Quick guide

The nucleolus

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What is it? 'What are they?' would be the better question. A nucleolus is never solitary, so its name usually appears in the plural form. Nucleoli are organelles found in the nucleus of every eukaryotic cell.

Are they easy to spot, then? They're visible under the light microscope as dense, ovoid structures, which keen-eyed microscopists first noticed three centuries ago. That vowel-packed name — the Latin diminutive for nucleus — dates from the mid-19th century.

Are they always about? Not necessarily. They come and go, disappearing in mitosis from late prophase until telophase. During this period, some nucleolar antigens, including RNA polymerase I and topoisomerase I, remain associated with tandemly repeated clusters of ribosomal RNA genes on the condensed chromatin — these chromosomal regions are presumptuously known as nucleolar organising regions (NORs). But other nucleolar components are dispersed throughout the mitotic cytoplasm.

So have the nucleoli had it when cells divide? Definitely not! Nucleoli re-form at the NORs when rRNA expression recommences at telophase. But nobody knows how nucleolar proteins know where to go; no common signal sequence that targets them to nucleoli has been identified.

What do they do? In the mid-1960s these organelles were shown to be the site of rRNA transcription, rRNA processing and ribosome assembly. But more recent research shows that nucleoli also play a role in the biogenesis of several non-ribosomal RNAs and in the regulation of some cell cycle antigens.

So are all nucleoli alike? Far from it. The typical nucleus boasts 2–5 nucleoli, ranging in size from 0.5 to 5 μm in diameter. But many tumour cells have more and bigger NORs. And the more NORs, the worse the prognosis.

So nucleoli could have a role in cancer. Anything else? Yes. Nucleoli may play a key role in the aging process. Some models for aging suggest that the rDNA in nucleoli is the Achilles heel of the cell — instability of the rDNA tandem repeat sequences may lie at the heart of aging. Furthermore, in yeast the Sir gene-silencing complex may be involved in regulating rDNA stability. Activity of the Sir complex has been linked to lifespan, and its redistribution to nucleoli may correlate with longevity.

Is there lots more to find out? There certainly is. We know little about how nucleoli form or how they coordinate all the transcription, processing and RNA modification reactions required for ribosome assembly. And there are tempting hints that nucleoli may have yet more roles in cells.

Most likely to be mentioned by… Thoru Pederson, Uli Scheer, E.G. Jordan, Peter Shaw or David Tollervey.

Where can I find out more?

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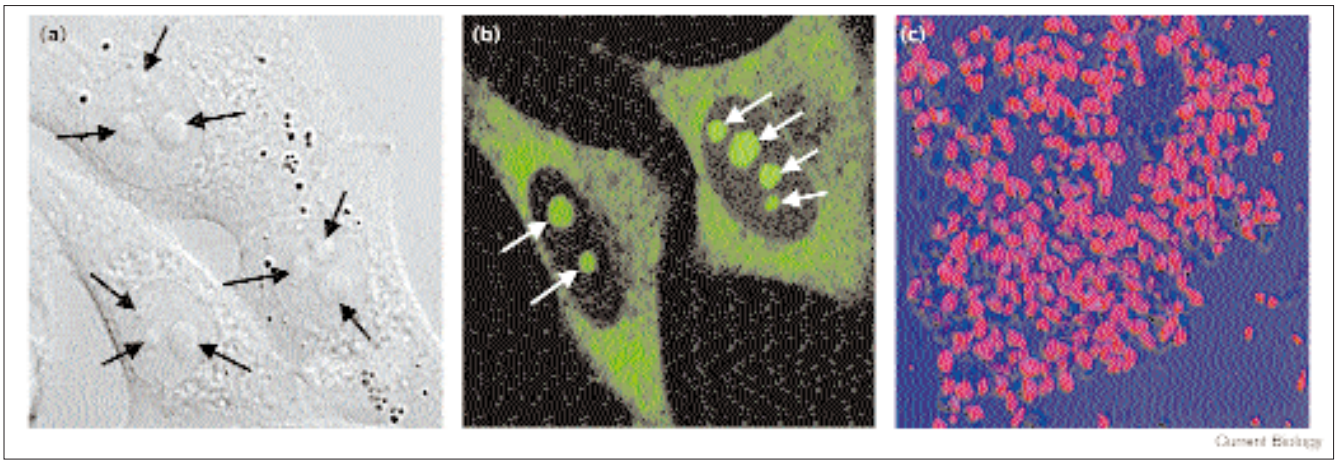

(a) Light micrograph of HeLa cells imaged using DIC optics. Arrows indicate positions of nucleoli. **(b)** HeLa cells transfected with a GFP-tagged ribosomal protein. The tagged protein can be seen in the nucleoli and on the endoplasmic reticulum. Arrows indicate positions of nucleoli. **(c)** Lower magnification image of nucleoli isolated from HeLa cells stained with Pyronin Y.