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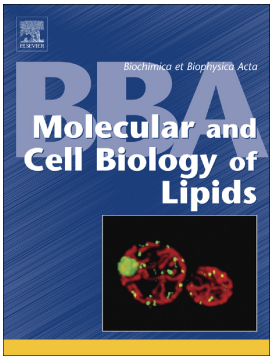

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REVIEW

Do lipids shape the eukaryotic cell cycle?

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Abstract

Successful passage through the cell cycle presents a number of structural challenges to the cell. Inceptive studies carried out in the last five years have produced clear evidence of modulations in the lipid profile (lipidome) of eukaryotes as a function of the cell cycle. This mounting body of evidence indicates that lipids play key roles in the structural transformations seen across this most fundamental of biological processes. The accumulation of this evidence coincides with a revolution in our understanding of how lipid composition regulates a plethora of biological processes ranging from protein activity through to cellular signalling and membrane compartmentalisation. In this review, we discuss evidence from biological, chemical and physical studies of the lipid fraction across the cell cycle that demonstrate that lipids are well-developed cellular components at the heart of the biological machinery responsible for managing progress through the cell cycle. Furthermore, we discuss the mechanisms by which this careful control is exercised.

Key words: lipid abundance; lipid metabolism; lyotropic phase behaviour; membranes; cell cycle; cell structure

Introduction

An intensive period of research into the cell cycle in the 1980s secured our understanding of the expression, activity and degradation of cyclins and cyclin-dependent kinases (CDKs), the control mechanisms that govern the synthesis of DNA and the existence of conditional checkpoints that ensure that cells not capable of completing the cell cycle undergo programmed cell death [1-3]. Recent research has, however, hinted that cell metabolism may also play a societal role in the initiation and progress of the cell cycle [4]. Such divergent thinking, away from the purist view of CDKs as the sole drivers of the cell cycle, raises the question of the scope of the involvement of lipids and other such molecules, in this process. This evidence therefore further undermines the long-standing assumption that lipids act as mere passengers, in which the accumulation and degradation of phospholipids is simply a downstream effect of progress of the cell cycle.

Moreover, lipids have a well-established role in both cell structure and signalling. Their structural role is irreplaceable as they comprise the biological membranes that are the basis for all living organisms yet discovered to control their internal environment. The biosynthesis of many lipids has been worked out in detail, for example the Kennedy pathway that details the steps by which the most abundant lipid, PC, is made [5]. Lipid signals form a