Statement of research achievements, if any, on which any award has already been received by the applicant. Please also upload brief citation(s) on the research work(s) for which the applicant has already received the award(s) (not to exceed 2000 words)

In 2020, Prof. Dash was awarded the most coveted Shanti Swarup Bhatnagar Prize for Science and Technology by the Council of Scientific and Industrial Research (CSIR) for her notable and outstanding research contributions in Chemical Sciences.

Dr. Dash and her group used simple synthetic methods to design novel molecular probes for selectively targeting different DNA secondary structures and evaluated their effects in cellular system. They have established that DNA quadruplexes and i-motifs can synthesize their own selective ligands that are capable of downregulating expression oncogene by directly targeting the promoter regions. The regulation of c-MYC oncogene by targeting its promoter quadruplex and i-motif can be a potential strategy for cancer therapeutics.

Non-canonical DNA i-motifs have recently emerged as potential anticancer targets. However, targeting i-motifs is less explored in comparison to G-quadruplexes. Her group demonstrated that peptidomimetics and carbazoles can selectively target c-MYC and BCL-2 i-motifs and modulate their gene expression. Thus, these ligands could be useful for treating cancer and neurodegenerative disorders. These studies address mechanisms for novel therapeutic approaches. In longer term, these findings have the potential to make significant impacts in the healthcare and pharmaceutical sectors.

Her group employed predictable and controllable properties of quadruplex helices to construct bio-nanowires, logic gates and DNA based ion transportation systems. However, the insertion of negatively charged DNA quadruplex into hydrophobic lipid membrane is energetically unfavorable. Moreover, the design of selective DNA based ion channels is challenging. DNA origami and double helical DNA based ion channels have been reported in literature, in these cases DNA sequences are covalently modified with porphyrin through lipophilic linkers. In a pioneering work, her group designed a lipo guanosine derivative that non-covalently binds and stabilizes human telomeric quadruplex and promotes its insertion within lipid bilayer. The resulting DNA ionophore selectively transports K+ ions across the biological membranes.

As a proof of principle, her group devised a DNA based logic system by varying nuclease enzyme inputs to determine non-zero square numbers up to 20. They also engineered DNA conjugated gold coated magnetic nanoparticles for developing new tools for analytical applications.

Furthermore, Dash and co-workers have used guanosine derivatives as molecular template in “bottom-up self-assembly” to design hydrogels, fluorescent carbon dots and synthetic ion channels. Guanosine derivatives can mimic G-quartet structures present in DNA/RNA quadruplexes and subsequently self-assemble to form synthetic G-quadruplexes like assemblies. The use of guanosine derivatives as synthetic ion channels may allow opportunities for programming antimicrobial agents, drug-delivery systems and sensors.

In addition, her group used ring-closing metathesis to synthesize heterocyclic ring systems and naturally occurring carbazole alkaloids. They developed new synthetic methods for the regiospecific synthesis of indole derivatives and modular construction of heteroaromatic carbazoles and pyridoindole ring systems. They designed new organocatalysts and supported organocatalysts for the synthesis of eantiomerically pure compounds. Her group reported sustainable procedures like uncatalyzed reactions, transition metal free synthesis and Ullmann-type C–N bond-forming reaction in aqueous media. These methods may find industrial applications for the synthesis of natural products and complex organic molecules.