अखिल भारतीय आयुर्विज्ञान संस्थान
अंसारी नगर, नई दिल्ली–110029

All India Institute of Medical Sciences,
Ansari Nagar, New Delhi-110029, India

Prof. Narinder K. Mehra

Ex Dr. C. G. Pandit National Chair
Former Dean (Research)
Ex. Prof. & Head
Dept. of Transplant Immunology & Immunogenetics

Oct 19, 2021

Sub: Nomination for the Sun Pharma Science Foundation Research Award 2021 in the area of Medical Sciences (Basic Research) – Prof Sunil K. Arora, PGIMER Chandigarh

Sir,

I am pleased to nominate Prof. Sunil K Arora for the Sun Pharma Science Foundation Research Award in the area of **basic medical research**. I have known Sunil since his student days and have closely watched him grow into an established scientist, particularly in the field of Immunology of HIV and other infectious diseases. He made ground breaking discoveries in the area of molecular diagnosis of ocular infections especially the extra-pulmonary TB for which he obtained a US patent also.

Prof Arora started his scientific career in 1980 when he completed Master's degree in Biochemistry from the prestigious Panjab University Chandigarh, followed by Doctoral degree (Immunology) from the Department of Immunopathology, Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh under the able guidance of an Immunology stalwart, Prof Shobha Sehgal. Following this, he moved to the US in 1991 to do post-doctoral training in Molecular Immunology under Prof. Peter Melby at the Department of Medicine, Division of Infectious Diseases at the University of Texas Health Science Center, San Antonio, Texas. On his return, joined as Assistant Professor in the Department of Immunopathology at the PGIMER, Chandigarh in 1993.

His major research focus has been in the area of Immunology of Infectious diseases, which includes Experimental leishmaniasis, HIV, HCV and tuberculosis. His group developed a robust program addressing challenges associated with developing an effective vaccine against visceral leishmaniasis, a neglected tropical disease, endemic in many countries including the Eastern region of India. His team worked on identifying novel clones from a cDNA library that they generated initially and carried on to evaluate the protective efficacy of novel vaccine candidates. He worked diligently and consistently to find novel strategies to improve the efficacy of this vaccine. After years of hard work and scientific enquiry, the group proposed *'multi-epitope constructs'* as vaccine candidates including the select T-cell based epitopes mapped from their previously cloned genes using immune-informatic tools. They found that one of these multi-epitope peptides was able to induce 'sterile immunity' in the hamster model of experimental visceral leishmaniasis. The animals were nearly 100% protected to a

Room No. 2008, 2nd Floor, Convergence Block, All India Institute of Medical Sciences, Ansari Nagar, New Delhi - 110 029.
Phones : (+91 11) 26588253, 26588500, Fax : 011-26588663, 26588641
e-mail : narin.mehra@gmail.com

lethal challenge with the virulent parasite. This study has recently been published in the journal, Vaccines (43). This is a remarkable progress in the field of vaccine development against such a tropical disease and this has been made possible due to a consistent and focused approach by Dr Arora and his team mates, as is evident from a series of research papers published in high impact peer reviewed journals (1-12, 14, 17-19, 32, 43). An important outcome of employing selective epitope mapping with designing of multi-epitope constructs as a vaccine candidate is that it may not remain restricted to leishmaniasis but could be highly translatable to similar epitope-based vaccine design for other emerging infections.

Besides, his group has been working to delineate the cellular immune defects in HIV and HCV infections. Another important observation from his laboratory is with regards to the HIV-1 subtype-C specific drug-docking prediction model for assessment of drug-resistant mutations based on binding energy to RT and PR genes (13, 14, 21, 24).

Further, they, reported that *Mycobacterium tuberculosis* (Mtb), the most common opportunistic co-infection among HIV-1 infected individuals, is able to modulate several genes in the co-infected host cells and thus facilitate replication of HIV-1, leading to faster disease progression in such individuals (25, 29).

Recently, they have further delineated the molecular mechanisms and described the genetic evolution of HIV-1 in the co-infected host in terms of accumulation of DR mutations and acquisition of additional NF-kB binding sites in the LTR region that turns the virus into more fit and replication competent in such individuals (41 42). These observations on the molecular pathways leading to maturation defective myeloid dendritic cells in the advanced HIV disease and chronic viral hepatitis (CHC) are phenomenal and have received the much-needed attention of the scientific community (20, 22, 23, 26, 27, 30, 33).

Sunil has also endeavored to explore the field of stem cell biology. His group successfully showed the regenerative capability along with anti-inflammatory potential of mesenchymal stem cells isolated from the Wharton's jelly of human umbilical cord when used in a collagen-induced arthritis (CIA) model in rats (40). Using micro-array expression profiling of isolated cancer stem cells from primary tumors of patients, his laboratory identified a set of signature genes in the cancer stroma that facilitate the expansion of intra-tumoral cancer stem cells, which are associated with aggressive behavior of human breast carcinoma (44).

Sunil rose to the level of full Professor in 2008 and I had the opportunity to evaluate him in the interview for this position. The selection committee was highly impressed with his progress both as a researcher as well as a popular teacher in Immunology.

Sunil also proved his mettle as an able administrator handling the 'import purchase department' of the institute most efficiently for close to four years. Further, looking at his credentials and special interest in the field of Stem Cell biology and Regenerative Medicine, the institute administration gave him the additional responsibility of building a newly carved out Department of Translational & Regenerative Medicine in the institute, which embodies the state-of-the-art Stem Cell Research Facility. It is due to his efforts that this department ranks as one of the finest stem cell facilities in India.

Prof Arora is a nationally recognized scientist in the field of Immunology and Biotechnology. He got elected as a member of the National Academy of Medical Sciences (India) in 2004. He showed extraordinary acumen and expertise as a facilitator for promotion of Immunology at the grass-root level in the national and international fora as President of Indian Immunology Society as well as Vice President of Federation of Immunological Societies of Asia-Oceania (FIMSA). His expertise in flowcytometry is well appreciated among fellow cytometrists in the country and abroad and he served as President of The Cytometry Society (India) for two years.

Sunil has been a very productive scientist throughout his career spanning over four decades. He was able to attract competitive funding from most major scientific agencies and enjoys a fine track record of successfully executing numerous research projects funded to him as Principal Investigator including 3-4 projects with international collaboration. He has been a visiting scientist/guest faculty to the University College London, Allex-Mowat Immunopathology Laboratory in Institute of Liver Studies at King's College London, UK, Hannover Medical School, Hannover, Germany, Miller's School of Medicine, University of Miami, USA and New York School of Medicine, NY, USA.

Besides, he has been a very popular research guide among research students as 25 scholars have already completed their PhD under his direct guidance while more are pursuing currently. Dr Arora's group in PGI have made tremendous scientific contributions in terms of highly rated scientific publications and review articles [current score 172] in the peer-reviewed journals of repute with Google-scholar H-index of 31 and i10 index of 78. He is member of the editorial boards and reviewing panel of many reputed scientific journals. In lieu of his scientific achievements he has received several awards including Indo-US Young Investigator's award in 1991, Fogarty Fellowship in 2012 and Senior Scientist Oration award in Immunology in 2018.

I am most happy to recommend him in highest terms for the Sun Pharma Science Foundation research award 2021 in the category of Basic Medical Sciences. Attached is a list of his most prominent over 40 publications.

Prof. N. K. Mehra

Hon. Emeritus Scientist, ICMR

Former Dean (Res) and National Chair, AIIMS, New Delhi

List of some important publication from Dr. Sunil K Arora group

1. Identification of major antigens of Leishmania donovani promastigotes using kala azar sera. Arora SK and Sehgal S. Med Microbiol Immunol 1988; 178:81-88.
2. Receptor mediated drug-delivery of macrophages: a novel chemotherapeutic approach against leishmaniasis. Mukhopadhyaya A, Chaudhri G, Arora SK, Sehgal S and Basu SK. Science 1989; 244:705-707.
3. Use of in vitro method to assess different brands of anti-leishmania drugs. Arora SK, Sinha R and Sehgal S. Med Microbiol Immunol 1991; 180:21-27.
4. Detection of leishmania antigen in kala azar patients using monoclonal antibodies. Sinha R, Arora SK, Datta U and Sehgal S. Med Microbiol 1992; 36:391-400.
5. Use of monoclonal antibodies for the detection of leishmania antigens in kala azar patients. Sinha R, Sehgal S, Datta U and Arora SK. Microbiol Immunol 1992; 32:391-400.
6. Comparative evaluation of the anti-heat shock protein antibodies in SLE and healthy controls. Arora SK, Singh G and Sehgal S. Scand J Rheumatol. 1995; 24:160-163.
7. Lack of serological specificity of recombinant leishmania hsp70. Arora SK, Melby PC and Sehgal S. Immunol Cell Biol 1995; 73:446-451.
8. Recombinant heat shock protein is recognised from individuals with prior L.donovani infection. Arora SK, Sehgal S, Tryon VV and Melby PC. Immunol Infect Dis 1995; 5:282-286.
9. Genetic polymorphism in leishmania isolates using restriction enzyme length polymorphism of kDNA and cDNA probes. Kapoor GS, Arora SK and Sehgal S. Med Microbiol Immunol 1998; 186:209-214.
10. Heterogeneity in the heat shock protein gene of leishmania isolates. Arora SK, Singh G and Sehgal S. Immunol Cell Biol 1998; 76:186-189.
11. Recognition of Leishmania donovani by CD4+ T-cells of naïve healthy uninfected individual, Pal N and Arora SK. Submitted to J PARASIT DIS, 2004; 28:11-16.
12. Recombinant antigens of Leishmania donovani inducing IFN-g release from Leishmania specific cell line, Arora SK, Pal NS & S.Mujtaba. EXP PARASIT 2005; 109:163-170.
13. Frequency of drug-resistance mutation coexisting with wild type in treatment-naïve patients in India. Sachdeva N, Sehgal S and Arora SK. eJ INT AIDS SOC, Medscape General Medicine 2005: 7(3).
14. An epitope-specific PCR test for diagnosis Leishmania donovani infections. Arora SK, Gupta S, Sachdeva N. TRANS R SOC TROP MED HYG 2007; 102(1):41-45.
15. Drug-resistance associated genotypic alterations in pol-gene of HIV isolates from ART-naïve individuals in North India. Arora SK, Gupta S, Toor JS, Singla A. AIDS RES HUM RETROVIRUSES 2008; 24(2):125-30.
16. Increased frequency of intra-tumoral CD4+ CD25+ Treg cells in hepatocellular carcinoma. Thakur S, Singla A, Rajwanshi A, Chawla Y and Arora SK. J HEPATOLOGY 2008; 48: Supplement 2, S136.
17. Vaccination with a novel recombinant Leishmania antigen along with MPL provides partial protection against L. donovani challenge in experimental model of visceral leishmaniasis. Bhardwaj S, Vasishta RK and Arora SK. EXP PARASITOL 2009; 121:29–37.
18. Synthesis and Antileishmanial activity of Piperoyl-Amino Acid Conjugates. Inder Pal Singh, Shreyans K Jain, Amandeep Kaur, Sukhvinder Singh, Rajendra Kumar, Prabha Garg, Shyam S Sharma and Arora SK. EUR J MED CHEM. 2010;45:3439-3445.
19. Efficacy of Leishmania donovani ribosomal P1 gene as potential DNA vaccine in experimental visceral leishmaniasis. Masih S, Arora SK and Vasishta RK. EXP PARASITOL 2011; 129: 55-64.
20. HBV specific T-cell responses in hepatitis B. Rana D, Menachery J, Chawla YK, Duseja A, Dhiman RK, Arora SK. TROP GASTRO 2011; 32(4): 273-278.
21. Prediction of drug-resistance in HIV-1 Subtype C based on protease sequences from ART naïve and first line therapy failures in North India using genotypic and docking analysis. Toor JS, Verma R, Gupta P, Garg P, Sharma A and Arora SK. ANTIVIRAL RESEARCH 2011; 92:213-18.

22. Functional reconstitution of defective myeloid Dendritic Cells in chronic Hepatitis C infection on successful anti-viral treatment. Rana D, Chawla Y, Duseja A, Dhiman RK, Arora SK. LIVER INTERNATIONAL 2012; 32(7): 1128-37. doi: 10.1111/j.1478-3231.2011.02754.x.
23. Maturation defective myeloid Dendritic Cells in Non-alcoholic fatty liver disease patients release inflammatory cytokines in response to endotoxin. Rana D, Chawla Y, Duseja A, Dhiman RK, Arora SK. HEPATOL INTNL 2012; 7(2):562-569. DOI 10.1007/s12072-012-9371-6.
24. Prediction of NRTI drug resistance in HIV-1 subtype C among first line antiretroviral-experienced virological failure patients from North India using genotypic and docking analysis. Toor JS, Kumar R, Garag P, Sharma A, Arora SK. J AIDS CLIN RES 2012, S5: 005. doi:10.4172/2155-6113.S5-005.
25. Differential expression of Rac-1, CxCR4 and CCR5 on CD4 T-cells at different stages of HIV-1 disease relate to its progression in therapy-naïve individuals. Toor JS, Sharma A, Kamboj SS and Arora SK. J AIDS CLIN RES. 2013; 4:207. doi:10.4172/2155-6113.1000207.
26. Viral proteins mediate upregulation of negative regulatory factors causing downmodulated dendritic cell functions in chronic hepatitis C virus infection. Rana D, Chawla YK, Duseja A, Dhiman RK and Arora SK. EUR MED J –HEPATOLOGY 2013;1:68-76
27. Success of Antiviral Therapy in Chronic Hepatitis-C Infection Relates to Functional Status of myeloid Dendritic Cells Rana D, Chawla YK and Arora SK. Invited review submitted to Special issue, 'Translational Research in Health and Disease' in IND J MED RES. 2013; 138(5): 766-778.
28. High producer haplotype (CAG) of -863C/A, -308G/A and -238G/A polymorphisms in the promoter region of TNF-α gene associate with enhanced apoptosis of lymphocytes in HIV-1 subtype C infected individuals from North India. Singh S, Sharma A, Arora SK. PLOS ONE. 2014, 9(5): e98020. doi:10.1371/journal.pone.0098020.
29. Mycobacterium tuberculosis modulates the gene interactions to activate the HIV replication and faster disease progression in a co-infected host. Toor JS, Singh S, Sharma A, Arora SK. PLOS ONE 2014; 9(9): e106815.
30. Functional Impairment of Myeloid Dendritic Cells during Advanced Stage of HIV-1 Infection: Role of Factors Regulating Cytokine Signaling. Sachdeva M, Sharma A and Arora SK. Plos One 2015; 10(10: e0140852. DOI:10.1371/journal.pone.0140852.
31. Combination of low producer AA-genotypes in IFN-c and IL-10 genes makes a high risk genetic variant for HIV disease progression. Singh S, Sharma A, and Arora SK. Cytokine 2015; 77:135-44.
32. Leishmania recombinant antigen modulates macrophage effector function facilitating early clearance of intracellular parasites. Ratna A; Arora SK. Trans Roy Soc Trop Med Hyg 2016 110 (10): 610-619. doi: 10.1093/trstmh/trw068.
33. Increased expression of negative regulators of cytokine signaling during chronic HIV disease cause functionally exhausted state of Dendritic cells. Sachdeva M, Sharma A and Arora SK. Cytokine 91:118-123; 2017.
34. Manα1-2Man binding anti-HIV lectins enhance the exposure of V2i and V3 crown neutralization epitopes on the V1V2 and V3 hypervariable loops of HIV-1 Envelope. Jan M, Upadhyay C, Sharma A, Hioe CE, Arora SK. AIDS Research and Human Retroviruses- 2017 Sep;33(9):941-945. doi: 10.1089/AID.2016.0262.
35. Innate sensing of HIV-1 by DC-SIGN on Dendritic Cells: degradation and presentation vs. transmission of virus to T cells is determined by glycan composition of viral envelope. Jan M & Arora SK. AIDS Res Human Retrovir. 2017 Jul 27. doi: 10.1089/aid.2016.0290. [Epub ahead of print].
36. a(1–6)-Fucosylated Complex Glycan-Binding Lentil Lectin Enhances In Vitro HIV-1 Infection and DC-SIGN-Mediated Viral Capture and Transmission to CD4 Cells. Jan M, Tomar S, Arora SK. AIDS Res Hum Retro. 2018; 34:641-44. DOI: 10.1089/aid.2018.0045.

37. Heterogeneity in the glycan composition on the surface of HIV-1 envelope determines the sensitivity to lectins. Jan M, Upadhyay C, Sharma A, Hioe CE, Arora SK. PLoS One, 2018 Mar 26;13(3): e0194498. doi: 10.1371/journal.pone.0194498. eCollection 2018.
38. Emerging strains of HIV-1 subtype C acquire multiple NF-ĸB binding sites in the LTR in co-infected individuals. Mehta G and Arora SK. Eur. J. Immunol 2019; 49, S3, (1236). P1558.
39. Signature genes associated with Immunological Non-responsiveness to Anti-retroviral therapy in HIV-1 infection. Singh S, Toor JS, Sharma A and Arora SK. Plos One 2020; 15(6): e0234270: 1-17. doi.org/10.1371/journal.pone.0234270 J.
40. Human Umbilical Cord derived Mesenchymal Stem Cells induce tissue repair and regeneration in collagen-induced arthritis in rats. Vohra M, Sharma A, Bagga R, Arora SK. J Clin Trans Res. 2020; 7(1): 6-19.
41. Human Immunodeficiency virus-1 (HIV-1) subtype-C genetically diversify to acquire higher replication competence in human host with co-morbidities. Mehta G, Sharma A, Arora SK. AIDS Res Hum Retroviruses. 2021 Jan 7. doi: 10.1089/AID.2020.0118. Online ahead of print.
42. Acquisition of additional NFκB binding sites in LTR of genetically evolving HIV-1 subtype C viral species in host with co-morbidities. Mehta G, Sharma A, Arora SK. AIDS Res Hum Retroviruses. 2021 Jan 13. doi: 10.1089/AID.2020.0195. Online ahead of print
43. A T-Cell Epitope-Based Multi-Epitope Vaccine Designed Using Human HLA Specific T Cell Epitopes Induces a Near-Sterile Immunity against Experimental Visceral Leishmaniasis in Hamsters. Arya A, Arora SK. Vaccines 2021, 9, 1058. https://doi.org/10.3390/vaccines9101058.
44. Evaluation of breast cancer stem cells in human primary breast carcinoma and their role in aggressive behavior of the disease. Dhanota N, Bal A, Singh G, Arora SK. Journal of Clinical and Translational Research. Published sept. 29, 2021; 7(5): 1-14. 10.18053/Jctres/07.202105.00.