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Mesosopic Lawlessness

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Whether physics will contribute significantly to unraveling the secrets of life, the grandest challenge of them all, depends critically on whether proteins and other mesoscale objects exhibit emergent law. By this I mean quantitative relationships among their measured properties that are always true. The jury is still out on the matter, for there is evidence both for and against, but it is spotty, on account of the difficulty of measuring 100 nm - 1000 objects without damaging them quantum mechanically. It is therefore not clear that history will repeat itself. Physics contributed mightily to 20th century materials science through its identification and mastery of powerful macroscopic emergent laws such as crystalline rigidity, superconductivity and ferromagnetism, but it cannot do the same thing in biology, regardless of how powerful computers get, unless nature cooperates. The challenge before us as physicists is therefore not to amass more and more terabytes of data and computational output but rather to search for and, with luck, find operating principles at the scale of life greater than those of chemistry, which is to say, greater than a world ruled by nothing but miraculous accidents.