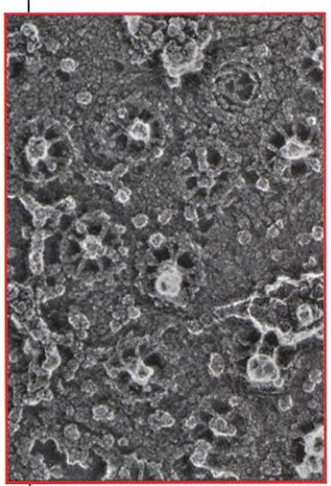
Macromolecular Ballet

For higher organisms, the nucleus is the command center of the cell. There, the chromosomes with their genetic material must be accurately copied and then separated when cells divide. The RNA that directs protein synthesis is also made in the nucleus, as are the ribosomes, the small cytoplasmic particles where that protein synthesis takes place. In order for the cell to run smoothly, all of these complex nuclear activities must be controlled and coordinated. In recent years, scientists have gained new insights into how that's done.

Essential to this control is the ability to regulate the movements of materials into and out of the nucleus. Entry or exit through the nuclear membrane can occur only through large protein complexes termed nuclear pore complexes (NPCs). Structural studies are now revealing the NPC at increasing resolution, and biochemical and genetic analyses have recently identified the complete protein composition of the NPC of yeast. In addition, much of the transport machinery required for RNA and protein movement has been defined. In a Viewpoint on page 1374, Wente reviews this work and points out that researchers are now positioned to examine the interplay between the NPC and transport factors that control movement through the pores.

The nucleus not only has to control nuclear transport and other such dynamic functions, it must also maintain the integrity of chromosomes. That's where the telomere, a repetitive DNA sequence that caps the ends of linear chromosomes, comes into play; telomeres help protect the ends from fusing with one another or being degraded. Since a cell must distinguish double-strand breaks from chromosome ends, cell biologists had thought that end-repair would use telomere-specific proteins. But in a Viewpoint on page 1377, Gasser discusses results showing that protein complexes involved in repairing double-strand breaks also play roles in telomere length maintenance and that telomere structure is affected by DNA damage checkpoint signals. She proposes that components shared by the DNA repair and telomere replication systems may link both events to proper cell cycle progression.



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For the cell division cycle of eukaryotic cells to operate normally, there must be a delay between the duplication of chromosomes in S phase of the cycle and their segregation later on. Without this delay, neither meiosis nor chromosome condensation during mitosis could occur. The prolonged physical connection of replicated DNA molecules is termed "sister chromatid cohesion." Recently, a number of chromosomal proteins required for cohesion and separation have been identified. Nasmyth, Peters, and Uhlmann review this work (p. 1379) and discuss possible mechanisms for connecting sister chromatids and then breaking the connections to allow their separation at the onset of anaphase. The cover image shows the dynamic structures of the chromosomes as a cell goes through mitosis.

The nucleus does not merely store and accurately replicate the genome, but it is also the site where protein synthesis gets under way as genes are transcribed into RNAs and the ribosomes are assembled. Nuclear structures such as the nucleolus, coiled bodies, and interchromatin granules are highly dynamic, forming as a result of the processing of the RNAs into their active forms. Lewis and Tollervey (p. 1385) review how organization of RNA processing gives rise to these nuclear structures.

And finally, the News section of this special issue includes two articles. One describes new results reported by Tjian's group on page 1422 that help clarify how the factors that control gene transcription recognize their targets; the other deals with an explosion of recent work showing that genes don't always have to be controlled in the nucleus, but can be "silenced" later through the cytoplasmic degradation of their messenger RNAs.

–VALDA VINSON, BEVERLY A. PURNELL, GILBERT J. CHIN, AND JEAN MARX

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