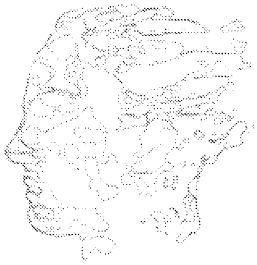
ONE HUNDRED REASONS TO BE A SCIENTIST

1964
40th anniversary
2004



ABEL
PRISEN

Special Edition for the Abel Fund and the Norwegian Academy of Science and Letters

ONE HUNDRED REASONS TO BE A SCIENTIST
- ABEL edition

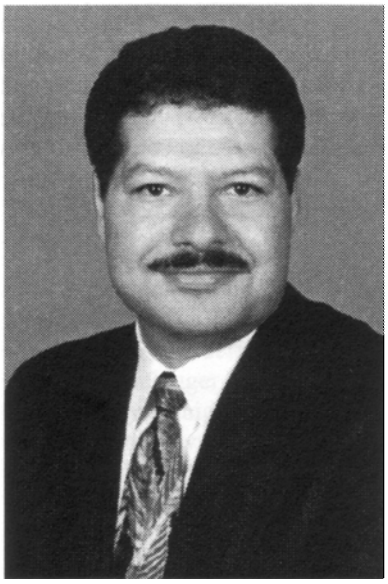
ISBN 92-95003-32-2

Printing History:
October 2004 - First edition
May 2005 - Second edition

Printed in Trieste by The ICTP Publications & Printing Section

IT IS POSSIBLE

Ahmed H. Zewail
California Institute of Technology, USA



© Courtesy of Ahmed H. Zewail

On the banks of the Nile, the Rosetta branch, I was born in Damanhur, the "City of Horus", only 60 km from Alexandria. In retrospect, it is remarkable that my childhood origins were flanked by two great places—Rosetta, the city where the famous Stone was discovered, and Alexandria, the home of ancient learning. I am the only son in a family of three sisters and two loving parents. My father was liked and respected by the city community—he was helpful, cheerful and very much enjoyed his life. He worked for the government and also had his own business. My mother, a good-natured, contented person, devoted all her life to her children and, in particular, to me. She was central to my life with her kindness, total devotion and native intelligence. Although our immediate family is small, the Zewails are well known in Damanhur.

The family's dream was to see me receive a high degree abroad and to return to become a university professor—on the door to my study room, a sign was placed reading, "Dr. Ahmed," even though I was still far from becoming a doctor. My father did live to see that day, but a dear uncle did not. Uncle Rizk was special in my boyhood years and I learned much from him—an appreciation for critical analyses, an enjoyment of music, and of intermingling with the masses and intellectuals alike; he was respected for his wisdom, financially well-to-do, and self-educated. Culturally, my interests were focused—reading, music, some sports and playing backgammon. The great singer, Um Kulthum (actually named Kawkab Elsharq—a superstar of the East) had a major influence on my appreciation of music. Reading was and still is my real joy.

As a boy it was clear that my inclinations were toward the physical sciences. Mathematics, mechanics, and chemistry were among the fields that gave me a special satisfaction. Social sciences were not as attractive because in those days much emphasis was placed on memorization of subjects, names and the like, and for reasons unknown (to me), my mind kept asking "how" and "why". This characteristic has persisted from the beginning of my life. In my teens, I recall feeling a thrill when I solved a difficult problem in mechanics, for instance, considering all of the tricky operational forces of a car going uphill or downhill. Even though chemistry required some memorization, I was intrigued by the "mathematics of chemistry". It provides laboratory phenomena which, as a boy, I wanted to reproduce and understand. In my bedroom I constructed a small apparatus out of my mother's oil burner (for making Arabic coffee) and a few glass tubes, in order to see how wood is transformed into a burning gas and

a liquid substance. I still remember this vividly, not only for the science, but also for the danger of burning down our home! It is not clear why I developed this attraction to science at such an early stage.

After finishing high school, I applied to universities. In Egypt, you send your application to a central Bureau, and according to your grades, you are assigned a university, hopefully on your list of choices. In the sixties, Engineering, Medicine, Pharmacy, and Science were tops. I was admitted to Alexandria University and to the faculty of science. Here, luck played a crucial role because I had little to do with the decision, which gave me the career I still love most: science. At the time, I did not know the depth of this feeling, and, if accepted to another faculty, I probably would not have insisted on the faculty of science. The passion for science became apparent on the first day I went to the campus in Maharem Bek with my uncle—I had tears in my eyes as I felt the greatness of the university and the sacredness of its atmosphere. My grades throughout the next four years reflected this special passion. I graduated with the highest honors—"Distinction with First Class Honor". With these scores, I was awarded, as a student, a stipend every month of approximately £13, which was close to that of a university graduate who made £17 at the time!

After graduating with the degree of Bachelor of Science, I was appointed to a university position as a demonstrator ("Moeid"), to carry on research toward a Master's and then a Ph.D. degree, and to teach undergraduates at the University of Alexandria. This was a tenured position, guaranteeing a faculty appointment at the University. In teaching, I was successful to the point that, although not yet a professor, I gave "professorial lectures" to help students after the Professor had given his lecture. Through this experience I discovered an affinity and enjoyment of explaining science and natural phenomena in the clearest and simplest way. The students (500 or more) enriched this sense with the appreciation they expressed. At the age of 21, as a Moeid, I believed that behind every universal phenomenon there must be beauty and simplicity in its description. This belief remains true today. On the research side, I finished the requirements for a Master's in Science in about eight months, and was ready to begin research for a Ph.D. degree. All the odds were against my going to America. First, I did not have the connections abroad. Second, the 1967 war had just ended and American stocks in Egypt were at their lowest value, so study missions were only sent to the USSR or Eastern European countries. I had to obtain a scholarship directly from an American University. After corresponding with a dozen universities, the University of Pennsylvania and a few others offered me scholarships, providing the tuition and paying a monthly stipend (some $300). There were still further obstacles against travel to America. It took enormous energy to pass the regulatory and bureaucratic barriers.

Arriving in the States, I had the feeling of being thrown into an ocean. The ocean was full of knowledge, culture, and opportunities, and the choice was clear: I could either learn to swim or sink. The culture was foreign, the language was difficult, but my hopes were high. I did not speak or write English fluently, and I did not know much about western culture in general, or American culture in particular. My presence—as the Egyptian at Penn—was starting to be felt by the professors and students as my scores were high, and I also began a successful course of research. My publication list was increasing, but just as importantly, I was learning new things literally every day—in chemistry, in physics and in other fields. I was working almost "day and night," and doing several projects at the same time. Now, thinking

about it, I cannot imagine doing all of this again, but of course then I was "young and innocent". The research for my Ph.D. and the requirements for a degree were essentially completed by 1973, when another war erupted in the Middle East.

I had strong feelings about returning to Egypt to be a University Professor, even though at the beginning of my years in America my memories of the frustrating bureaucracy encountered at the time of my departure were still vivid. With time, things changed, and I recollected all the wonderful years of my childhood and the opportunities Egypt had provided to me. Returning was important to me, but I also knew that Egypt would not be able to provide the scientific atmosphere I had enjoyed in the U.S. A few more years in America would give me and my family two opportunities: first, I could think about another area of research in a different place (while learning to be professorial!). Second, my salary would be higher than that of a graduate student, and we could then buy a big American car that would be so impressive for the new Professor at Alexandria University! I applied for five positions, three in the US, one in Germany and one in Holland, and all of them with world-renowned professors. I received five offers and decided on Berkeley.

Early in 1974 we went to Berkeley, excited by the new opportunities. Culturally, moving from Philadelphia to Berkeley was almost as much of a shock as the transition from Alexandria to Philadelphia—Berkeley was a new world! I saw Telegraph Avenue for the first time, and this was sufficient to indicate the difference. I also met many graduate students whose language and behavior I had never seen before, neither in Alexandria, nor in Philadelphia. The obstacles did not seem as high as they had when I came to the University of Pennsylvania because culturally and scientifically I was better equipped. Berkeley was a great place for science—the BIG science. My general research direction was established, and I immediately saw the importance of the concept of coherence. I decided to tackle the problem, and, in a rather short time, acquired a rigorous theoretical foundation which was new to me. I believe that this transition proved vital in subsequent years of my research. We wrote two papers, one theoretical and the other experimental which were published in Physical Review. These papers were followed by other work, and I extended the concept of coherence to multidimensional systems, publishing my first independently authored paper while at Berkeley. In collaboration with other graduate students, I also published several papers.

During this period, many of the top universities announced new positions, and I was encouraged to apply. I decided to send applications to nearly a dozen places and, at the end, after interviews and enjoyable visits, I was offered an Assistant Professorship at many, including Harvard, Caltech, Chicago, Rice, and Northwestern. My interview at Caltech had gone well, despite the experience of an exhausting two days, visiting each half hour with a different faculty member in chemistry and chemical engineering. The visit was exciting, surprising and memorable. The talks went well and I even received some undeserved praise for style. At one point, I was speaking about what is known as the FVH picture of coherence, where F stands for Feynman, the famous Caltech physicist and Nobel Laureate. I went to the board to write the name and all of a sudden I was stuck on the spelling. Half way through, I turned to the audience and said, "you know how to spell Feynman". A big laugh erupted, and the audience thought I was joking—I wasn't! After accepting the Caltech offer, I was granted tenure in two years and the research group was well established. I never regretted the decision of accepting the Caltech offer.

At Caltech over the years, my science family came from all over the world, and members were of varied backgrounds, cultures, and abilities. The diversity in this "small world" I worked in daily provided the most stimulating environment, with many challenges and much optimism. My research group has had close to 200 graduate students, postdoctoral fellows, and visiting associates. Many of them are now in leading academic, industrial, educational, and governmental positions. Working with such minds in a village of science has been the most rewarding experience—Caltech was the right place for me.

My biological children were all "made in America". I have two daughters whom I am very proud of, Maha, a graduate of Caltech (B.S.) and the University of Texas, Austin (Ph.D.), and Amani, a graduate of Berkeley (B.S.) and currently an M.D. student at the University of Chicago. Dema, my wife, has her M.D. from Damascus University, and completed a Master's degree in Public Health at UCLA. We have two young sons, Nabeel and Hani, and both bring joy and excitement to our life.

The journey from Egypt to America has been full of surprises. As a Moeid, I was unaware of the Nobel Prize in the way I now see its impact in the West. We used to gather around the TV or read in the newspaper about the recognition of famous Egyptian scientists and writers by the President, and these moments gave me and my friends a real thrill—maybe one day we would be in this position ourselves for achievements in science or literature. Some decades later, when President Mubarak bestowed on me the Order of Merit, first class, and the Grand Collar of the Nile ("Kiladate El Niel"), the highest State honor, it brought these emotional boyhood days back to my memory. I never expected that my portrait, next to the pyramids, would be on a postage stamp or that the school I went to as a boy and the road to Rosetta would be named after me. Certainly, I never dreamed that one day I would be honored with the Nobel Prize. But with passion and sincerity, *It Is Possible*, as human achievements should be limited neither by race nor by origin.