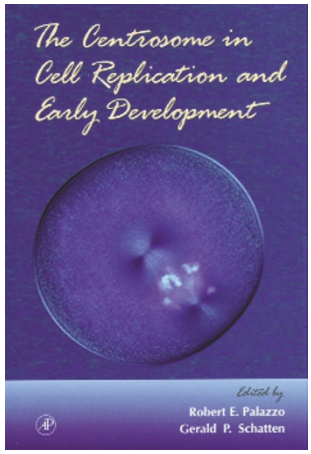
The mystery of the centrosome



The Centrosome in Cell Replication and Early Development
by Robert E. Palazzo and Gerald P. Schatten
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The centrosome has been a subject of fascination for cell biologists for at least a century. It is at the centre of the cell and is the structure on which microtubules organize themselves both during interphase and mitosis. At its core sits a pair of centrioles, which are cylindrical organelles of a precise and intricate design. However, it is somewhat humbling, in this age of proteomics and genomics and in the era of unfolding signal transduction pathways and the action of the corresponding regulatory machinery, that this obvious object sitting at the focus of all cycling cells remains an enigma in many of its aspects.

But how is the centrosome an enigma? For virtually every key observation made regarding the centrosome, there are exceptions. Take the centrosome itself. Plants do perfectly well without it, and yet its detailed conservation in metazoans speaks of an evolutionary imperative to maintain its structure. In addition, take the centriole at the core of the centrosome. It is normally present as a pair at each mitotic spindle pole, and its presence dictates the number of spindle poles that will form in mitosis. However, in many cases, spindle poles form in mitosis whether it is present or not, and sometimes, if multiple centrosomes are present, they coalesce towards a single pole in mitosis. In addition, its presence is required to serve as the focus on which daughter centrioles form in the cell cycle, and yet, if the original centriole is destroyed, there are cases where new centrioles can form *de novo*.

Furthermore, there are more enigmas regarding the centrosome. It is specifically destroyed in female meiosis in many organisms, creating the condition for paternal inheritance of the centriole from the sperm basal body. And yet, after parthenogenesis, the centriole can be created anew in the oocyte in many organisms.

Although there is a much information on constituent proteins of the centrosome and their roles in the regulation of duplication and of microtubule assembly, the above points indicate that there are many fascinating aspects to centrosome behaviour. These aspects, as well as the mysteries of centrosomes, are well covered in *The Centrosome in Cell Replication and Early Development*. For example, is there an elaborate control machinery, as for DNA, that licenses only one duplication of the centrosome per cell cycle? Sluder and Hinchcliffe state that this is likely in culture cells, but then show that in some zygotes regulation of centriole duplication is independent of DNA replication.

In a separate chapter by Kevin O'Connell ask what exactly the metazoan centrosome does. One hint comes from the obvious fact that the centrosome sits as a single focal point in the cell, naturally determining polarity and asymmetry. Is this of significance to the development of the metazoan organism? Finally, here is something that has the air about it of an imperative. For example, there is a requirement for centrosome-based spindle rotation so that the cleavage plane can align with developmental determinants in the early development of *Caenorhabditis elegans*. Similar processes are possibly at work in the asymmetric divisions that occur in *Drosophila* development, and they might be a general phenomenon in metazoans.

There is no book in print that treats the subject of the centrosome as the only focus of its publication. Thus, the arrival of *The Centrosome in Cell Replication and Early Development* on the bookshelf is most welcome and fills a genuine need. As the diversity of subjects in this book makes evident, there is a wealth of literature on the subject, coming from various directions in multiple research systems. The greatest enlightenment, and the most substantial detailed information on the roles of components of the cell centre, comes from work on spindle pole bodies in yeast. The work so far in yeast is impressive indeed, and is well described in this volume in a chapter by Francis and Davis. As inherently beautiful as the yeast work is, it has shed little light on centrosome function and inheritance in higher eukaryotes, whose centrosomes share some components with spindle pole bodies but are quite different in both structure and mechanism.

The book covers its subject well. The topics have been well thought out, and the contents are quite up-to-date, but there are the inevitable oversights and redundancies inherent in any multi-author work. For example, there is incomplete treatment of the literature on the change in mammalian centrosome composition and function during the progression from interphase to mitosis. NuMA, a major element of the mitotic centrosome, is not discussed, nor are the radical changes in microtubule dynamics from static seeding at the centrosome in interphase to constant inwards flux during mitosis. Further, it would have been useful, given the diversity and complexity of the systems described, if there had been an overview chapter summarizing in one place the major discoveries, enigmas and challenges in centrosome research.

This book will serve as a very useful reference guide to cell biologists and a rather comprehensive introduction to the topic for cell-biology students, who can find much of the complexity and the mysteries, along with the great variety among systems, presented in a single place. There is much here to stimulate the imagination. □

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