Pharmaceutical Research, Vol. 23, No. 10, October 2006 (© 2006)
DOI: 10.1007/s11095-006-9115-1

Editorial

George Zografi: Researcher and Educator

George Zografi is professor and dean emeritus of Pharmaceutical Sciences at the University of Wisconsin-Madison. He is recognized worldwide for his expertise in the physical properties of solids and lipids as applied to pharmaceutical systems. He is equally well known for his skills as an educator and mentor to students and colleagues alike. His unique blend of scientific depth and rigor and his human warmth and sensitivity have stimulated and promoted the research efforts of at least three generations of pharmaceutical scientists.

March 2006 marked the 70th birthday of Prof. Zografi. To celebrate the life and work of this truly outstanding scientist and educator, a special issue of *Pharmaceutical Research* was planned over a year ago. The goal of this issue is to highlight the impact and influence of his scientific contributions on the current thinking and direction of research in the areas of pharmaceutics and drug delivery. We invited researchers from both academia and industry whose own scientific careers have been strongly influenced by Prof. Zografi to submit manuscripts of original research for publication. The 24 papers that were peer-reviewed and accepted in this issue are divided into the "Four Points of the George Zografi Compass." These points are: 1. Molecular Mobility and the Amorphous State, 2. Crystals: Formation, Structure and Behavior, 3. Physical Chemistry of Solid State, and 4. Lipid Systems and Transport. In each paper, the reader will recognize the extent to which the scientific outlooks of authors have been extended by the work and insight of the scientist whom we honor here. We are confident that you will enjoy reading this issue as much as we have enjoyed putting it together.

We share with you an excerpt from Prof. Zografi's personal and professional biography below:

LIFE AND SCIENTIFIC CAREER

George Zografi was born to Albanian immigrant parents in New York City in 1936. His father was a pharmacist with his own pharmacy in lower Manhattan where the young George worked and was exposed to the field of pharmacy first hand. Following his father's career, he earned a B.S. degree in pharmacy from Columbia University in 1956. Heeding the call of laboratory science, he pursued graduate studies in pharmaceutical chemistry at the University of Michigan and earned a Ph.D. in 1960. For his dissertation he studied the adsorption of dyes onto starches under the mentorship of Albert M. Mattocks. Thus began his career-long interest in surface and interfacial chemistry.

For his first academic appointment, Prof. Zografi returned to Columbia School of Pharmacy where he held the rank of assistant professor from 1960 to 1964. Asked why he chose to go back to Columbia, his answer was that there were two simple reasons. First, he felt strongly that both the administration and the younger faculty members at the school at that time could provide him with a supportive environment for cutting-edge research. Secondly, and equally important, Columbia provided him an opportunity to teach students in both the professional program (B.S. level) and graduate studies in pharmaceutics. From the beginning of his career, Prof. Zografi believed that teaching and research are mutually supportive and are both necessary components of the pursuit of knowledge. This view that active teaching and research components are both required for the truly successful academic career would be expressed later in his tenure as the Dean at the University of Wisconsin.

It was during his time at Columbia that he honed his fundamental understanding of dispersed systems and surface monolayers by carrying out research in collaboration with Professor John Schulman, originator of the term "microemulsion" at the Columbia School of Mines. He embarked on studying the interfacial properties of lipids and drugs with his first Ph.D. student, Norman Weiner, who studied the correlation between surface activity of quaternary ammonium salts and their antimicrobial activity. He also began to study monomolecular films of lipids at the air–water interface as a model for biological membranes. His first paper on insoluble monolayer films was a systematic study of factors that affect the surface activity of phenothiazine derivatives in the presence of mixed phospholipid monolayers (1). As those who have followed his research and have worked closely with him know extremely well, this approach to doing research in a systematic and comprehensive manner became the norm throughout his scientific career.

In 1964 Prof. Zografi accepted an offer to return to the University of Michigan, School of Pharmacy as an assistant professor. There, he mentored the dissertation work of students and future academicians, Sylvan Frank and Samuel Yalkowsky, on the properties of dispersed systems. His tenure at Michigan was marked by his efforts in bridging the gap between fundamental research in the area of interfacial properties that had received scant attention until then and the practical applications of this field for the pharmaceutical sciences. He continued his research on interfacial properties of lipids and proteins to better understand the relationship between the interactions of drugs with biological membranes. In 1970, he was awarded a fellowship from the American Foundation for Pharmaceutical Education and spent a year as a visiting scientist at Utrecht University in Netherlands, where he studied the kinetics of hydrolysis of lecithin monolayers by phospholipase A.

While at Michigan, another seminal turn in his scientific thinking and focus came about in the summer of 1966 when

he was a visiting scientist at The Upjohn Company. Through his interactions with Dr. Everett Hiestand, he became interested in the surface chemistry of solids and the effect of processing parameters on solids' energetics. This experience was the seed that led to his latter interest and significant contributions to the understanding of molecular mobility and disorder on the stability of pharmaceutical solids.

In 1972, he joined the faculty of the University of Wisconsin-Madison as a full professor. Three years later, he was named the Dean of the School of Pharmacy. Although he led the school during a dynamic time, he was able to accomplish what few deans have done so successfully: keeping his laboratory operational. The creation of the first minority affairs program at the school, undertaking a significant expansion of the clinical pharmacy program, and instilling in all the faculty members the need for vibrant research and educational programs are among his most noteworthy accomplishments during this time.

After 5 years of leading the School, he returned to full-time professorship and reinvigorated his research efforts. Shortly thereafter he received his first Ebert Prize for best manuscript in the *Journal of Pharmaceutical Sciences* along with co-authors Lynn Van Campen and Gordon Amidon for the study of heat transport-limited water vapor sorption kinetics of water-soluble solids (2). In 1982, Prof. Zografi began a collaboration with Prof. Hyuk Yu, a macromolecular physical chemist, to study the kinetic and dynamic properties of monolayers. For more than a decade, they studied the surface phase behavior and viscoelastic properties of fatty acid, phospholipid, and polymer monolayers at the air–water interface and published more than 20 papers. In 1990, he began collaborating with Prof. Steven Byrn at Purdue to study the role of molecular mobility in crystalline and amorphous solid stability. This fruitful collaboration resulted in the co-training of a number of graduate students and postdoctoral fellows from both laboratories. His pioneering work with the effect of water on the stability of amorphous compounds showed the extent to which water can be taken up by various disordered regions of pharmaceutical solids, and by plasticizing these regions, allow reaction or crystallization to occur. Work in this area of research resulted in the awarding of his second Ebert Prize with co-author Jiang Zhang concerning the fundamental relationship of physical and chemical instability of pharmaceutical solids to molecular mobility as the result of the presence of water (3). Overall, the implications of this body of work in our understanding the chemical stability of drugs in the solid state, and ultimately their bioavailability, continue to reverberate through the field of drug delivery.

In all, he has contributed over 160 publications and book chapters to the scientific literature. Most of the top 50 pharmaceutical and biotech companies have sought his insight and counsel through on-site visits at one time or another over the years. In recognition of his seminal research contributions, Prof. Zografi has been awarded the Research Achievement Award for the Stimulation of Research by the American Pharmaceutical Association in 1988, the Dale E. Wurster Research Award in Pharmaceutics by the AAPS in 1990, the Distinguished Pharmaceutical Scientist Award by the AAPS in 1995 and the Ernest Volwiler Award for Research Achievement form the American Association of Colleges of Pharmacy (AACP) in 1996. He has also been honored by election to the National Institute of Medicine by the National Academy of Sciences in 1989.

EDUCATIONAL CONTRIBUTION AND LEGACY

To understand the character of Prof. Zografi, it is important to realize that all the above-mentioned research efforts have been carried out in the context of an educational process with students and colleagues. As a child of immigrants, early on he learned both the personal and collective value of higher education. It was a natural extension then for Prof. Zografi to commit his professional life to the advancement of scholarship in education. In addition to his aforementioned role as the Dean at the University of Wisconsin (1975–80), Prof. Zografi promoted excellence in pharmacy education in the U.S. by his leadership roles in the AACP (President 1983–84) and the Board of Directors of the American Foundation for Pharmaceutical Education (Member 1983–84). His colleagues in the AACP recognized his extraordinary contributions to pharmacy education by awarding him the *Distinguished Educator Award* in 1989. Prof. Zografi became the first ever to receive both this award and the *Volwiler Research Achievement Award* from AACP.

In view of Prof. Zografi's commitment to education, it is no surprise that working directly with students and postdoctoral fellows has been a labor that is closest to his own heart. He has been the dissertation advisor for 25 Ph.D. students spanning three universities. The doctoral family tree of Prof. Zografi as assembled by two of his former students, Samuel Yalkowsky and Jayne Hastedt, is shown in Fig. 1. Not shown here are the additional dozens of bachelors and masters students, postdoctoral fellows and visiting scholars from around the globe whom he has advised, and the untold number of other graduate students who sought him out for his scientific insight and words of encouragement.

Excellence in education can be measured in many ways, but the true measure of an educator involves more than just numbers of publications or of professional accolades. The true measure lies in the lasting effects that the mentor has on the realization of the full intellectual potential of the individual student. W.B. Yeats once said that "Education is not the filling of a pail, but the lighting of a fire." Such is the unspoken educational mantra of Prof. Zografi. He has that elusive ability to light the fire of discovery in each of his students and postdoctoral fellows and thereby make each an equal partner in their own education. The truly unique part of his fire-lighting was to do so while keeping in mind the human qualities of the individual. It is easy to allow young researchers to make their own mistakes. The difficult but critical follow-up part of this educational exercise that Prof. Zografi has handled so well for so many was to help the student see where his/her thinking went awry, and how then to adjust and keep moving in the right direction, accompanied by his steady encouragement. Always dedicated to providing effective, not necessarily efficient, mentoring, his resource-heavy and student-centric pathway to education has been challenging for both himself and his students. But this was not a matter of choice for the Professor: he took this

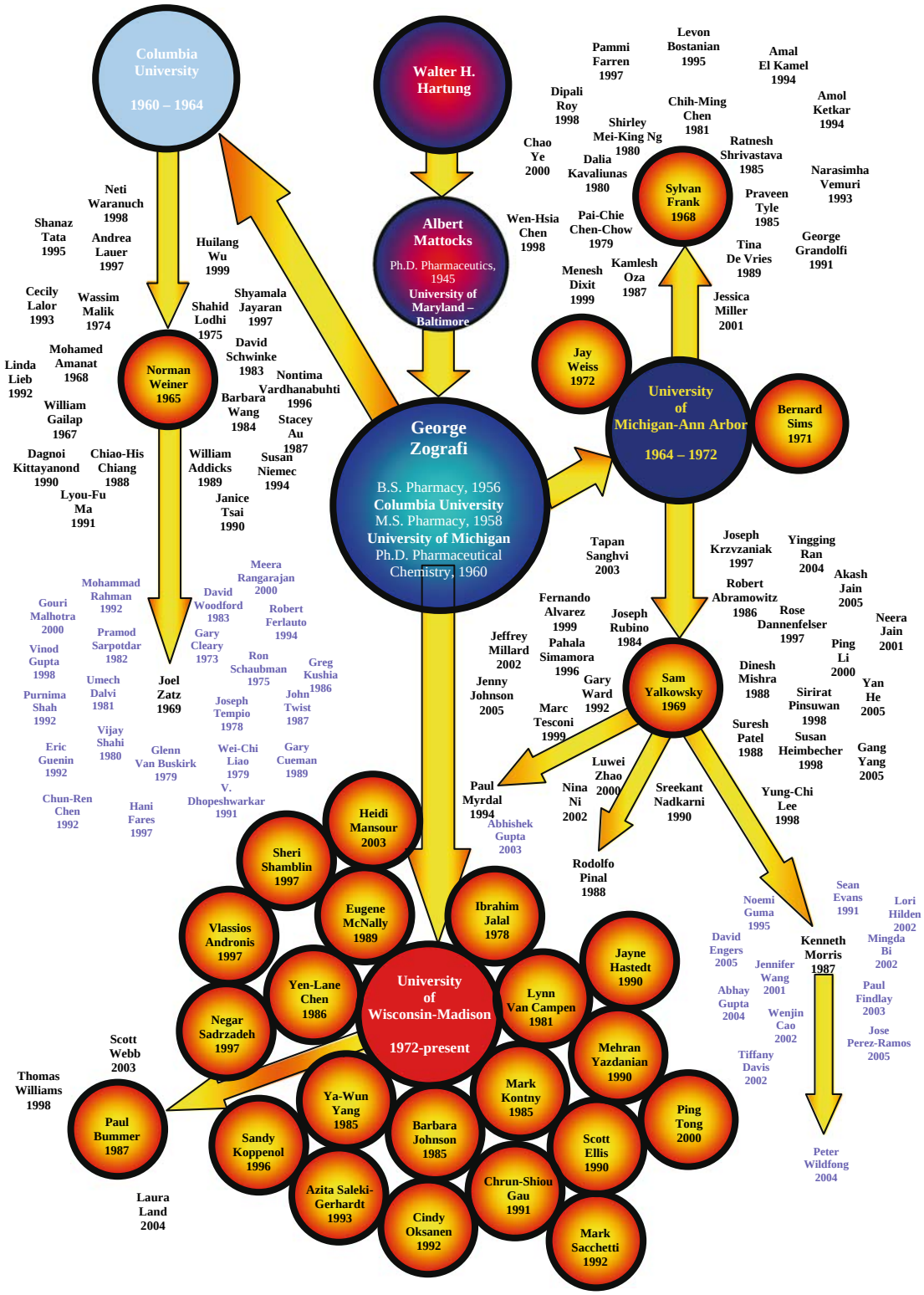

Fig. 1. Academic doctoral family tree of Professor George Zografi.

pathway because it was the best means to bringing out the full potential of each student to think critically and analytically, and to enjoy doing it!

To sum up the 46-year career of the man in a few short sentences is no small task and we are not convinced that we have done the job justice. Perhaps this final brief personal observation may say it best. For as long as we have known him, Prof. Zografi has talked about how much he has learned from and how proud he is of the scientific accomplishments and careers of his extended academic family. For him, the

most satisfying part of his job has been in the scientific success of those whom he has mentored, students and colleagues alike. That fact says more about the character of the man than we ever could. By knowing him we have all been truly blessed.

Paul M. Bummer
College of Pharmacy,
University of Kentucky,
Lexington, Kentucky, USA

Mehran Yazdanian
Worldwide Drug Development, Cephalon, Inc.,
145 Brandywine Parkway,
West Chester, Pennsylvania 19380, USA

ACKNOWLEDGMENTS

The authors would like to acknowledge helpful suggestions and discussions with Mr. Kenneth Niemeyer and Drs. Lynn Van Campen and Jayne Hastedt.

REFERENCES

1. G. Zografi and D. E. Auslander. Surface activity of chlorpromazine and chlorpromazine sulfoxide in the presence of insoluble monomolecular films. *J. Pharm. Sci.* **54**:436–442 (1965).
2. L. Van Campen, G. L. Amidon, and G. Zografi. Moisture sorption kinetics by water-soluble substances, I. Theoretical aspects of a heat transport mechanism. *J. Pharm. Sci.* **72**: 1381–1388 (1983).
3. J. Zhang and G. Zografi. Water vapor absorption into amorphous sucrose–poly(vinylpyrrolidone) and trehalose–poly(vinylpyrrolidone) mixtures. *J. Pharm. Sci.* **90**:1375–1385 (2001).