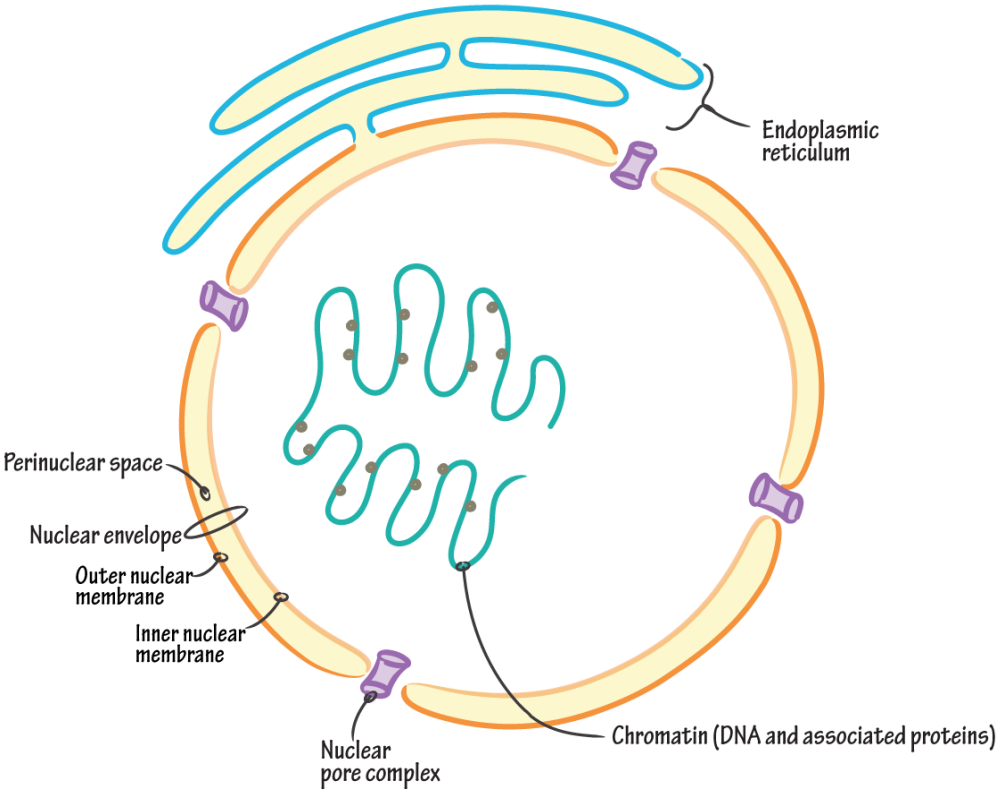
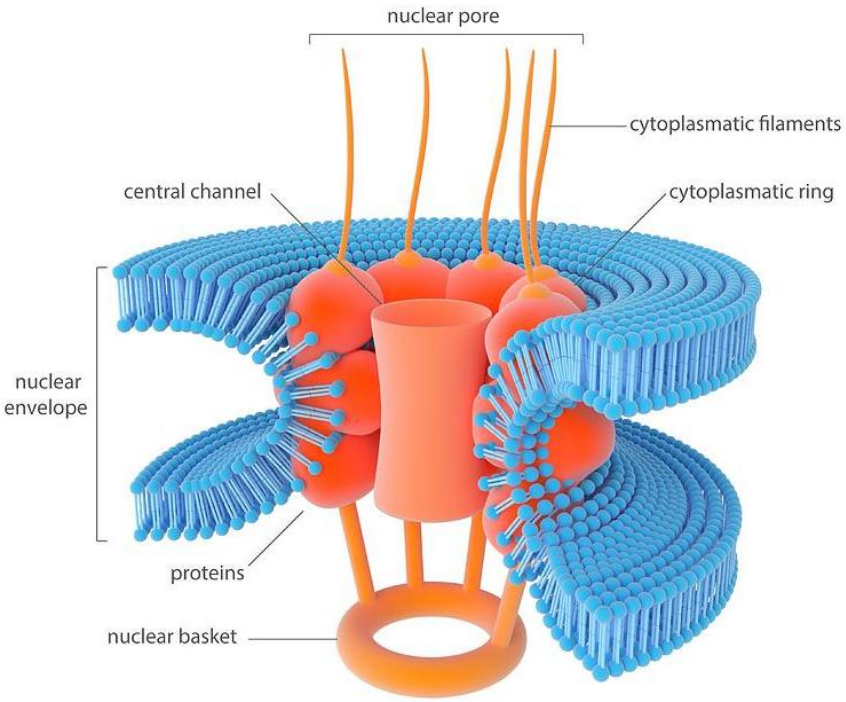
STRUCTURE OF NUCLEAR ENVELOPE

WHAT IS THE NUCLEAR ENVELOPE?

a. The nuclear envelope separates the contents of the nucleus from the cytoplasm and provides the structural framework of the nucleus.
b. The two envelope membranes, acting as barriers that prevent the free passage of molecules between the nucleus and the cytoplasm, maintain the nucleus as a distinct biochemical compartment.
c. By separating the genome from the cytoplasm, the nuclear envelope defines the hallmark of eukaryotic cells, the cell nucleus.
d. The nuclear envelope has a complex structure consisting of two concentric nuclear membranes, called the inner and outer nuclear membranes with an underlying nuclear lamina, and nuclear pore complexes.
e. The envelope inner and outer nuclear membranes, which enclose a lumen, the perinuclear space, which is continuous with the endoplasmic reticulum (ER) lumen.
f. The inner and outer nuclear membranes are connected at the sites of nuclear pore complexes, large, aqueous protein channels that mediate all traffic through the nuclear envelope.
g. Underneath the inner nuclear membrane of multicellular organisms lies the nuclear lamina, a peripheral meshwork of intermediate filament proteins called lamins and their associated proteins.





Nuclear Pore Complex (NPC)

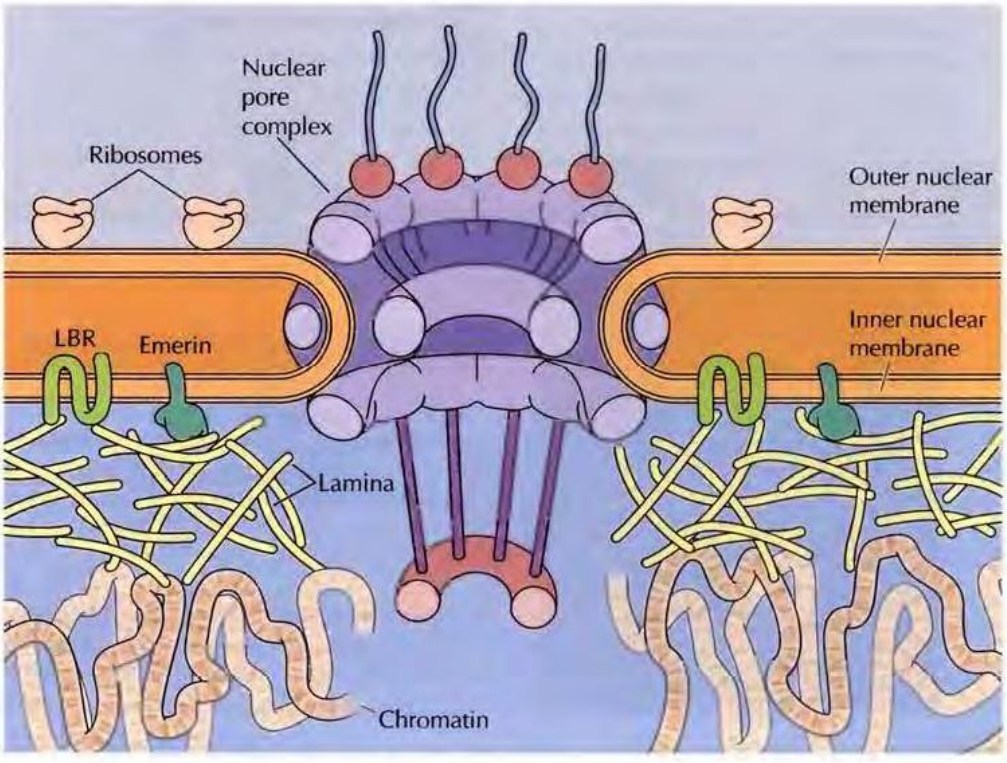
WHAT IS THE FUNCTION OF THE NUCLEAR ENVELOPE?

a. Like other cell membranes, each nuclear membrane is a phospholipid bilayer permeable only to small nonpolar molecules. Other molecules are unable to diffuse through the bilayer. The inner and outer nuclear membranes are joined at nuclear pore complexes-the sole channels through which small polar molecules and macromolecules pass through the nuclear envelope
b. It is a barrier separating nuclear processes such as transcription from cytoplasmic processes such as translation.
c. The selective transport of macromolecules between the two compartments of a eukaryotic cell via nuclear pore complexes (NPCs) makes it possible for gene expression to be regulated, for example at the levels of pre-mRNA splicing and mRNA degradation, not seen in simpler prokaryotic cells.
d. The nuclear envelope is not simply a passive barrier: it also has a critical role in the organization of chromatin, gene expression, nuclear anchorage to the cytoskeleton and cell division.

WHAT IS THE NUCLEAR LAMINA?

a. Underlying the inner nuclear membrane is a dense network of protein filaments called **nuclear lamina,** a fibrous meshwork that provides structural support to the nucleus.
b. The nuclear lamina is composed of 60- to 80-kilodalton (kd) fibrous proteins called **lamins.**
c. Lamins are a class of intermediate filament proteins; the other classes are found in the cytoskeleton.
d. Mammalian cells have three lamin genes, designated A, B, and C, which code for at least seven distinct proteins.
e. This peripheral structure is composed of two types of lamins, which are members of the intermediate filament family, as well as interacting inner nuclear membrane and soluble proteins.

f. The B-type lamins are ubiquitously expressed and in their mature form carry a carboxy-terminal farnesylation which mediates association with the inner nuclear membrane.
g. A/C-type lamins are made only in differentiated cells; they arise from splice variants of a single gene and their farnesyl modification is removed by proteolytic cleavage during maturation.
h. Once assembled, the lamina as well as the nuclear pore complexes anchored in it is very stable throughout interphase. The lamina is thought to have mainly a structural role in stabilizing the shape of the nucleus.



WHAT HAPPENS TO THE NUCLEAR ENVELOPE WHEN THE CELL DIVIDES?

a. Chromosome segregation during cell division in higher eukaryotes is driven by a microtubule spindle formed in the cytoplasm. To allow the interaction of microtubules and chromosomes, the nuclear envelope breaks down in prophase, leading to an ‘open’ mitosis.
b. Nuclear envelope breakdown occurs by stepwise disassembly of nuclear pore complexes, inner nuclear membrane proteins and, finally, lamins, and is thought to be driven mostly by the phosphorylation of these proteins by mitotic kinases.
c. In somatic cells, nuclear envelope breakdown is additionally facilitated by mitotic microtubules, which pull on the nuclear envelope creating invaginations which eventually cause rupturing of the stretched nuclear lamina.
d. Nuclear membranes are absorbed by the ER, where nuclear membrane proteins disperse by diffusion.
e. Interestingly, some nuclear envelope proteins found to have additional functions in mitosis; for example, a subset of nucleoporins becomes part of the kinetochore complex that mediates microtubule – chromosome attachment and these nucleoporins are required for faithful chromosome segregation.