PHOTO-KINETICS OF VISUAL PIGMENTS

by

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Thesis submitted to the Indian Institute of Technology,Delhi
for the award of the Degree of
DOCTOR OF PHILOSOPHY

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March,1979

ACKNOWLEDGEMENTS

No words can express my deep sense of gratitude to Professor M.S.Sodha and Dr. I.C.Goyal for their invaluable guidance, constant encouragement and inspiration without which this work would not have been possible. I am also grateful to them for creating my interest in the field of vision. I am also extremely grateful to Professor A.K.Ghatak for his helpful guidance, constant encouragement and keen interest shown in the progress of this work.

I am grateful to my senior colleagues, Dr. B.P. Pal, Dr. Arun Kumar and Dr. K.Thyagarajan for numerous stimulating discussions at various stages of the work.I gratefully acknowledge the help which I have got from my colleagues Anurag Sharma and Enakshi Khular at various stages of the work. I would also like to thank Aruna Rohra and Dr. Ram Chandra for their help. I am thankful to my many other colleagues specially Bhumesh Gupta, Govind and S.Q. Hussain for friendly cooperation and help received from them.

I would be failing in my duties if I do not express my gratefulness to my parents, brothers and other well wishers who, in many ways, encouraged me to pursue this work.

Finally I wish to thank Mr. T.N.Gupta for an extremely efficient typing of the thesis and help in one way or the other.

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ABSTRACT

The visual pigments contained in the eyes play an important role in vision. They are the main constituents of the retinal photoreceptor cells, which are situated at the focus of light entering the eye and are linked to the complex system of nerve fibres that carry information to the brain. By their light absorbing properties, they determine which parts of the spectrum the animal shall see. There are two types of visual pigments namely rhodopsin and iodopsin corresponding to two types of photoreceptor cells, namely, the rods and the cones. The light falling on the eye is absorbed by these visual pigments which triggers a photochemical reaction called bleaching. In this reaction various transient photoproducts are formed. The short lived photoproducts are related to the excitation of the photoreceptors while the long lived photoproducts are connected to the adaptation of the photoreceptors. We have studied theoretically the light absorbing and thermal properties of rhodopsin, isorhodopsin and their short lived photoproducts. Some theoretical work has also been carried out on iodopsin. From the available experimental data on cattle rhodopsin we have shown that rhodopsin and its short lived photoproducts behave like planar absorbers having a ratio of about 100:7 between the extinction coefficients along the long axis and perpendicular to it. Using this

result and available experimental data a model for the configuration of chromophores in the disc membranes has been derived in which the plane of the chromophore is perpendicular to that of the disc and the long axis of the chromophore makes an angle of 6.6° with the plane of the disc. Flash photolysis of rhodopsin in rabbit's retina has been analysed theoretically to determine the quantum efficiencies of various reactions. It has been reported that the quantum efficiencies of conversion of lumirhodopsin into rhodopsin and isorhodopsin lie in the range 0.24-0.45 and 0.20-0.44 respectively; quantum efficiencies of conversion of metarhodopsin I into rhodopsin and isorhodopsin are found to have values greater than 0.52 and 0.45 respective and the quantum efficiency of conversion of isorhodopsin into lumirhodopsin has been found to be approximately 0.86. Also the maximum value of the rate constant of the reaction metarhodopsin I $\rightarrow$ metarhodopsin II at $37^{\circ}C$ has been determined in decerebrated eye.

The temporal distribution of the flash intensity which may be an important parameter is generally not considered in the theoretical analysis of the flash photolysis experiments. We have studied its effect on the bleaching kinetics of rhodopsin and have reported its importance in various cases. Further, using the results of the above analysis and available experimental data of flash photolysis experiments on the solution of cattle rhodopsin we have determined the values of various kinetic activation parameters for the reactions, metarhodopsin I $\longrightarrow$ metarhodopsin I', metarhodopsin I' $\longrightarrow$ metarhodopsin I, metarhodopsin I' $\longrightarrow$ metarhodopsin II and metarhodopsin II $\longrightarrow$ metarhodopsin I'.

We have also theoretically analysed the available experimental data on the time variation of the change in absorbance of chicken iodopsin solution (at $-195^{\circ}C$). Our analysis predicts the presence of a new intermediate during the bleaching of chicken iodopsin.

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