

"Geometry of an Intracellular Membrane"

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"I seemed to see the membraneous and cylindrical tubes
tremble
beneath the undulation of the waters."

-- Jules Verne (describing Captain Nemo's underwater
garden
in *20,000 Leagues Under the Sea*)

Abstract:

The endoplasmic reticulum (ER) has long been considered an exceedingly important and complex cellular organelle in eukaryotes (like you). It is a network that threads its way outward, from the cell's nucleus all the way to its periphery. For over sixty years, microscopists have seen amazing things in the ultrastructure of the ER, and the complexity of its shape has inspired various picturesque characterizations: tubules, sheets, spheres, lamellae, cisternae, flattened vesicles. Despite the elegant mechanics of bilayer membranes offered by the work of Helfrich and Canham, as far as the ER is concerned, theory has mostly sat on the sidelines.

However, refined imaging of the ER has recently revealed beautiful and subtle geometrical forms -- almost "simple" geometries, from the mathematical point of view -- which some have called a "parking garage for ribosomes". Rather than being a footnote in a textbook on differential geometry, these structures suggest answers to classic, long-standing questions: What is the structure of the entire organelle? How does it form? and Why did it evolve?