Marxism & Cell Biology

Can political perspectives enrich science?

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There is no royal road to science, and only those who do not dread the fatiguing climb of its steep paths have a chance of gaining its luminous summits.

—Karl Marx, *Das Kapital*

Few biology teachers have likely heard of Alex Novikoff (1913-1987) (Figure 1), while surely recognizing the fruits of his science. He helped discover lysosomes in 1955, visualizing the organelle that Christian de Duve had characterized only cytochemically. He demonstrated the first enzyme of the Golgi body (nucleoside diphosphatase). He also developed electron microscope stains for identifying lysosomes (acid phosphatase) and peroxisomes (catalase), critical to their complete study. Novikoff was also targeted by the anti-Communist movement in the mid-20th century. In 1953 he was dismissed from the University of Vermont for declining to answer questions before a Congressional committee. In 1974 he was elected to the National Academy of Sciences. His FBI file then contained 822 pages. Novikoff's fascinating case (Holmes, 1989; Allchin, 2007) raises important issues about how science and political ideology relate.

In 1982 the American Society for Cell Biology honored Novikoff with its prestigious E. B. Wilson Award for his foundational contributions to the emerging field. In the late 1930s he was, indeed, a member of the Communist Party. For him, it expressed his quest for social justice and his appreciation of Karl Marx's scientific posture towards society. While he researched experimental embryology as a Ph.D. student at Columbia University, he also helped write and distribute the Communist newsletter at Brooklyn College, where he taught. Political efforts to disrupt the teachers union there ultimately led to secret files listing Novikoff as a suspected Communist. When World War II began, Novikoff wanted to serve the nation. He applied for a medical commission in the military. He was twice denied, however, due to doubts about his loyalty. He later consulted for the Army on two biological films—until they found his vague Communist record. (One wonders: Did someone imagine that he could render enzymes and carbohydrate metabolism subversive?!) Later, Novikoff lost his faculty position—not for any political activity, but for invoking the Fifth Amendment in anti-Communist hearings—and despite recommendations from fellow faculty about his "tireless" research efforts. In short, cultural politics adversely affected Novikoff's scientific career.

Figure 1. Alex Novikoff in 1955, at the electron microscope of Albert Einstein College of Medicine. Photo by Jay Walker, courtesy of Phyllis Novikoff.

Novikoff's case may seem at first to epitomize how science and politics "don't mix." Yet it also illustrates vividly that science is not wholly insulated from culture, despite popular images of science as pure and transcendental. How are the two to coexist? The case may seem to confirm a widespread impression that politics can only damage or interfere with the conduct of science. Still, one may profitably consider the assumption – another sacred bovine? – that science is best sheltered from political ideologies.

Novikoff's story would not be nearly so engaging – nor perhaps merit much further comment – if his politics did not also positively influence his work. Traces of Marxist ideas permeate his conceptual outlook and his interpretations of evidence, as well as his professional conduct. Cell biology, of all subjects, may seem incredibly remote from politics. Yet Novikoff's work, carefully considered, shows how political ideology may sometimes contribute fruitfully to the practice, and even the content, of science. Ultimately, such analysis might deepen reflection on the nature of science and what students might learn about what makes knowledge reliable.

Dialectics & Cells

Novikoff came from a poor, struggling immigrant family. An outstanding student, he graduated from high school at age fourteen. When he completed studies at Columbia University, institutions had begun limiting opportunities for Jews. Despite stellar credentials, Alex was not admitted to medical school. He was bitter and developed an uncompromising advocacy for social justice. Those feelings were ignited when he began teaching at Brooklyn College in 1931 and encountered disparities

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between junior and senior faculty, blind to ability. For Novikoff, Communist ideology offered prospective solutions to what seemed an unjust power structure.

By 1945 Novikoff, married, age 32, had formally severed ties with the Communist Party. But Marxist patterns of thinking remained. In one paper that year, Novikoff (1945a) profiled the problems for biology of extreme reductionism, on the one hand, and implicit vitalism, on the other. Parts and wholes needed to be understood together, he urged, using a "dialectical approach" (p. 215). The concept of *dialectics* was from Marx. For Marx society exhibited a struggle between two economic groups: those who owned capital (and thus held power) and laborers. Their conflict would be resolved—and workers freed—only by generating a new system that completely dissolved the owner-laborer relationship and integrated everyone at a new level of communism. Philosophically, there was a synthesis of opposing perspectives. That was Marx's essential dialectic: progress emerging from integrating polar opposites, as modeled in political history. Novikoff echoed that concept and language. He argued for reconciling the two opposing biological views in what he called "the concept of integrative levels in biology."

Novikoff privileged neither atomism nor organicism. Nonetheless, he reserved his strongest criticisms for the reductionists. He reminded readers that to understand cells fully, biochemistry, however essential, was not enough. One also needed knowledge of cell structure. Likewise, isolated cell functions alone were not physiology. One needed the developmental context. Novikoff's primary concern, however, was interpreting society — and doing so scientifically, as Marx advocated. He decried the misleading organism-society analogy, as proposed by Herbert Spencer and his followers, that reduced culture to biology (*Sacred Bovines*, 2007). Conflating levels, he claimed, could lead to "erroneous and dangerous social conclusions" (p. 213). Novikoff pointedly identified as an example the fascists (namely, the Nazis), who had alleged that "man's biology decides his social behavior" (p. 214). Socio-cultural inheritance supplements genetics, he observed. Distinctly sociological principles (at the appropriate level) were needed, he maintained, to keep society "free and democratic" (p. 214). Here, his anti-reductionist science was clearly informed by political ideology.

Novikoff continued to apply Marx's dialectical approach fruitfully over the next three decades *to his investigations of cells*. In a reductionist vein, he localized biochemical functions to parts within cells. But he also did not lose sight of context and more holistic perspectives. He studied lysosomes and peroxisomes in diverse cell types and tissues and in pathological conditions (such as fatty liver, tumors or nephrosis). That revealed how the "same" units differed depending on various cellular contexts, or wholes.

In 1965 James Watson published *Molecular Biology of the Gene*. Novikoff saw an unproductive molecular bias. In 1970 he aimed to remedy it "dialectically" in co-authoring his own text on *Cells and Organelles*. It was one of the first textbooks of cell biology, widely used through three editions. Here, parts and wholes received parity. After descriptions of the many *organelles* (as parts), Novikoff included just as much coverage on the many *cell types*, made from recombining them into different wholes. An unstated Marxist perspective highlighted how cells (like societies) did not reduce to a simple sum of their independent component parts.

Novikoff's political perspective led to an appreciation of how parts related in forming higher levels of biological organization. For example, while lysosomes, peroxisomes, and endoplasmic reticulum were not considered "dominant" organelles, he recognized the implicit significance of their "labor" to the whole and devoted study to them. Novikoff was also sensitized to see differences in parts, with their import for integrated wholes. In an important 1953 paper, he centrifuged broken cells into ten fractions, rather than the customary four. That allowed a finer scale analysis. He tested each fraction for the activity of seven carefully selected enzymes, then modified the fractions, aligning the differences by matching particular particle sizes with enzyme activity. Ultimately, he had mapped the characteristic enzymes to *six* organelles, two not yet known. In a similar way, he examined liver tissue, demonstrating that cells assumed to be all the "same" were biochemically and cytologically different. Studying peroxisomes with an eye to differences also allowed Novikoff to discover microperoxisomes in 1972. He also noticed a close association of the Golgi body, endoplasmic reticulum and lysosomes, a hybrid structure he called GERL, which helped clarify lysosome biogenesis. Novikoff's discoveries were guided by a conceptual map of what merited notice.

Materialism & Evolution

The 1945 paper on integrative levels exhibited another core Marxist principle: *materialism*. Novikoff noted that many non-reductionists appealed to various guiding forces in evolution, such as an "organizing trend," inherent progress, or directional (orthogenetic) trajectories. Today, such forces are well outside sound biology, but all had been postulated by biologists in the early 20th century to explain various features of the fossil record. Novikoff criticized such non-materialistic forces as unsubstantiated and superfluous. Here, he echoed Marx's view of history. Marx saw how economic relations shaped society, as well as political changes through history. He thus regarded intellectual movements as responses, not causes. He emphasized instead the material causal elements of history. Accordingly, Marx viewed Darwin's theory of descent with modification quite favorably. It described organic change in material terms. For Marx, natural history and human history were parallel. That materialist framework enabled Novikoff to identify the biological weaknesses of the evolutionary concepts.

Novikoff's discussion had political overtones here, as well. Many followers of Spencer claimed that progress was "natural," and that humans should not disturb it, lest it cease. They promoted a laissez-faire approach to society (*Sacred Bovines*, 2007). From a Communist perspective, Novikoff could easily see that such an argument, aimed at preserving the status quo, served only the interests of the already powerful. He called such trust in progress unsound fatalism. Rather, "social progress," he declared, "rests upon the planned activities of men" (p. 214). In a sense, he set political action in a biological context.

Communist ideology aimed to inspire laborers to act to change history materially. Novikoff echoed those sentiments in portraying the evolution of humans and their traits. He observed that humans are able to control their environment: They are not bound to their political history. Their intelligence, likewise, is plastic: Political change is possible. He further commented that "man possesses a unique head and hand" (p. 211), alluding in particular to the power of manual laborers. Marxist ideology gave special relevance to certain features of evolution.

Novikoff also viewed science concretely as a form of work. In the opening and closing chapters of his textbook, he profiled the history and methods of cell biology. Science was not static

information, but an active, engaging field that the reader might consider pursuing. Similarly, in a children's book on physiology, Novikoff described many historical scientists: science as a human endeavor. Novikoff himself was extremely active. He worked with little sleep. He wrote most of his Ph.D. thesis while commuting to and from school and work. In 1955, he collaborated with Christian de Duve on lysosomes. Because no electron microscope was available in Louvain, Belgium, he packed up the cell samples in an iced thermos at the end of the day, took two trains to a lab in Paris, and continued working into the night to produce the images, returning to repeat the routine again the next day. Colleagues repeatedly described Novikoff's efforts as "tireless." He certainly exemplified the principle valuing material work.

Socialism

Finally, one may note how Novikoff's Marxist orientation affected the practice, not just the content, of his science. Socialist ideals were expressed in many ways. First, Novikoff was one of the first to write science books for children. *Climbing Our Family Tree* (1945b), an introduction to evolution, is a landmark in children's literature. Novikoff, not yet with children of his own, clearly saw even young readers as important. So too, presumably, did the Communist press that published the book. The text is informative, while also highlighting Marxist themes. Novikoff dramatized evolutionary innovations—such as homeostatic internal environments, the transition to land, internal development, and homeothermy—as steps in organisms becoming freer from their environment. The final chapters introduced human society, too, as a product of evolution, and underscored the basis for culture and cooperation. "Men, working with each other," he concluded, "can become ever more free—ever more human" (p. 93).

Second, Novikoff viewed the scientific community as one of equal peers. (Not all scientists do.) At one level, he generously shared credit for work done. Nearly all his published papers are coauthored. More deeply, he was also open to conversing with anyone, much to the surprise of students and junior scientists. Such discourse promotes the exchange of ideas. Given that Novikoff endorsed dialectics, he also enjoyed the opportunity to vigorously debate alternate views with anyone – yet graciously conceded when shown to be wrong. That "socialist" spirit contributed to critical analysis and thereby to more robust scientific conclusions.

Interpreting Politics in Science

Not all influences of politics on science are positive, surely. One may readily point to Lysenko's notorious suppression of Mendelism in the former Soviet Union. Given Novikoff's case, however, one must qualify any universal negative claim. One may also be tempted to consider Novikoff as "just a good biologist," his achievements wholly unrelated to his politics. However, such a conclusion fails to explain *how* Novikoff came by his skills. The language of his 1945 publications, in particular, leaves no doubt about his conceptual roots. To explain Novikoff's scientific achievements fully, his personal history and Marxist perspective are essential.

Novikoff's science was "science" in part because it was not *exclusively* Marxist. Nor did Novikoff ever present political arguments to *justify* his conclusions (as Lysenko did). Rather, his political ideology functioned in what philosophers of science sometimes call the "context of discovery." Accordingly, Novikoff's ideology was a valuable tool for generating alternative approaches or probing possible interpretations. Novikoff could sometimes appreciate what others could not, due to the blind spots of their conceptual orientations. Science also relies on a complementary "context of justification," where standards of evidence apply. Science "evolves" through a coupling of blind variation *and* selective retention: a process familiar to biologists.

Novikoff did indeed respect arguments for alternatives. In his 1953 study of cellular enzymes, for example, he first interpreted the heterogeneity of his fractions as variations in the size and enzyme activity of the known organelles, the mitochondria, and microsomes (ribosomes). After Christian de Duve learned of the results, the two met in New York and chatted in Central Park. De Duve shared his results indicating the presence of an undocumented organelle: the lysosome. Novikoff accepted his interpretation. The two went on to collaborate briefly and became lifelong friends. Political ideology can be productive, so long as one still listens to criticism and minds the evidence.

Ultimately, Novikoff's Marxist political perspective enriched science. Ironically, such real—and fruitful—influences were never the concern of the anti-Communist demagogues who dogged Novikoff for the allegedly subversive consequences of his political views.

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