

FOREWORD

The study of the erythrocyte has been and continues to be a fascinating discipline. It is probably the world's best recognized cell. Its biological relevance, for example, is inseparably linked with the French expression "*Le sang c'est la vie*" (i.e., Blood is life). This cell is also an optimal model for cellular and molecular evolutionary investigations.

The objective of this text is to identify and consider the diverse cytologic aspects of the erythrocyte in birds and generate a better understanding of these characteristics as they are presented among the Orders, Families and Genera of avians. The relationships of the avian erythrocyte with the red cells of the phylogenetically earlier cold blooded vertebrates and the later mammals are included in these considerations.

The red cell made its debut in a few scattered invertebrates and thereupon has conducted a conceptual phylogenetic odyssey through the Classes Chondrichthyes, Osteichthyes, Amphibia and Reptilia. At this juncture its next evolutionary taxonomic level was the avians, the focus of this text. The Class Aves (whose members are warm blooded) is recognized as the link that bridges the taxonomic interval between the cold blooded poikilotherms and the warm blooded mammals. It is to be expected that the avian erythrocyte will (and does indeed) present cytological characteristics derived and adapted from cold blooded species, further modified for the specific requirements of avians and also predictive of its manifestations in mammals (including man). The cytologic aspects of the avian erythrocyte that are addressed in the text are many and diverse, embracing inter-avian species' differences as well as non-avian versus avian erythrocytic considerations. Illustrative of the subjects that are explored are a detailed analysis of the light microscopy and ultrastructure of the maturational sequence of the erythrocyte from its onset as the proerythroblast to the mature cell, the quantitative representation of the erythroid progenitors in hemopoietic bone marrow, the histologic relationship of erythropoiesis with the vascular sinuses in the bone marrow, the cytoskeletal architecture of the erythrocyte, staining, and cytochemistry. The clinically important reticulocyte is specifically addressed in regard to its numerical presence in the blood, morphology, and conditions that promote or diminish

its occurrence in the circulation. The embryonic germ disc and its participation in the genesis of the erythroblast, yolk sac erythropoiesis, and development of the primitive and definitive generation erythrocytes are considered. The role of the inordinately facilitative quail-chick chimera embryo in establishing the identity, source(s) and migratory pathways of the hemopoietic stem cell as well as the loci of erythropoiesis in the embryo are accorded detailed examination. The erythrocyte counts, hemoglobin levels, hematocrits and erythrocyte indices (MCV, MCH, MCHC) obtained among the various avians are evaluated to identify, compare and illuminate species-related differences and similarities. Extensive tabular data with citations indicating the author(s), and primary source of the erythroid hemograms of a vast number of representatives of avian taxa are included to serve as a source of data for the reader as well as to provide validation for statements presented in the text. Another area is that is specifically investigated (including comparisons with species antecedent to the avians) is the dimensional aspects of the erythrocytes obtained among the different avians. Documentation is tendered revealing that the sizes and shapes of the red cells in avians are rheologically and functionally improved over that of prior species and that, even among avians, taxonomic and physiologic correlations are reflected in the physical profiles of the erythrocytes found in different species of birds. Gender, age, environmental and biological relationships relative to the size of erythrocytes, red cell counts, hematocrits etc are given generous attention along with statistical documentation whenever available. The impact of various other situations, physiologic conditions, biochemical factors, and cell regulators on the erythrocyte is analyzed. Some of these are the life span of the erythrocyte, blood volume, apoptosis, erythrocytic osmotic fragility, telomeres, the occurrence of erythroplastids, development of megaloblasts in folic acid deficiency, avian C-values, reproductive status, and the avian erythrocyte as a generator of cytokines. The erythrocellular morphologic picture associated with pathologic agents such as excessive amounts of lead, phenylhydrazine, organophosphates, rapeseed and aflatoxin are discussed. One section is relegated to erythroleukemia. Sporozoan parasites that invade the avian erythrocyte such as *Haemoproteus*, *Plasmodium*, and the rickettsial organism *Aegyptianella* are each individually discussed, as are the resultant effects they have on the red cell(s) they inhabit. The etiologies of anemia in avians including immune-mediated anemia and the response to experimentally induced anemia (e.g., phlebotomy) are examined. The text includes a comparative discussion of the benefits, limitations, and disadvantages of the anticoagulants used for avian blood. Other uncited topics are also considered.

The text offers an Appendix of the Genus and Species of all birds noted in the text, a Glossary of their common titles, a Subject Index, a complete

Bibliography and an aggregate of photomicrographs that underscore some salient features of the avian erythrocyte. As indicated, a major segment of the monograph is an expanded taxonomically organized Table of Avian Erythrographic Data. Whenever offered in the original publication, statistically significant differences in the erythrocytic values between the sexes, age of birds, environmental, physiologic and experimental conditions are indicated in the table.