VIII. CONCLUSION

It can be concluded, from the results obtained in the present study, that among the three commercial formulations of carbamate insecticides used viz., Baygon spray (Propoxur), Sevin (Carbaryl) and Carbogran 3G (Carbofuran) only Baygon spray exerts its toxic effects on animal cells to a considerable extent. Whereas, Sevin and Carbogran 3G are totally non-toxic due to the fact that the active ingredient in these preparations are present in non-soluble complex forms. Clinical case reports in humans, as published by Hayes and Vaughan, 1972 that deaths occurred by accidental or suicidal consumption of Baygon spray but not in case of Sevin or Carbogran 3G consumption are comparable to the present findings. However, the above report by the same authors also highlighted that workers in factories manufacturing these chemicals, those employed in the store houses, where the carbamates are stored and the farmers who are regularly using these formulations are at a higher risk of toxic effects of not only Baygon spray but even that of Sevin and Carbogran 3G. This is due to the fact that the factories manufacturing the commercial formulations of these carbamates use the pure form of the active ingredient; hence the workers are at higher risk, due to inhalation or contact with skin. Those working in the store houses and farmers using them are exposed to the active ingredients released by the microbial action upon the commercial preparations of these insecticides. The microbes degrade the “TRADE SECRET” ingredient in the stored commercial formulations thereby releasing
the active ingredient as fine dust that can be inhaled by the workers or comes in contact with the skin and gets absorbed, thereby causing the toxic effects.

Among the three cell types used, hepatocytes, owing to their detoxifying ability did not experience much toxicity of even Baygon spray. However lymphocytes and spleenocytes did get affected by Baygon spray but not by Sevin or Carbogran 3G. Hence, Sevin and Carbogran 3G did not effect on the immunity of the animal, however Baygon spray could reduce the immunological response due to excessive cell destruction and death. Further, there should be no effect on hepatocyte metabolism in presence of any of these three commercial preparations of insecticides. Therefore, it could be concluded that the household pesticide Baygon spray should be preserved very carefully at home, especially from children. The other two preparations *i.e.*, Sevin and Carbogran 3G should not be stored for longer periods either in the store houses or at farmers residence.

As for the technical grade carbamates tested in the present study, carbaryl had the most deteriorating effects on the animal cells, followed by baygon and carbofuran had the least toxicity among the three carbamates studied. Carbaryl effected not only the cellular integrity but also cellular metabolism. This was evidenced by the fact that carbaryl treated samples had higher degree of cellular deformity, destruction and death in addition to inhibition in the formation and release of proteins, lactic acid and lactate
dehydrogenase by the cells. The technical grades of other two carbamates viz., baygon and carbofuran also had profound toxic effects, but not to the extent as that exhibited by carbaryl. Hence, it could be concluded that the toxic effects of these three carbamate insecticides as reported by previous works (Gosselin, 1984), that they are mutageic, teratogenic, carcinogenic, causes anaemia, reduces reproductive capabilities and induces immunosuppression may most probably, seem to be due to their inhibitory effects on cellular metabolism. However, paralysis and/or deaths occurred by these insecticides are due to their inhibitory effects on the enzyme acetylcholine esterase and not directly due to inhibition of the cellular metabolism, though it can be a contributory factor to some extent.

Hepatocytes, again owing to their detoxifying ability did not experience much toxicity of technical grade insecticide as compared to lymphocytes and spleenocytes that were effected to about 70%. This might induce reduction in the immunological response in-vivo due to excessive cell destruction, death and inhibition of cellular metabolism. Erythrocytes were also tested for the hemolytic effects of these chemicals, wherein it was observed that the fragility of RBC reduces due to exposure to carbaryl, thereby resulting in some degree of anaemia and hypoxia. However, exposure of the technical grade insecticides to man and the animals is limited due to the fact that they are neither easily available in the market nor are they used in the original form, and hence are at no or least risk. However, workers in the factories/laboratories using the
technical grade insecticides are to be cautious about their handling, wherein they have to avoid contact with the skin and prevent inhalation.

The most striking outcome of the present study was the toxicity of carbamates on tumor cells. Carbamate insecticides, not only inhibit the growth of tumor cells but they also cause tumor cell destruction and death. Therefore, this study opens a new option for testing the feasibility of using carbamates, and carbaryl in particular for the treatment of cancer. It seems, from the review of literature that no such attempt has been made to use carbamate insecticides in the treatment of cancer. While treating cancer with carbamates, the toxic effects on other cell types can be overcome by preinjecting the antidote; atropine sulphate as shown by Kimmarle (1996) in his experiments, wherein he used 50 mg/kg atrophine sulphate prior to intra peritoneal dose of 100 mg/kg propoxur without any neurotoxic signs.
RECOMMENDATIONS FOR FUTURE STUDY

1. The exact nature of *in-vitro* effects of carbamate insecticides on each of the animal cell types needs to be evaluated.

2. The chemistry and degree of inhibition of the cellular metabolism by the insecticides has to be studied.

3. Extraction of active ingredients from commercial formulations of carbamates and their effect on the cells cultured *in vitro*.

4. Effect of hepatocyte culture supernatant on other cells cultured *in vitro* with commercial formulations and technical grade carbamates.

5. Effect of *in vitro* hepatocyte co-culture with other cells and incubated with carbamates.

6. Feasibility of use of carbamates, especially carbaryl in the treatment of cancer has to be worked out *in vitro*.

7. *In vivo* experiments for the treatment of peripheral tumors with carbamates especially in cattle and dogs has to be conducted.

8. In the event of use of carbamates in the treatment of cancer, the effect of the same on other body cells-organs are to be monitored in addition to the use of atropine as antidote in the prevention of the toxicity to other cells or organs.

9. Development of hepatocyte cell lines by using carbamates has to be worked out.