INTRODUCTION

Man's inherent desire to understand and unravel the secrets of the complexities of living organisms has brought about a remarkable progress in science - especially in Biochemistry. Proteins and nucleic acids with their potential for diversity in structure and function have very significant positions in the study of living things. To the biochemist the field of study of molecular evolution is of great importance, for a knowledge of ancestral structures, functions and the roles of evolution are essential for the full understanding of the biochemical structure and processes existing in contemporary species. The proteins contain a record of phylogeny which when deciphered reflect their own origin and the evolution of the species in which they are found. Hemoglobin with its primary function of oxygen transportation proves to be a unique protein for such a study. Vertebrates, due to their environment and habitation have had increasing demands placed on their oxygen carrying system. The result of such a physiological pressure was the evolution of present day hemoglobins with its complex structural characteristics.

Early investigators on hemoglobin molecule were aware of the possibility that it may exist in more than one molecular form in the same individual or in different individuals of the same species. Thus Korber in 1966 (18)
showed that hemoglobin from human placental blood is more resistant to alkali than human adult blood. Brinkman and Jonxis in 1936 (8) confirmed this finding and demonstrated that other mammalian species also contain a fetal and an adult form of hemoglobins. An important step in the development of molecular genetics of hemoglobins came in 1949 with the discovery, by Pauling, Itano, Singer and Wells (23) that hemoglobins in sickle-cell anemia is electrophoretically abnormal and that hemoglobin in sickle-cell trait is a mixture of abnormal form and normal adult hemoglobins. In the same year Neel (22) and Beet (6) independently showed that this 'molecular disease' was inherited as a single Mendelian factor. Since then, research on molecular genetics and evolution of hemoglobins has enormously increased.

In recent years the primary structure of hemoglobin has been correlated with genetics (1,15,26,27) and the hemoglobin variation in different species has been used to derive the gene species phylogeny (4,9,21). Thus, not only the $\alpha$ - and the non $\alpha$ -chains which go to make up hemoglobin tetramer has shown to be products of corresponding genetics loci (7,14,17) but also the various genetic loci which gave rise to different hemoglobin chains and myoglobins have been shown to arise from a common ancestor (16,28). Similarly, separate genes coding for myoglobin and hemoglobin has been traced to a gene duplication which occured when
annelids and chordates still shared a common ancestor probably at the close of the precambian era, those coding for α- and β-chains to a gene duplication in the common ancestor of teleosts and tetrapods, those coding for γ- and β-chains to a gene duplication in basal therians and those coding for β- and δ-chains to a gene duplication in the basal catarrhine primates (11, 12, 13). Our laboratory, engaged in the study of hemoglobins in the descent of animal species since 1962 have made significant contribution on this subject (2, 3, 10, 19, 20, 24, 25). In the present work we have attempted a comprehensive study of comparative structure, molecular genetics and evolutionary trends of hemoglobins of animal species from subfamily Caprinae common to India. The number of molecular forms of hemoglobins existing in this group of animals are significantly large. The genetic implications and probable evolutionary trends were obviously attractive to study. From the subfamily, tribe Caprini and tribe Nemorhaedini are represented in our studies. Caprines belonging to three genera were chosen for our studies. They were Domestic goat (Capra Species) and Mountain goat (Capra ibex sibirica) from genus Capra, Nilgiri tahr (Hemitragus jemlahicus hylocrius) from genus hemitragus and sheep (Ovis aries) from genus Ovis. The only representative of tribe Nemorhaedini available to us was Cashmere goral (Nemorhaedus goral goral).
Characterisation of molecular forms of hemoglobin were carried out using different electrophoretic and chromatographic techniques. Structural studies on isolated polypeptide chains of hemoglobins were undertaken with special emphasis on the identification at the amino acid level, of molecular forms which are electrophoretically distinguishable as well as electrophoretically silent. Lack of ready availability of an automatic amino acid analyzer was felt many times and this was particularly disheartening during the final stages of structural studies. The data gathered during the investigation was used for the elucidation of molecular genetics and evolutionary trends of Caprinae hemoglobins. Phylogenetic trees for α- and β-chain genes were constructed by Maximum Parsimony Method of Barnabas et al (5). The evolutionary trends and rates of evolution of these genes during descent are discussed. Molecular genetics of Caprinae hemoglobins is dealt in detail.

The thesis is divided into four chapters. Chapter I contains a review on the pertinent aspects of structure, function, biosynthesis, genetics and evolution of hemoglobins. Chapter II deals with the methodology employed during the investigation and Chapter III presents the results obtained. Discussion on the results are presented in Chapter IV. References are given at the end of each chapter.
REFERENCES

1. Baglioni, C.

2. Balani, A.S. and Barnabas, J.

3. Balani, A.S., Ranjekar, P.K. and Barnabas, J.

4. Barnabas, J., Goodman, M. and Moore, G.W.

5. Barnabas, J. Goodman, M. and Moore, G.W.

6. Beet, E.A.


9. Fitch, W.M. and Margoliash, E.

10. Gandhi, N.S. and Barnabas, J.

11. Goodman, M., Barnabas, J., Matsuda, G. and Moore, G.W.

12. Goodman, M., Barnabas, J. and Moore, G.W.


14. Huisman, T.H.J.

15. Ingram, V.M.
16. Ingram, V.M.  

17. Itano, H.A.  

18. Korber, E.  
   Uber Differenzen des Blutfarbstoffes  
   Thesis. Dorpat (1866) cited in 'Comparative Study  
   on the structure of Mammalian and Avian Hemoglobins'  
   Ph.D. Thesis of Muller, C.J. 1961, University of Groningen

19. Lalthantluanga, R. and Barnabas, J.  
   Biochimica et Biologica Graeca 11, 65 (1974).

20. Lalthantluanga, R., Gulati, J.M. and Barnabas, J.  
   Indian J. Biochem. Biophys. 12, 51 (1975).

21. Moore, G.W., Barnabas, J. and Goodman, M.  

22. Neel, J.V.  
   Science 110, 64 (1949).

23. Pauling, L., Itano, H.A., Singer, S.J. and  
   Wells, I.C.  
   Science 110, 543 (1949).

24. Ranjekar, P.K. and Barnabas, J.  

25. Ramakrishnan, P. and Barnabas, J.  
   Acta Physiol. Pharmacol. Neerlandica  
   (Netherlands), 11, 328 (1962).

   Bolle, A.  

27. Yanofsky, C., Carlton, B.C., Guest, J.R., Helinski, D.R.  
   and Henning, V.  

   in 'Horizons in Biochemistry' Kosha, M. and  
   Pullman, B. Academic Press N.Y. and  