh (2016). Development of recombinant protein-based vaccine for BoNT. Bio-Science meeting, Baltimore, June 7, 2016.
21. Aisha Furey, **Raj Kumar**, Bal Ram Singh (2016). Investigation of cellular binding and effect of P-80 on Caco-2 cells. Botulinum Research Symposium, 17 - 19th August 2016.
22. Thomas Feltrup, Kruti Patel, **Raj Kumar**, Shuowei Cai, and Bal Ram Singh (2016). The implications of the BoNT/A endopeptidase C-terminus on substrate binding, enzyme activity, and maintaining a functionally disordered structure in solution. Botulinum Research Symposium, 17 - 19th August 2016.
23. **Raj Kumar**, Pedro De Sousa, Thomas M. Feltrup, and Bal Ram Singh. A Novel and innovative approach for axonal regeneration after spinal cord injury (SCI). Botulinum Research Symposium, 16-18th August 2017; Inter Botulinum Research Coordination Committee Conference in Philadelphia, October 25-28, 2015.
24. Ghuncha Ambrin, **Raj Kumar**, and Bal Ram Singh. Distinctive endopeptidase activity of different forms of type A botulinum neurotoxin. Botulinum Research Symposium, 16- 18th August 2017.
25. Soniya Balli, **Raj Kumar**, and Bal Ram Singh. Functional characterization of p80 and Hn33 in Caco2 and HT29 cell lines. Botulinum Research Symposium, 16 - 18th August, 2017.
26. Niraj Ram Samooj, Bal Ram Singh, and **Raj Kumar**. Cloning, expression, and purification of recombinant C3 exoenzyme. Botulinum Research Symposium, 15 - 17th August 2018.
27. Niraj Ramsamooj, Shuowei Cai, and **Raj Kumar**. A novel oral delivery platform for therapeutic proteins. Botulinum Research Symposium, 15 - 17th August 2018.
28. Thomas Feltrup, Kruti Patel, **Raj Kumar**, Shuowei Cai, and Bal Ram Singh. A novel role of C-terminus in introducing a functionally flexible structure critical for the biological activity of botulinum neurotoxin. Botulinum Research Symposium, 15 - 17th August 2018.
29. Kruti Patel, Thomas Feltrup, **Raj Kumar**, and Bal Ram Singh. Detoxified Recombinant Botulinum Neurotoxin Light chain B. Botulinum Research Symposium, 15 - 17th August 2018.
30. Andrew Zhu, Niraj Ramsamooj, Sirisha Mukkavalli, **Raj Kumar**, Bal Ram Singh. Investigation into experimental green synthesis of phytonanoparticles for vaccine delivery. Botulinum Research Symposium, 15 - 17th August 2018.
31. Niraj Ramsamooj, Alice Wong, Raj Kumar, Bal Ram Singh. Binding and internalization of detoxified recombinant botulinum neurotoxin to M17 neuronal cells. Botulinum Research Symposium, 15 - 17th August 2018.

32. **Raj Kumar** and Bal Ram Singh. Mechanism of Evolution: An Alternative View. Botulinum Research Symposium, 14 - 16th August 2019.

33. Niraj Ramsamooj, Bal Ram Singh and **Raj Kumar**. Purification of engineered botulinum toxin-based for axonal regeneration. Botulinum Research Symposium, 14 - 16th August 2019.

34. Weiping Yang, Kruti Patel, Paul Lindo, **Raj Kumar**, Bal Ram Singh. Botulinum toxin associated proteins as carriers for the oral delivery of tetanus vaccine. Botulinum Research Symposium, 14 - 16th August 2019.

Memberships:

1. American Academy of Advancement of Science Member (2009 - 2017).
2. American Chemical Society Member (2010-2012)
3. American Federation of Teachers (2012 - 2014)
4. Society for Science and Public (2014 - present)
5. American Society for Pharmacology and Experimental Therapeutics (ASPET) (2015 - 2019).