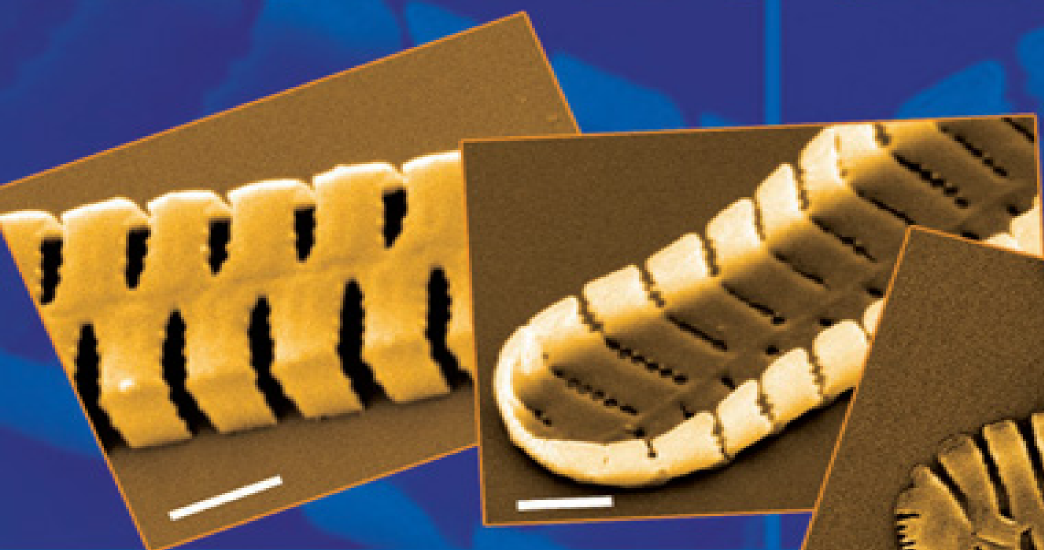
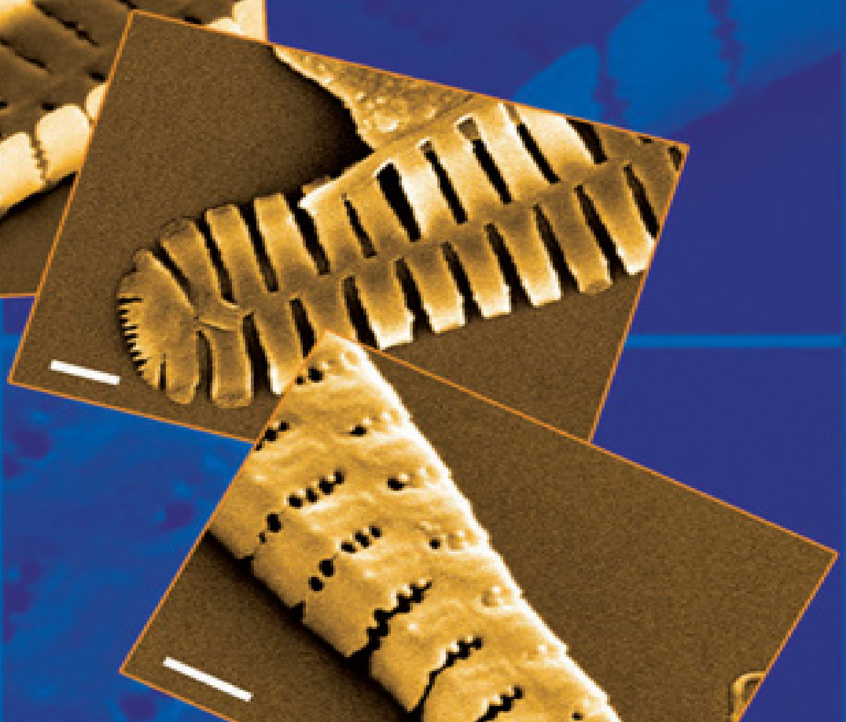
DIATOMS: BIOLOGY AND APPLICATIONS SERIES

DIATOM MORPHOGENESIS





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Diatoms: Biology and Applications

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Scope: The diatoms are a single-cell algal group, with each cell surrounded by a silica shell. The shells have beautiful attractive shapes with multiscalar structure at 8 orders of magnitude, and have several uses. 20% of the oxygen we breathe is produced by diatom photosynthesis, and they feed most of the aquatic food chain in freshwaters and the oceans. Diatoms serve as sources of biofuel and electrical solar energy production and are impacting on nanotechnology and photonics. They are important ecological and paleoclimate indicators. Some of them are extremophiles, living at high temperatures or in ice, at extremes of pH, at high or low light levels, and surviving desiccation. There are about 100,000 species and as many papers written about them since their discovery over three hundred years ago. The literature on diatoms is currently doubling every ten years, with 50,000 papers during the last decade (2006-2016). In this context, it is timely to review the progress to date, highlight cutting-edge discoveries, and discuss exciting future perspectives. To fulfill this objective, this new Diatom Series is being launched under the leadership of two experts in diatoms and related disciplines. The aim is to provide a comprehensive and reliable source of information on diatom biology and applications and enhance interdisciplinary collaborations required to advance knowledge and applications of diatoms.

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Diatom Morphogenesis

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Cover image: Colored scanning electron micrographs (SEMs) of a morphogenetic sequence of the diatom *Fragillaria capucina var. mesolepta* by Dr. Mary Ann Tiffany, Biology Department, San Diego State University, USA Sample taken from Lake Murray (a freshwater San Diego Reservoir) on 3/18/2000.

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Preface

Diatoms comprise a large, unicellular eukaryotic algal group that thrives mainly in aqueous environments: in fresh water, and in ponds, lakes and oceans. They may be attached to benthic substrates, in moist habitats or in floating debris and on macrophytes, and as phytoplankton; they form a substantial basis of aquatic food webs. They are ubiquitous, being distributed among various ecological locations. Among this group are some extremophiles with varying features, such as living in high temperatures, surviving desiccation, or in ice and at extreme ranges of pH. Some 20%-30% of the oxygen we breath is produced by diatom photosynthesis.

Vegetative cells of diatoms are diploid (2N), and meiosis can take place, producing male and female gametes fusing to zygotes which grow to auxospores.

One of their specific features is that their chemical composition includes siliceous (glassy) cell walls (frustules). Their exoskeleton is made of two halves called “valves” that fit inside one another, secured by silica “girdle bands”.

Diatoms’ fine structure is very impressive as revealed by transmission electron microscope, scanning microscope, and atomic force micrographs. The appearance of their cells is strikingly unique, and their shells are beautiful attractive shapes, with 60,000 to 200,000 species.

Why Valve Morphogenesis is Important?

Because there is so much detail in their silica wall shapes, spanning 8 orders of magnitude, diatoms are model organisms for single-cell morphogenesis. The problem of single cell morphogenesis has a long history, as yet unsolved, and perhaps diatoms rather than desmids and ciliates will now lead the way, especially given their 200 million years fossil record. This may further be because diatoms serve as a source of biofuel, food supplements and lipids and serve as significant material for nanotechnology. Thus, they are of very wide interest.

This volume focuses on the morphogenesis of diatoms, namely, the formation of their shape and the initial developmental steps.

The chapters were contributed by experts on morphological diatoms. The authors stem from the USA, Russia, Denmark, Germany, Greece, Israel, and Portugal.

Topics Addressed in This Volume

Topics include computer simulation of morphogenesis, silicic acid to silica frustules, inhibition in valve morphogenesis, pores within frustules, mesopores of pennate diatoms, frustule photonics and light harvesting, clonal chains, silica cell wall, geometric models of centric diatoms, morphology, surface features, buckling of valve morphogenesis, on mantle profiles, genetic-biochemical approaches, modeling silicon pools, valve morphogenesis, diatom teratology in taxonomy, phenotypic plasticity, geometric and morphometric analysis, silica morphogenesis in sister algae, and the uncanny symmetry of some diatoms.

This volume is the third book in the series Diatoms: Biology and Applications. The first book, *Diatoms: Fundamentals and Applications* appeared in 2019, and was edited by Joseph Seckbach and Richard Gordon. The second book, *Diatom Gliding Motility*, was published in September 2021 and is edited by Stanley A. Cohn, Kalina M. Manoylov and Richard Gordon.

We would like to thank the authors, the reviewers, the guest editor (Vadim V. Annenkov), and our publisher Martin Scrivener of Massachusetts, USA.

Joseph Seckbach
Hebrew University Jerusalem, Israel September 2021