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Laudatio for Harry Goldsmith

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Professor Harry Goldsmith was born May 11, 1928, in Nurnberg, Germany. His marvelous journey in science started with his undergraduate study at Oxford University, where he received B.A. (Honours) in Chemistry and B.Sc. in Physical Chemistry in 1950 and 1951, respectively. After serving as a Technical Officer at Imperial Chemical Industries Ltd. in Manchester, UK, for six years, and as a Defence Research Board Fellow at Royal Military College of Canada for one year, Harry began his Ph.D. study in Chemistry at McGill University, Montreal, in 1958. Under the advisorship of the late Dr. Stanley G. Mason of the Pulp and Paper Research Institute, Harry completed his outstanding thesis on The Microrheology of Suspensions in 1961. After three years of postdoctoral training in the Department of Chemistry at McGill University, Harry was appointed as an Assistant Professor in the Department of Experimental Medicine in 1964 and was promoted to Associate Professor in 1969. In 1972, he became Full Professor in the Division of Experimental Medicine in the Department of Medicine at McGill, and he was Director of the Division from 1976 to 1995. In addition to his stellar research contributions, Harry played a major leadership role in the education of graduate students and the administration of the Division.

Harry Goldsmith made outstanding contributions to the theory and application of rheology. He established the fundamental principle of the rheological behavior of particles in suspension by a combination of ingenious experiments and elegant analysis. The 176-page Chapter on "The Microrheology of Dispersions" by Harry Goldsmith and Stanley Mason in F.R. Eirich's book in 1967 [1] is a Classic. This marvelous chapter established the fundamental principles of particle motion in laminar and non-uniform flows, with applications to suspension viscosity and blood rheology in large and small vessels, covering the entire field of microrheology, including blood rheology. Having started to work on blood rheology only a few years before, I found this Chapter to be a treasure and read it many times. It gave me tremendous inspiration and had great influence throughout the years on my studies on biorheology.

Harry Goldsmith is not only a superb scientist, but also an ingenious designer of instruments for his sophisticated research. For example, his traveling microscopy system allowed the tracking of cells flowing in a tube by the controlled motion of the tube with a velocity that is equal and opposite to that of the cell, thus keeping the cell always in the field of observation for dynamic cinematographic filming and quantitative analysis. He has performed experiments on particles, red blood cells, white blood cells, platelets, and other types of cells. He has the unique capability to apply elegant hydrodynamic theory to analyze such quantitative experiments on individual or groups of cells in terms of their translation, rotation, collision, deformation, adhesion, and aggregation/disaggregation, thus providing novel insights on a whole range of microrheological dynamics at the cellular levels. He also deduced the molecular level force (in microdynes) of antibody–antigen bonding between two cells in a doublet.

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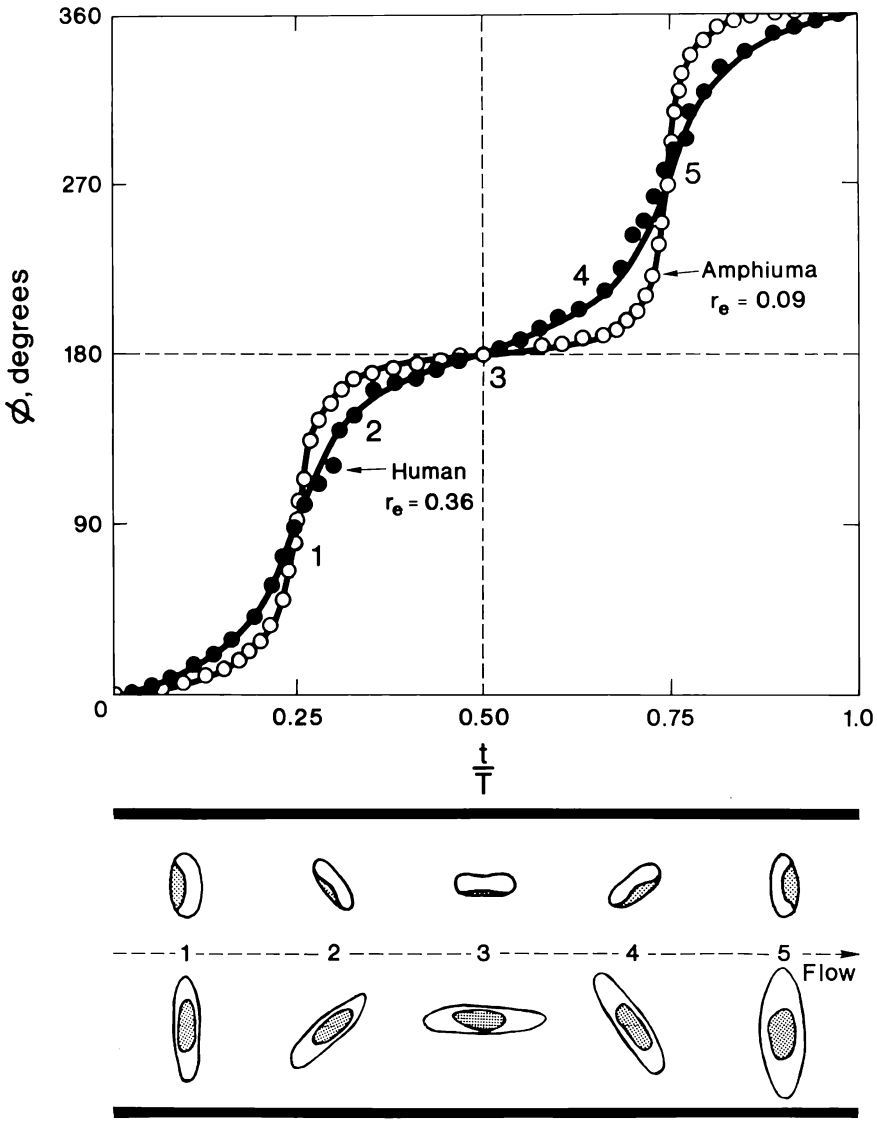


Fig. 1. Orientation angles (with respect to the perpendicular Y axis) of human (dots) and amphiuma (circles) red blood cells during a cycle of rotation. In the tube below, the non-nucleated human RBC is shown on the top half and the nucleated amphiuma RBC is shown on the bottom half.

In late 1960s I was working on comparative rheology including nucleated and non-nucleated RBCs and became interested in the microrheology of nucleated RBCs. Shunichi Usami and I went to Montreal in 1970 to work with Harry on the RBCs from amphiuma (Congo eel, which has the largest nucleated RBCs) that was purchased from a supplier in Alabama. We got some very interesting results showing that the rigid nucleus does not deform and only the cytoplasm and the membrane undergo periodical folding and extension as the cell traverses the tube rotating under flow, with the grace of a ballet dancer. The orbiting of these RBCs is shown in Fig. 1, which is taken from a very generous article written by Harry in the book for my 70th birthday [2], in which he said:



Fig. 2. Harry Goldsmith presents the Biorheology Festschrift to Shu Chien, June 2001, San Diego, CA, USA. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/BIR-675.)

Do you remember a snake?
Dr. Chien, a Congo snake?
That a journey from Alabama did make
And her red cells that tumbled in flow
Through the tube, and bent like a bow
Around the nucleus, just so!

This wonderful poem shows the artistic side of Harry's multi-faceted talent. For that birthday celebration, Harry also edited a special issue of *Biorheology* [3] (Fig. 2), with Geert Schmid-Schönbein and Amy Sung. I am extremely grateful to Harry for his kindness.

Shunichi and I have visited Harry many times. In one of the trips, Harry gave valuable advices to Shunichi on how to make RBC ghost by gently lysing the cell to release the hemoglobin content with minimal alterations in membrane structure or function. They succeeded in making RBC ghosts with perfect biconcave discoid shape. Harry was very happy about the result and called Shunichi the Grand Wizard of Ghost Making. Actually, Harry himself also merits this virtuous title together with Shunichi.

My research since coming to UC San Diego has been focused on mechanotransduction in the vascular endothelial cells, particularly their differential responses to different flow patterns. For these studies, I am also indebted to the pioneering work done by Harry and Takeshi Karino on elucidating the flow patterns in vessels of simple and complex geometries [4,5]. Their meticulous and ingenious work led to the mapping of the detailed trajectories of particles and blood cells in post-stenotic expansion, curvatures,

and branch points with different angles. They identified the spiraling vortexes with flow separation and reattachment points, which are the sites prone to atherogenesis. Their fundamental discoveries provided an important foundation for our research on the differential behaviors of endothelial cells in response to pulsatile or laminar flow vs. disturbed flow in athero-protective vs. atheroprone regions of the arterial tree, respectively.

Over the years, I have learned a great deal from Harry. Many of these are from our meetings, but even more from reading his outstanding publications, which are innovative in concept, comprehensive in design, meticulous in execution, and superb in presentation. His papers always address important subjects and transmit inspiring thoughts; they are excellent models for all of us working in the field. As indicated above, every major direction of my research has benefitted from Harry's writing and advice. I believe this applies to a large number of researchers in biorheology and related fields.

Harry's outstanding accomplishments have led to many accolades and recognition. In 2008, at the occasion of his 80th Birthday, Scott Diamond, Mike Lawrence, and Sriram Neelamegham edited a Special Issue in *Annals of Biomedical Engineering* on "Cellular Biomechanics and Biorheology in honor of Harry L. Goldsmith, on his 80th Birthday" [6]. It contains 2 Forewords and 14 original articles in Harry's honor.

Harry has received many top awards and honors, including the Landis Award from the American Microcirculatory Society (1984), Scholar of the German Academic Exchange Service (1988), and Stanley G. Mason Award from the Canadian Rheology Group (1992). In 1992, he received the Poiseuille Medal, which is the highest award of the International Society of Biorheology.

Harry has made important contributions to professional societies in leadership positions. He has served as Presidents of the International Society of Biorheology (1983–1986) and the North American Society of Biorheology (1990–1992). He has served on the Editorial Boards of *Microvascular Research* (1975–1987), *Microcirculation, Clinical and Experimental* (1981–1987), and *Current Medicine* (2000–present).

Particularly pertinent to this special issue is Harry's outstanding service as the Editor-in-Chief of *Biorheology* for the past two decades. Since taking over this important position, Harry has devoted a tremendous amount of time and effort to improve the journal in terms of paper quality, review process, and paper submission. All of us working in the field of biorheology are deeply indebted to Harry for his superb contributions to the excellence of our journal. This special issue can only express in a small way our deep gratitude and sincere appreciation of Harry's extraordinary contributions as the Editor-in-Chief for two decades.

Harry is most generous in sharing his precious thoughts and special expertise with people. He has a marvelous personality that is kind, gentle, amiable, considerate, generous, honest, positive, and encouraging. I am most fortunate to have him as a close colleague and a wonderful friend.

Harry Goldsmith is a superb scientist, a great teacher, and a marvelous leader. He is a **mensch *par excellence***.[1]

[1]Mensch (Yiddish) means a person of integrity and honor. According to Leo Rosten: "A mensch is someone to admire and emulate, someone of noble character. The key to being 'a real mensch' is nothing less than character, rectitude, dignity, a sense of what is right, responsible, decorous". This is the word Harry kindly used to describe me in [2], but he befits this much better.

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I wish to thank Professor Herbert Lipowsky, the current Co-Editor-in-Chief of *Biorheology*, for giving me the opportunity to express my deep gratitude and admiration for Professor Harry Goldsmith's marvelous contributions and wonderful friendship.

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