Preface

Centrosomes are cytoplasmic organelles composed of two centrioles that recruit and organize a network of proteins called the pericentriolar material or PCM. Centrosomes are the major microtubule organizing center of most animal cells, and as such participate in a variety of cellular processes. In yeasts, the spindle pole body (SPB), which lies embedded in the nuclear membrane, is the functional homologue of the centrosome.

Since the initial studies of Edouard Van Beneden, Theodor Boveri, and Walther Fleming during the nineteenth century, the positioning of the centrosome at the center of the cell has contributed to its recognition as an important organelle in cellular organization. Much of the attention given to this organelle during the twentieth century has been related cell division. Upon mitotic entry, the PCM, which is the site of microtubule nucleation, grows in size causing an increase in the microtubule nucleation capacity of the centrosome. Large mitotic embryos containing large microtubule asters emanating from the centrosome, beautifully illustrated by T. Boveri, clearly sustained the view that this organelle participated in cell division.

The observations that plant cells divide without centrosomes combined with fact that most female meiotic divisions across the animal kingdom occur in the absence of centrosomes showed, however, that in certain cell types these organelles are dispensable for cell division. This is also true in the flat worm planaria, which even lacks genes encoding PCM components, and in mice at certain developmental stages. Moreover, in flies, mutations that affect centrosome assembly do not impair mitotic divisions during development from late embryogenesis till adulthood.

The fact that we found that centrosomes were not required for all cell divisions, suggested that maybe other important yet unidentified functions were associated with this organelle. Indeed, centrosomes are required for a variety of other cellular processes. The presence of centrosomes at opposite poles of the mitotic spindle allow, for instance, the correct segregation of centrioles during mitosis into daughter cells. This might be essential if these cells need to assemble a cilium in the following cell cycle. Centrosomes, through aster microtubule nucleation respond to polarity cues and forces exerted by molecular motors to orient the mitotic spindle, which is essential for tissue morphogenesis in a diversity of developmental contexts. Centrosome positioning is also thought to contribute in certain cell types for polarity establishment or maintenance, cell migration, and unexpectedly to generate an efficient immune response.

The last 15 years have remarkably changed our view of the centrosome. The loss-of-function screens first performed in *Caenorhabditis elegans* identified the molecular components responsible for duplicating centrioles and for PCM assembly. Proteomics approaches were also essential to build a part list of the molecules that contribute to centrosome biogenesis. These initial studies were further

complemented by other studies performed in other model organisms, which allowed us to obtain a bigger picture of the molecules and pathways involved in centrosome assembly. But, more important than providing with a detailed list of centrosome molecules, all these studies allowed us to be able to manipulate the centrosome assembly machinery to start to unravel how defects in centrosome assembly can lead to loss of cell and organism homeostasis, leading to pathological conditions.

The presence of more than two centrosomes in a cell, centrosome amplification has since the dispermic experiments performed by T. Boveri, been correlated with cancer. Indeed, more than 80% of human solid tumors contain a percentage of cells with extra centrosomes. More recently, centrosome numerical and structural abnormalities have also been described in growth-related disorders such as microcephaly, Seckel syndrome, and primordial dwarfism. The etiology underlying these centrosome alterations and human diseases are still under investigation, but several factors such as defects in mitosis, spindle positioning, ciliogenesis, and cell migration, to name a few seem to be implicated.

The centrosome field has also profited from important technological improvement notably in microscopy. The recent use of Cryo-EM tomography or high resolution techniques such as structural illumination, allowed us to go deeper into the structure of centrioles and PCM.

In these times of translational driven research and applications at the expense of basic research, the centrosome field is a good example of how knowledge accumulated in the past 50 years using basic cell and molecular biology has contributed enormously to our current understanding of cellular alterations implicated in human health. In this method series, we brought together both different model systems and approaches with the aim of providing researchers interested in centrosomes or SPBs with methodologies that can be applied to their questions. These include different types of electron microscopy related techniques (**D. Kong & J. Loncarek, pp. 1–18; D.K. Clare et al., pp. 61–82; P. Guichard & P. Gonczy, pp. 191–210; D. Serwas & A. Dammermann, pp. 341–368**), structured illumination microscopy (**V. Mennella et al., pp. 129–152**), methods for centrosome purification (**Gogendeau et al., pp. 171–190**), methods for in vitro analysis of PCM assembly (**J. Woodruff & A. Hyman, pp. 369–382**), methods for yeast two hybrid screens (**B. Galletta & N. Rusan, pp. 251–278**), and methods for performing genome-wide screens in S2 cells (**J. Dobbelaere, pp. 279–300**). Furthermore, methods for genome engineering in human cells (**T. Moyer & A. J. Holland, pp. 19–36),** methods for centrosome analysis in organotypic cultures (**T. Arnandis & S.A. Godinho, pp. 37–50**), in human cancers (**S. Duensing, pp. 51–60**), in chicken DT40 cells (**P.L. Chavali & F. Gergely, pp. 83–102),** in multiciliated cells (**S. Zhang & B.J. Mitchell, pp. 103–128**), in *Drosophila* embryos (**P. Conduit et al., pp. 229–250**), in Ascidian embryos (**A. McDougall et al., pp. 317–340**), in the *Drosophila* and mouse neuroepithelium (**M. Rujano et al., pp. 211–228**) and in *Drosophila* neuroblasts (**J. Pampalona et al., pp. 301–316).** Finally,

a chapter dedicated to SPB biogenesis in fission yeast completes this volume (**I.B. Bouhlel et al., pp. 383–392**).

It is our hope that by bringing together methods for studying centrosomes using a wide range of model systems and techniques, this volume might spark researchers to explore other model systems with unique potential, but also to bring researchers together who work on different models to explore areas of commonality.

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