From 'Order-from-Order' to 'Order-from-Disorder': Towards a Post-Schrödingerian View of the Cell

Daniel J. Nicholson

George Mason University.

It seems unproblematic to state that cancer reflects a disruption of biological order. And yet this characterization assumes that we have a firm grasp of the source of this order. For a long time, during the heyday of molecular biology, nobody doubted this. But recent empirical findings made possible by the advent of new methods are challenging hitherto sacred assumptions and prompting a fundamental reconceptualization of the nature of biological order down to the molecular level. To understand what is wrong with our current picture, we must first understand how we acquired that picture in the first place.

The best way to do this is to revisit a very famous and influential book published just over 75 years ago by one of the most celebrated physicists of the twentieth century: Erwin Schrödinger's *What is Life? The Physical Aspect of the Living Cell*. Though published more than a decade before Watson and Crick's discovery of the double helix, this little book laid the foundation for the mechanicist, reductionist, and determinist view of the cell that drove the agenda of molecular biology—as well as that of cancer research—throughout the second half of the last century. It is a familiar view that emphasizes the dominant agential role of genes, and which is governed by what Schrödinger called the 'order-from-order' principle (which also rules the operation of machines). Schrödinger contrasted this with the 'order-from-disorder' principle at play in the physical world, which is based not on designs or blueprints but on the statistical averaging of vast numbers of stochastically-acting molecules that collectively display regular, law-like patterns of behaviour.

Despite Schrödinger's insistence in demarcating the biological and mechanical forms of order-from-order from the physical forms of order-from-disorder, we now have abundant experimental evidence that suggests that much—if not most—of the order in the cell is better captured by the idea of order-from-disorder. This shift has profound implications for how we think about biological processes at different levels of organization, and also about what happens when their normal operation is disrupted and diseases such as cancer develop. Only by 'unlearning' Schrödinger's lessons regarding biological order can we make room for recognizing the role of self-organization and stochasticity and thereby equip ourselves with the resources we need to meet the explanatory challenges posed by cancer.