

ADDENDUM to Genetic Recombination in Bacteria, A discovery Account

The following footnotes were in large part deleted from the accompanying article. The footnote matter was less pertinent to the main readership of the Annual Reviews of Genetics.

Amplification at page 25:

New York City at that time thus had a network of institutions directed to enhancing the intellectual and social mobility of its melting pot youth. Generationally, I was fortunately placed: my teachers were already successors to an earlier era of patronizing condescension to the wave of Eastern European immigrants. Many of them were Jewish; all were inculcated with ethnic neutrality, and liberal minded tolerance: attitudes conveyed to their students. {Cf. Brumberg "Going to America, Going to School"}.

The numerous Nobel Prizes that have emerged from New York's science high schools and City Colleges are further witness of the encouragement given to the talent and ambition of its students, perhaps more than of the laboratory facilities or of the academic attainments of their faculty at the time.

Equally important as the schools to my own education was the local Washington Heights branch of the Carnegie- Astor New York Public Library system. These institutions symbolized and embodied the melting pot ideology. My father was an orthodox rabbi, born and educated in Israel, and thus had more prestige, higher intellectual aspirations for his children, and less income than most of his neighbors. Like many other children of Jewish immigrants in New York City of the first quarter-century, I was recruited into an efficient and calculated system of Americanization, fostered by the rich opportunities and incentives of the educational system. So recently arrived, the very last of the wave before the restrictions on immigration took hold, my parents had an uncomplicated appreciation of America as a promised land. My own political ideologies have been more consistent with than reactive to that belief.

My earliest recollections aver an unswerving interest in science, as the means by which man could strive for understanding of his origin, setting and purpose, and for power to forestall his natural fate of hunger, disease and death. The Jewish reading in Genesis of the expulsion from Eden makes no presumptions of the benignity of Nature. "By the sweat of thy brow" This may have been the most acceptable deviation from the orthodox religious calling of my family tradition. These images were reinforced by the role of Albert Einstein and Chaim Weizmann as culture heroes - heroes whose secular achievements my parents and I could together understand and appreciate, regardless of the intergenerational conflicts evoked by my callow agnosticism. I could not then see how the monotheistic worldview and the central teachings of the Old Testament, and their ethical imperatives for contemporary life, related to the tribal rituals shaped in the Diaspora. But the utopian-scientific ethic offered an acceptable resolution. My own career could advance our shared ideals in a modern, American idiom. Science would be a path to knowledge of the cosmic order. It would also be a means of alleviating human suffering. The Jewish tradition is remarkably tolerant of skepticism. The sages were more insistent that ultimate questions be in mind than that they be answered in the framework of a particular dogma. I have in mind, e.g., Maimonides' teachings of the

unknowability of God. The agnostic set of mind thus permitted, together with my reaction to my father's orthodoxy, carried over into my reflex responses to other sources of authoritative knowledge. This was an integration, not a rejection of Jewish identity: what could be a more Jewish name than "Joshua"? and I have always borne it proudly.

The library was my university as I went through grade school and junior high school. Here was the universe of knowledge, huge but finite. The teen-ager, unencumbered by any informed guidance and tutelage, fantasized mastering all of it. There were few books (except perhaps musical scores) that were totally incomprehensible to me; most were merely difficult and would eventually yield to diligent study. At that age, of course, there is little sense of the finitude of human life. After 1938, I also had access to the Stuyvesant High School library, and more importantly Cooper Union, for its stacks gave access to scientific journals like the *Journal of the American Chemical Society* and *Science* magazine. The librarians did (and do) welcome me as their most enthusiastic patron; I loved nothing better than to scan the shelves, discipline by discipline, and try to find whatever work both challenged, and was accessible, to me. I was also a voracious reader of contemporary fiction.

In the main text, I refer to having received Bodansky's *Introduction to Physiological Chemistry* as a Bar Mitzvah present. In my original writing, I referred to it as testimony of my firm and precocious interest in biochemistry, crystallized already by my 13th birthday. It was also my covenant with my father, that a career in science would be a redeeming surrogate for the study of Torah, an alternative approach to enlightenment and truth.

I did have some opportunity for "experiment" at home, what with the toxic and explosive chemicals that could then be purchased in chemistry sets, and over the counter at Eimer & Amend's, near Stuyvesant High School. Besides nearly destroying myself with looking for the threshold of explosion in throwing metallic sodium in water, most of these were elementary syntheses of azo dyes and the like, sometimes in concert with some high school chums. I did make a more original study of the reaction of ferric iron with thiosulphate, but got little satisfaction either from experiment or the published literature. Stuyvesant also sponsored a Biology Club, and one could beg the storekeeper to use the microtome to cut histological sections. I started a project to try to understand the effect on tissues of fixatives, chemicals intended to coagulate and solidify tissue proteins but hopefully leave the essential structures close to their living form. These chemicals, like formaldehyde, acetic acid, picric acid, etc. do alter the staining properties, and I thought this interaction should give clues to the chemical nature of tissue materials. Indeed it should; however, the use of specific enzymes, and then of antibodies, have provided much more specific probes for this kind of histochemistry.

The New York Museum of Science and Industry, and the NY World's Fair (starting 1939) were also wonderful stimuli, picturing science-technology utopias of the near future. They offered samples of polaroid optical sheets, and of the new bakelite plastics that could be taken home for further experiments. Above all they left a vision of "Better Things for Better Living Through Chemistry." (DuPont's slogan now leaves out the word chemistry -- it has become a dirty word!)

One of the guides at the New York World's Fair was a young psychologist, Henry Platt.

He had a vision of a means of encouraging young scientific minds, namely to offer them a laboratory where they could conduct authentic scientific research, with appropriate equipment and supervision. By lucky chance, he met Thomas J. Watson at the Fair, and persuaded him to support the project. This materialized as the American Institute of Science Laboratory, housed in an IBM showroom building on Fifth Avenue, in the shadow of the Empire State Building. I was lucky to be accepted into that program: having graduated from High School in January, and being obliged to wait until September to start at Columbia, it was a happy way indeed to occupy the interval. And I was too young to work without running afoul of the child labor laws! The AISL did indeed offer better facilities, and unbroken time, to continue the cytochemical work I started at Stuyvesant; and I begin to focus on the chemistry of the nucleolus. It had many of the properties of nucleic acids, but not consistent with being pure DNA. (My own studies were hardly contributory to a solution: Brachet had already applied ribonuclease to the histochemical identification of RNA in nucleoli. His work, published in Nazi-occupied Brussels in November 1940, was not communicated to the U. S. until some time later). The work did confirm my fascination with the chemistry of the cell, and I determined to concentrate on such studies as soon as I could acquire the authentic and mature expertise that Columbia could offer.

Before entering Columbia College, however, I had not yet met a working scientist. I can recall having attended popular lectures by Wendell Stanley, on the chemistry of tobacco mosaic virus; earlier, as a ten-year old, how impressed I had been by the newspaper accounts of his having crystallized life {cf. Lila Kay}. These stories were among many accounts that pointed to the Rockefeller Institute as the sanctum sanctorum of biomedical science.

With these cardinal inspirations, my entry to Columbia that fall was motivated by a passion to learn how "to bring the power of chemical analysis to the secrets of life". I looked forward to a career in medical research where such advances could be applied to problems like cancer and the malfunctions of the brain.

I had applied to Cornell, on account of Leslie Sharp's presence on the faculty - a name that I knew from his Textbook of Cytology. But Cornell was in practice open only to wealthy tuition-paying students, or to farm boys who could enroll in the N.Y. State funded College of Agriculture. My application for a scholarship at Telluride House was rejected. I also had City College in mind, but thought of this as a last resort, as it had limited graduate work, and scarcely any research facilities. No one so much as hinted that I could seek work and scholarships at other state universities. Berkeley might have been a superb possibility, but California seemed like the other side of the moon. Financially, a commuter school like Columbia was almost the only feasible possibility, barring a scholarship. This perhaps did not exist for a Jewish boy from New York at that time.

Hitler had achieved power in Germany when I was eight years old, just old enough to have no doubt about the aims of his march across Europe. Eight years of fascinated horror at the unfolding of history followed -- the persecution of the German Jews, the flight of intellectuals like Albert Einstein, the occupation of Austria, Munich, the Nazi-Soviet pact and partition of Poland, the fall of France, the victory of the RAF in the Battle of Britain, the Nazi invasion of Russia, the Japanese attack on Pearl Harbor. Then, in December 1941, we knew that the War would dominate our lives until a painful victory was won. My debt to the

Navy for sponsoring my education, and to my age peers who served in combat can hardly be discharged. That sense of obligation, and the generational scar of the costs of unpreparedness, of the delusions of unilateral disarmament, continue to mark my ongoing volunteer service on consulting bodies like the Defense Science Board and the Chief of Naval Operations' executive panel.

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ADD at p. 35:

... I then wrote Tatum of my research plan (Fig. 1) and applied for such an accommodation. Dean Aura E. Sevringhaus of P&S also approved such a visit as qualifying for an elective quarter offered to medical students during their third year of study. Part of my justification was the potential practical applications in medicine of a better understanding of bacterial genetics. I am sure that he concurred (perhaps with different emphasis) with my own private judgment that I could make a greater contribution to medicine as an investigator than in clinical practice.

ADD at foot of p. 39 My arrangements to move to Stanford were completed several weeks before I received a telephone call from a Swedish journalist probing my reactions to having received the Nobel Prize. The timing added a bittersweet note to the award, to be receiving it literally whilst packing to leave Madison for Palo Alto. It was hard enough to turn one's back on so many old friends and a fine institution, without the glare of public enquiry: "just why are you moving?". It also ambiguated the claim that either institution might make on behalf of that prize: this account should help make clear how much in fact belongs to Columbia and to Yale.