**Chapter 6**

# Conclusion and Future Direction

DNA computing algorithms/models of logic gate and Boolean circuit using new readout techniques such as micro cantilever and ND induced hairpin in gate strand which acts as MB to reproduce the behavior of electronic logic functionality have been presented for the first time. The gate strand which is designed using the proposed algorithm is immobilized on micro-cantilever surface and the hybridization induced deflection is transduced to human understandable output. Also in another model the induction of hairpin in the gate strand which is used as molecular beacon by attaching a fluorophore at 3'end and a quencher at 5'reduced the implementation cost of the setup.

Gate design algorithms have been presented in this thesis to simulate and reproduce electronic behavior of logic gate and Boolean circuits. The bio-compatible DNA logic gates are designed on the basis of the proposed algorithm using only simple DNA manipulation techniques. For reusability the gate strands have been immobilized on solid surface. The use of micro cantilever deflection as read out mechanism is introduced for the first time in the field of simulation of logic gate and Boolean circuits. The molecular outputs of the gate operation are transduced with

the help of deflection which added an advantage of reducing human intervention to some extent. The wet lab experimental results have indicated that the designed DNA gate has the potential to reproduce the electronic property at molecular level.

Further the induced hairpin property of DNA strand with G-G mismatch in presence of Napthyridine Dimer is exploited in the simulation of a reusable, parallel, generalized and cost effective DNA gate model. Apart from simple logic gate, combinational circuits such as half-adder, full-adder,four-bit carry ripple adder are also theoretically simulated. The final output is read on the basis of success or failure of appearance of hairpin structure. The proposed model has advantages over prior model as it avoids use of erroneous processes.

DNA strands are sensitive to certain cations and ligands and shows specific conformation changes. An algorithm is proposed to simulate an AND-OR circuit using the change in structure of C-rich single strand of DNA at acidic pH by regulating $H^+$ and $Cu^{2+}$ ions. This model added features like fast response time, reusability and controllability.

**Scopes for Future Work:**

Following points have been identified for future work:

1. Presently the DNA computing model is capable of reproducing only a few logic gates as implementation complexity increases with increase in the number of gates due to which the model / circuit could not be used to evaluate complex Boolean circuits. In future, therefore, there is scope for new algorithm / model with feature to scale up the circuit to obtain a complex molecular circuit.

2. Developing a model with substantial automation by reducing human intervention between the levels of circuit.

3. Experiments may be conducted using different bio-operations to implement

different models in laboratory and to study the time complexity and practical feasibility. Bridging the gap between theoretical work and experimental work would enrich the field of gate simulation by opening new possibilities.