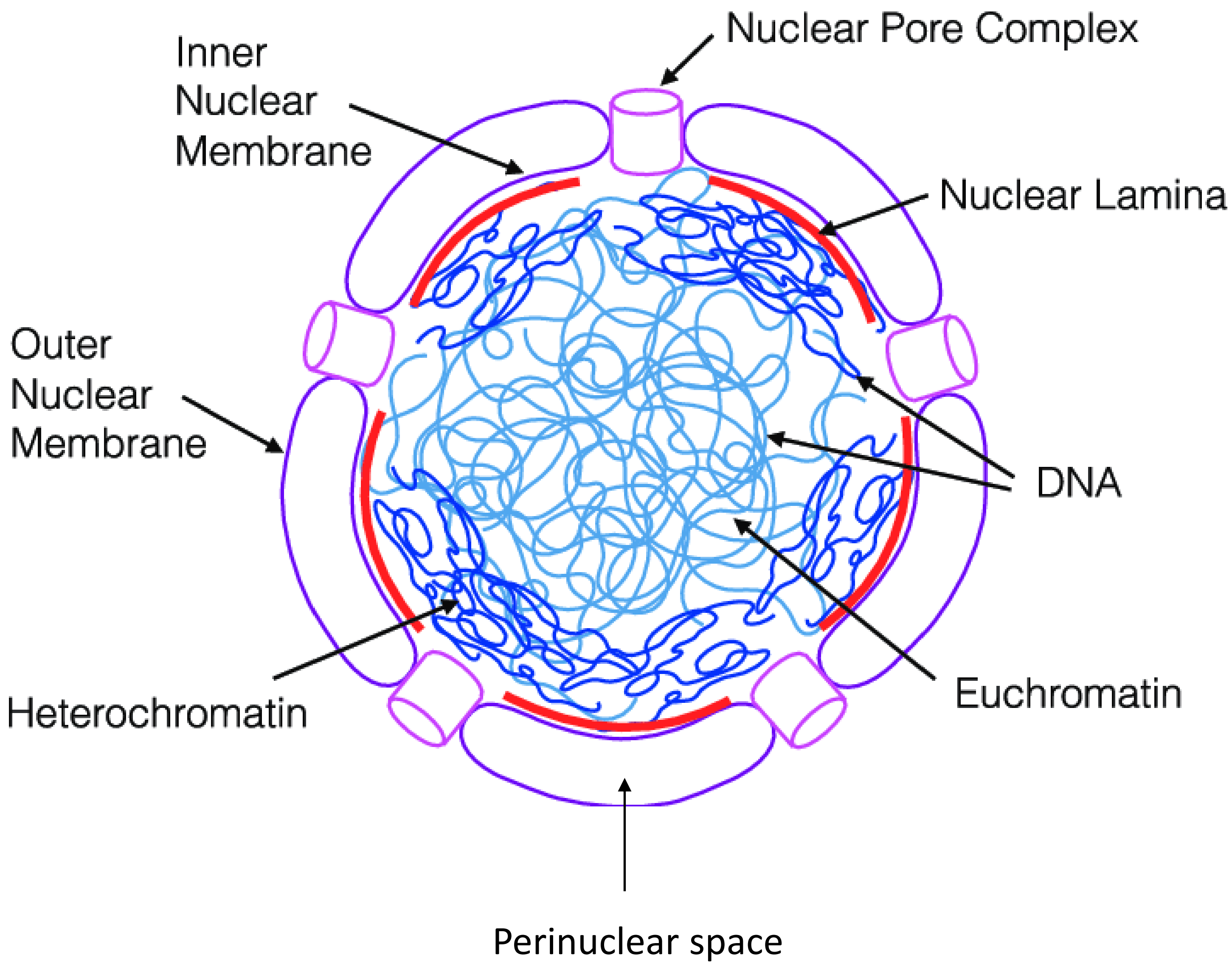
# Cell biology

Cell biology is the study of cell structure and function, and it revolves around the concept that the **cell is the fundamental unit of life**. Focusing on the cell permits a detailed understanding of the tissues and organisms that cells compose. Some organisms have only one cell, while others are organized into cooperative groups with huge numbers of cells. On the whole, cell biology focuses on the structure and function of a cell, from the most general properties shared by all cells, to the unique, highly intricate functions particular to specialized cells.

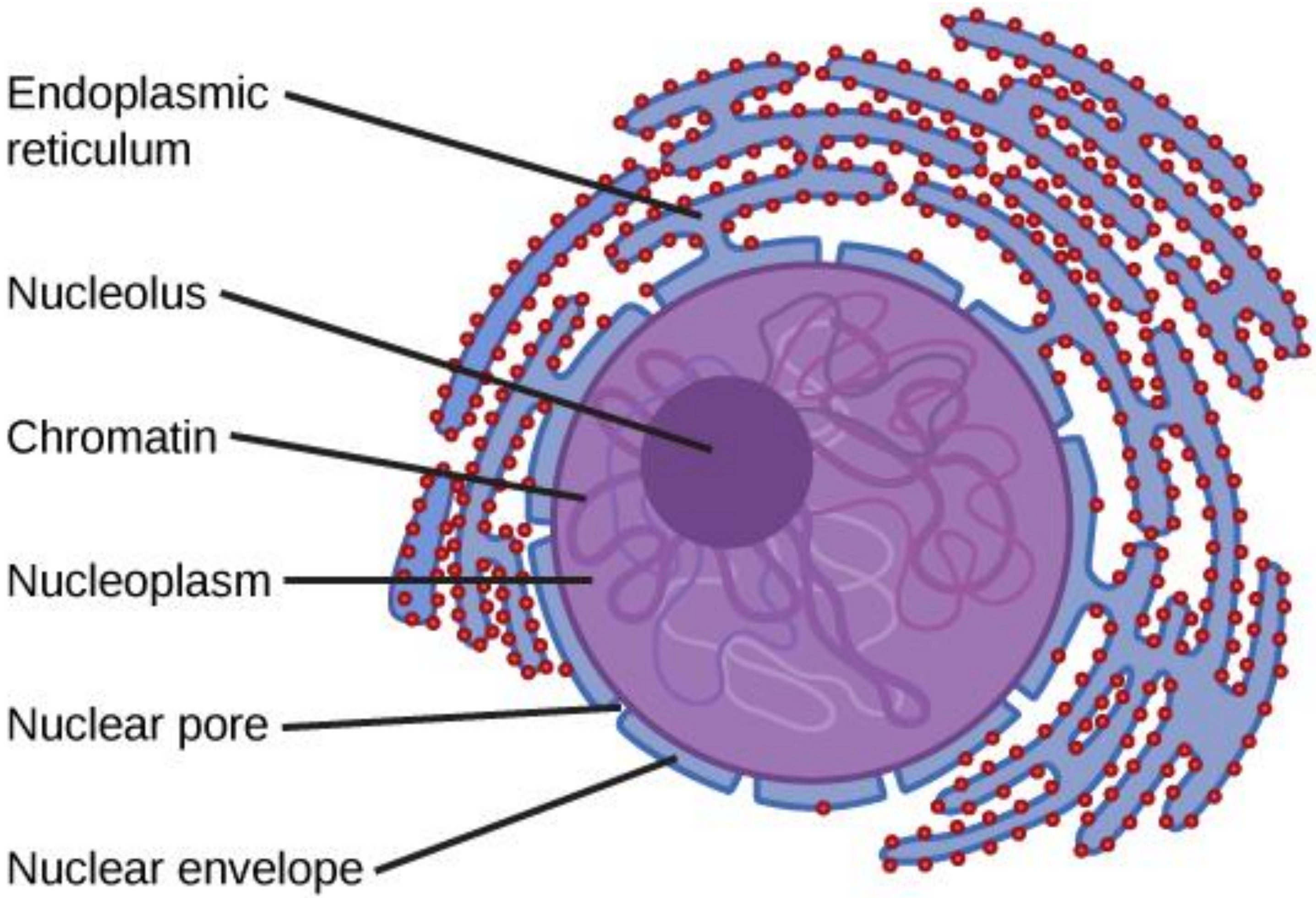
# Nucleus


Nuclear Pore Complex
Inner
Nuclear
Membrane
Nuclear Lamina
Outer
Nuclear
Membrane
DNA
Heterochromatin
Euchromatin
Perinuclear space

# What is a nucleus

- The nucleus is a membrane-bound organelle that contains genetic material (DNA) of eukaryotic organisms. As such, it serves to maintain the integrity of the cell by facilitating transcription and replication processes.
- It's the largest organelle inside the cell taking up about a tenth of the entire cell volume. This makes it one of the easiest organelles to identify under the microscope.

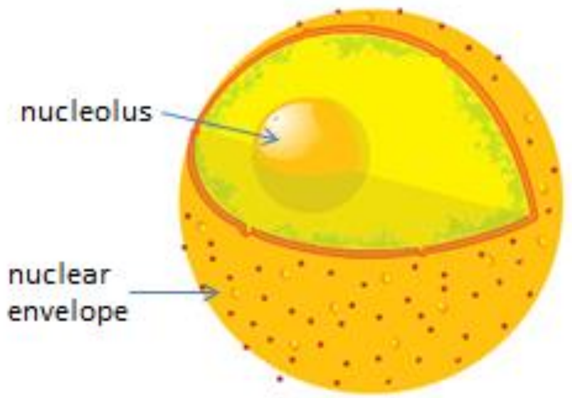
# Diagram representing parts of a nucleus



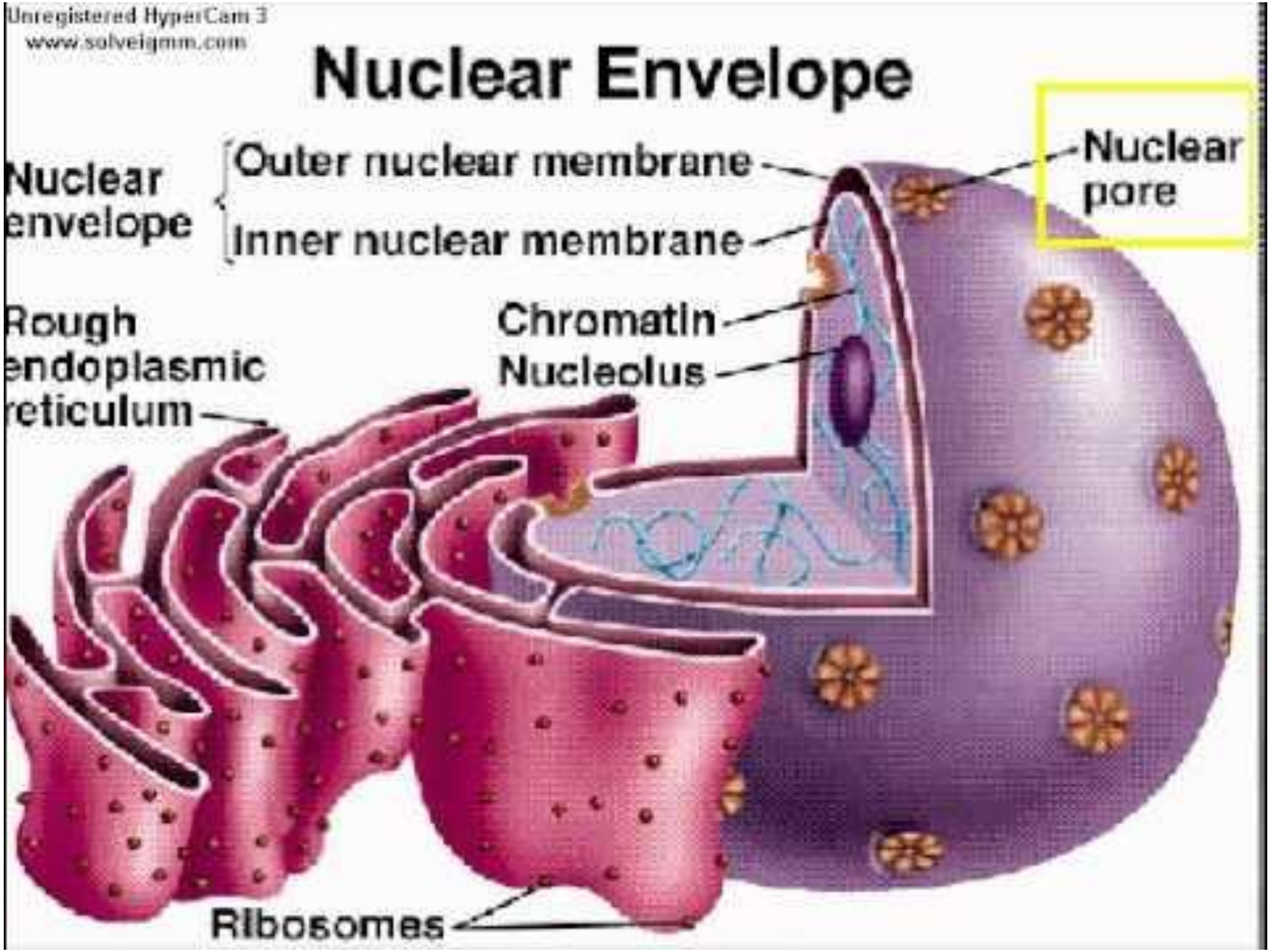
# Structure and organization of the nucleus

- Nucleus stores genetic material of the cell.
- Inside nucleus chromatin, RNA and nuclear protein move freely in aqueous solution.
- The most obvious aspect of the internal organization of the nucleus is the nucleolus
- nucleolus the site at which the rRNA genes are transcribed and ribosomal subunits are assembled
- Additional elements of internal nuclear structure are
  - the organization of chromosomes
  - the potential localization of functions such as DNA replication and pre-mRNA processing to distinct nuclear domains.

# Nuclear envelope




- The nuclear envelope (NE) is a highly regulated double layer membrane barrier that separates the nucleus from the cytoplasm in eukaryotic cells.
- The nuclear envelope protects the cell's genetic material from the chemical reactions that take place outside the nucleus.
- It contains a large number of different proteins that have been implicated in chromatin organization and gene regulation.
- Early electron microscopy (EM) images revealed that the inner (INM) and outer nuclear membranes (ONM) are continuous with the endoplasmic reticulum (ER) (Watson 1955)
- In the double layer of nuclear envelope, each layer is about 100 to 300 A° apart, leaving a discontinuous space called perinuclear space


Unregistered HyperCam 3
www.solveigmm.com
Nuclear Envelope
Nuclear envelope
Outer nuclear membrane
Inner nuclear membrane
Nuclear pore
Rough endoplasmic reticulum
Chromatin
Nucleolus
Ribosomes

# Nuclear pore

- The envelope is interrupted at intervals by numerous pores, known as nuclear pores.
- The two membrane around this pore are continuous and form a rounded circular area.
- The number and diameter (50-100nm) of the pores varies from cell to cell.

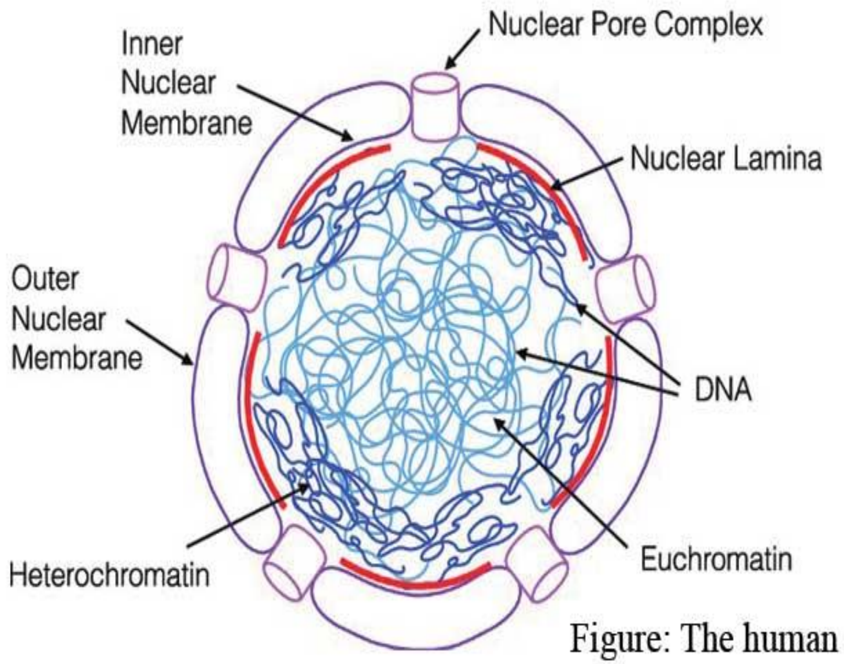
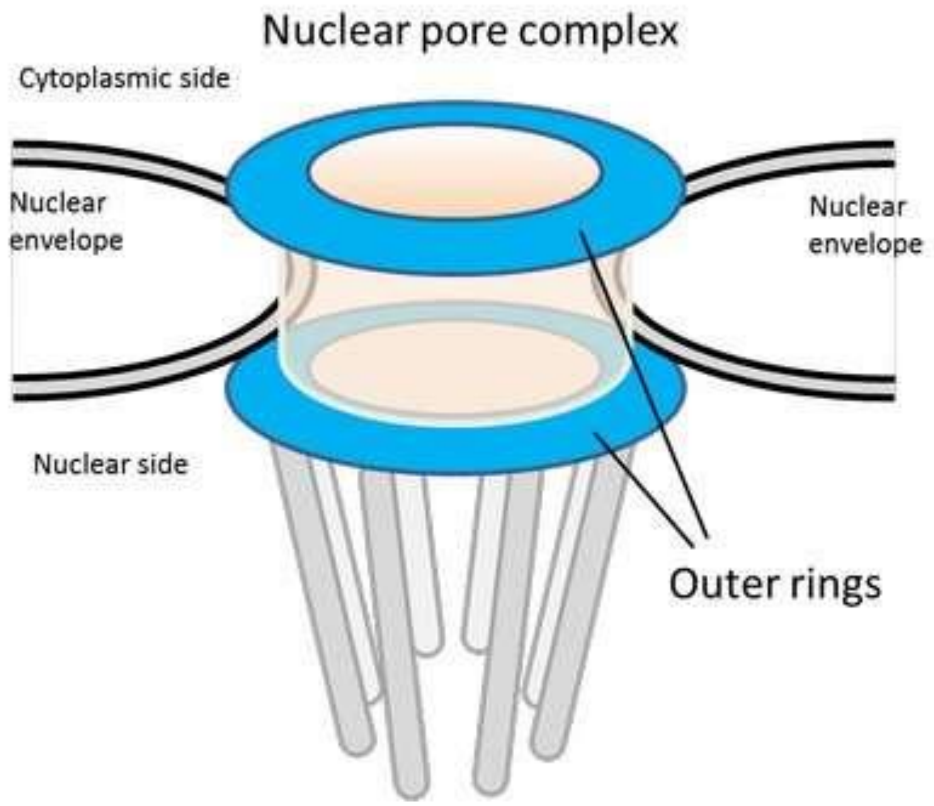


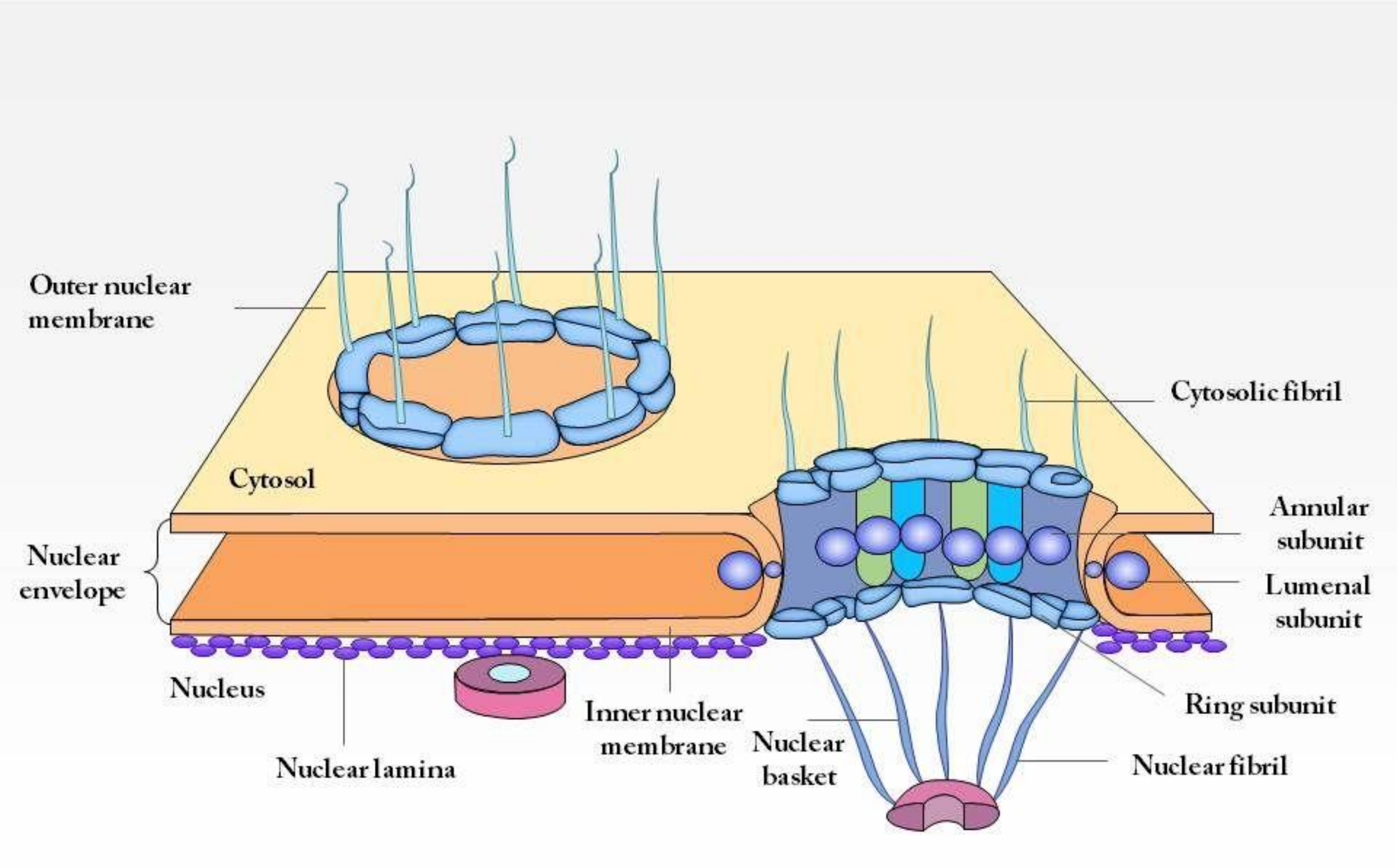
Figure: The human cell nucleus.

# Nuclear pore complex

- **Nuclear pore complexes** (NPCs) are the gateways connecting the nucleoplasm and cytoplasm.
- This structures are composed of over 30 different proteins and 60–125 MDa of mass depending on type of species.
- NPCs are bilateral pathways that selectively control the passage of macromolecules into and out of the **nucleus**.



# Nuclear Pore Complexes Scanning Electron Micrograph

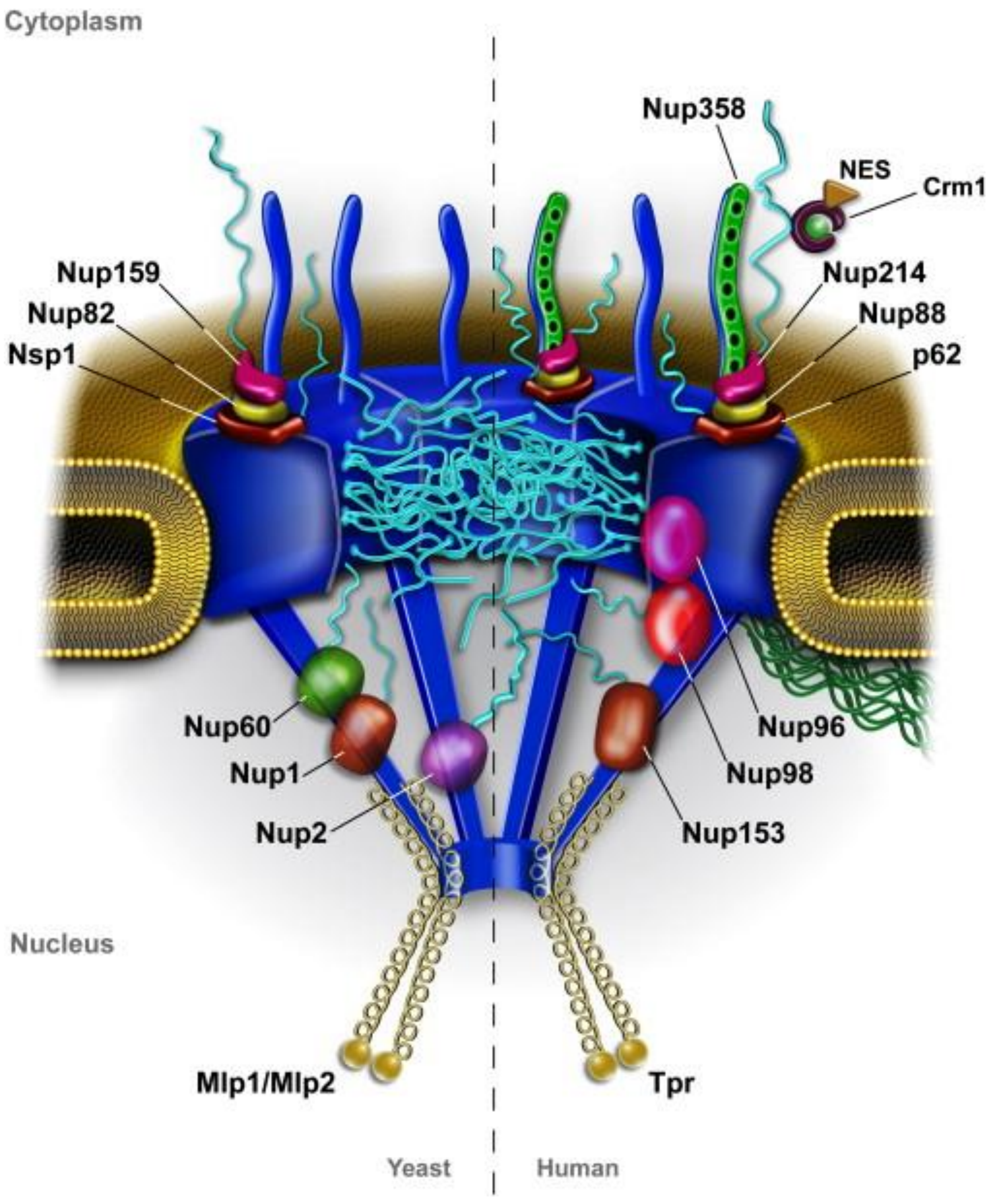


# NPC electron microscopic structure

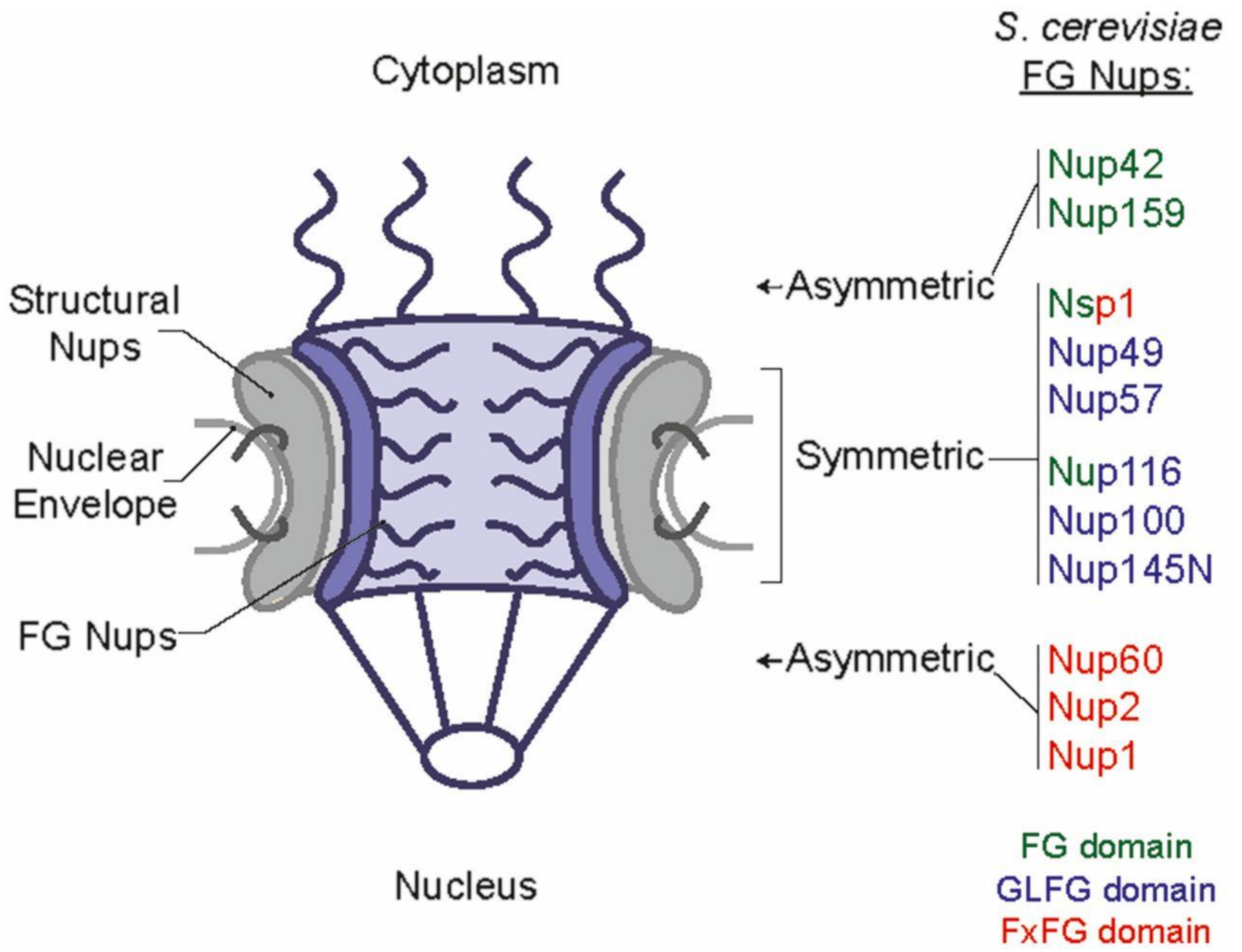
- the NPC is one of the largest and most complex protein structures of eukaryotic cells. The NPC structure as revealed by electron microscopy has been described as eight spokes symmetrically encircling a central channel. This assembly of spokes has a diameter of 120 nm and a height of 70 nm, and constitutes the central NPC framework or scaffold. The spoke substructure is sandwiched between a cytoplasmic and a nuclear ring. Attached to these peripheral rings are eight cytoplasmic filaments and a basket-like structure on the nuclear ring

# Nucleoporins (Nups)

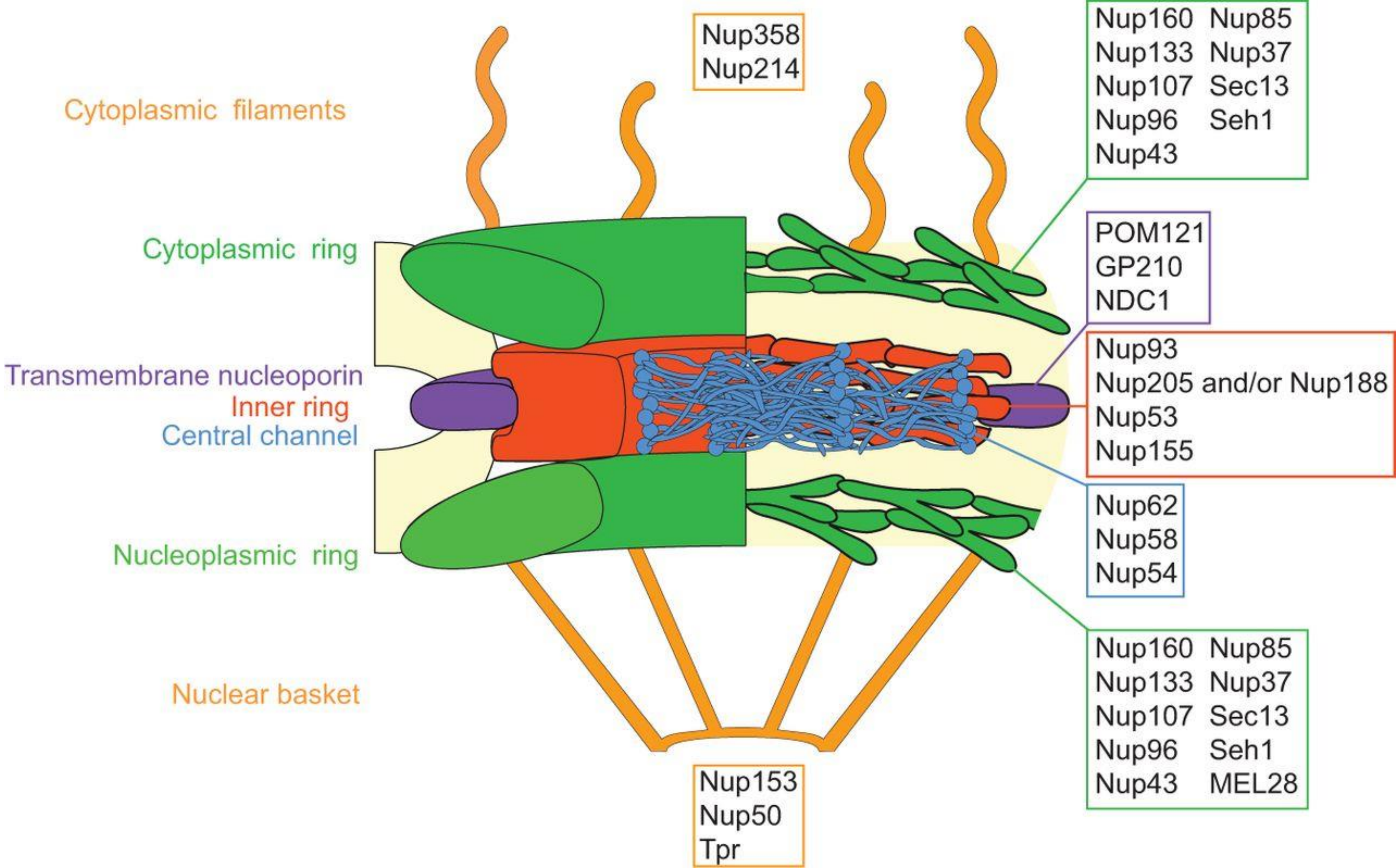
- **Nucleoporins (Nups)** are a family of proteins which are the constituent building blocks of the nuclear pore complex (NPC)
- **Nucleoporins**, a family of around 30 proteins, are the main components of the nuclear pore complex in eukaryotic cells.
- **Nucleoporins** are able to transport molecules across the nuclear envelope at a very high rate.


Cytoplasm
Nup358
NES
Crm1
Nup159
Nup82
Nsp1
Nup214
Nup88
p62
Nup60
Nup1
Nup2
Nup96
Nup98
Nup153
Nucleus
Mlp1/Mlp2
Tpr
Yeast
Human

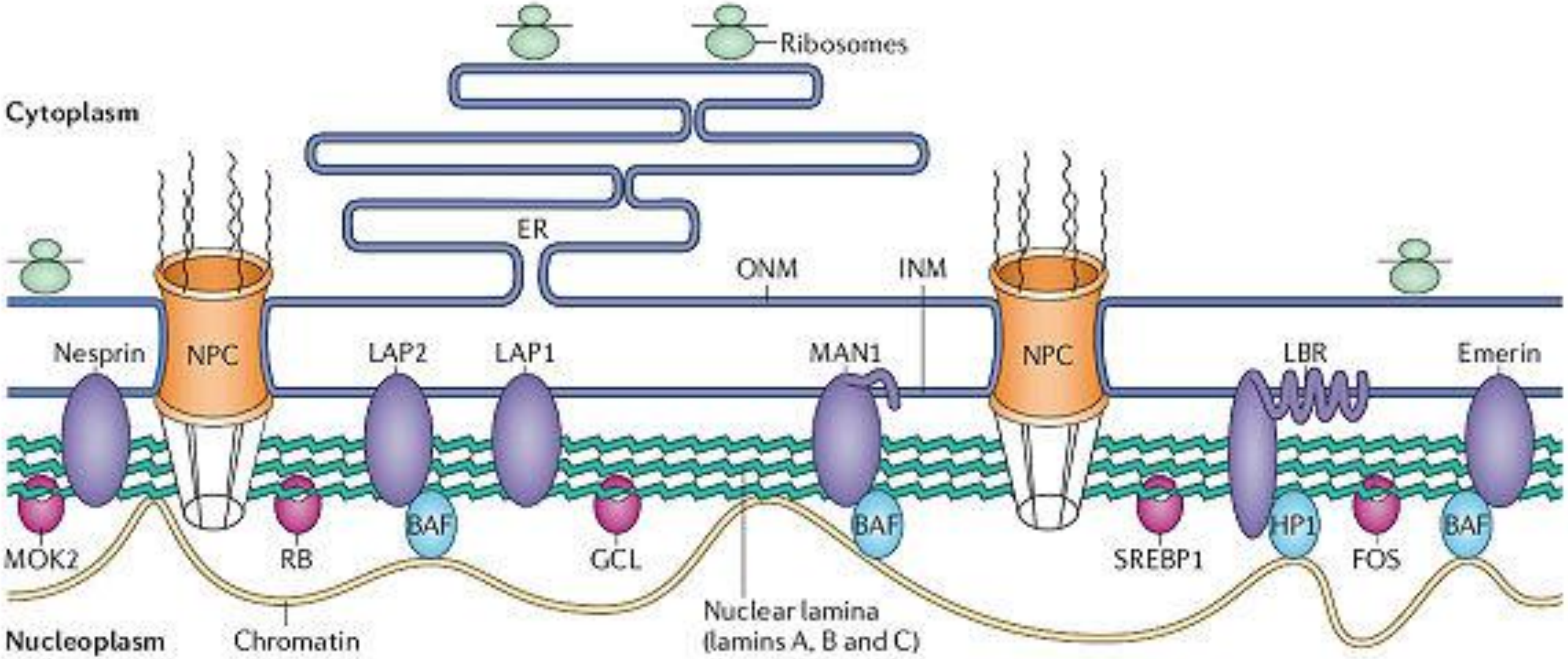
- Nups can be classified according to their sequence motifs, structural folds, mobility, or relative localization within the NPC (Rout *et al.*, 2000; Tran and Wente, 2006; Hoelz *et al.*, 2011; Grossman *et al.*, 2012).
- An example of Nup-classification is (1) membrane Nups, (2) scaffold Nups, and (3) peripheral Nups.
- One characteristic sequence motif/structural folds of Nups is the tandem repeats of phenylalanine-glycine (FG repeats).
- These FG repeats are found in approximately one-third of Nups (also called as FG-Nups), mostly belonging to the peripheral Nups.

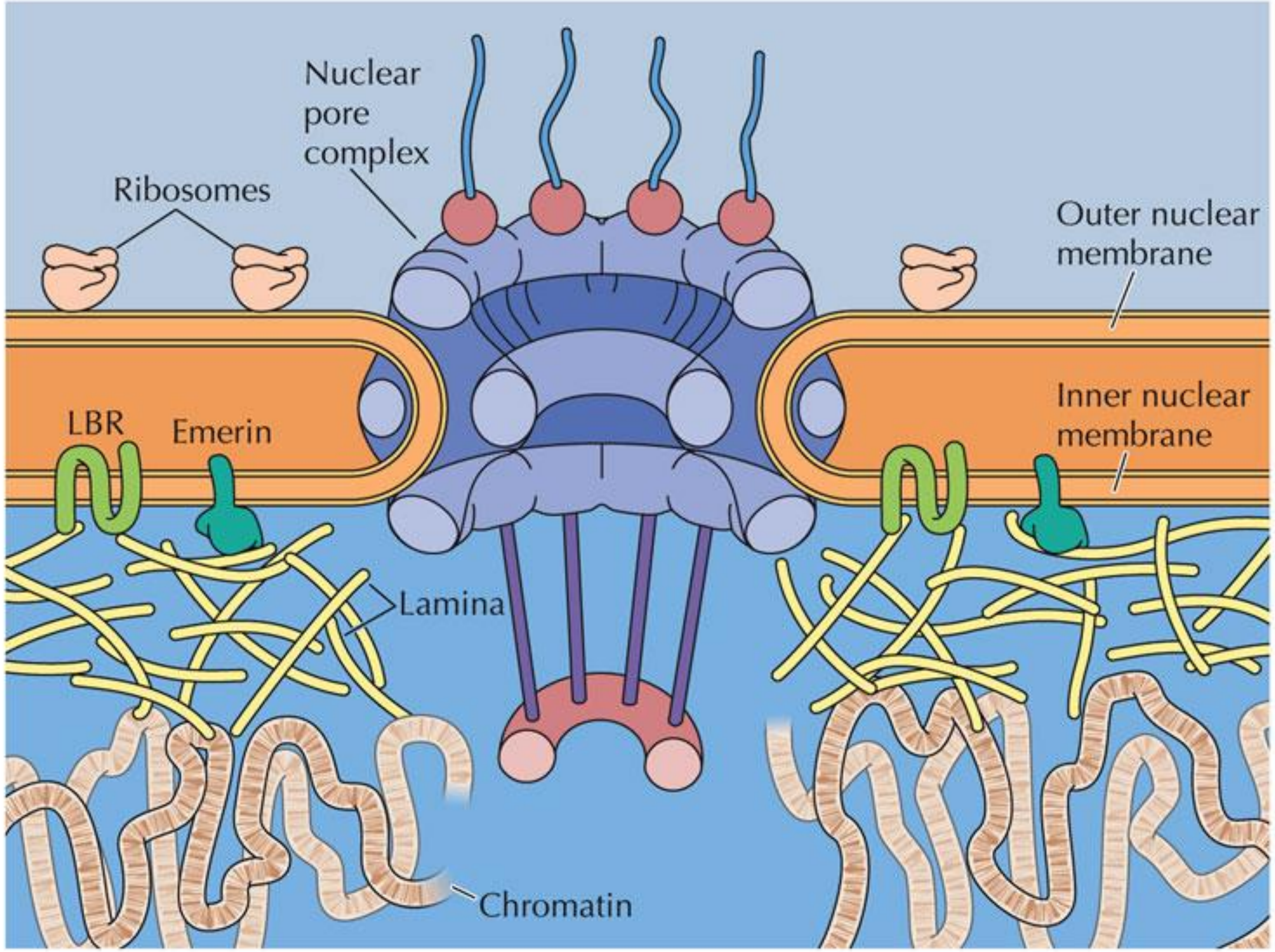


Cytoplasm
S. cerevisiae
FG Nups:
Nup42
Nup159
Asymmetric
Structural
Nups
Nsp1
Nup49
Nup57
Nuclear
Envelope
Symmetric
Nup116
Nup100
Nup145N
FG Nups
Asymmetric
Nup60
Nup2
Nup1
Nucleus
FG domain
GLFG domain
FxFG domain


Nup358
Nup214
Cytoplasmic filaments
Nup160 Nup85
Nup133 Nup37
Nup107 Sec13
Nup96 Seh1
Nup43
Cytoplasmic ring
POM121
GP210
NDC1
Transmembrane nucleoporin
Inner ring
Central channel
Nup93
Nup205 and/or Nup188
Nup53
Nup155
Nup62
Nup58
Nup54
Nucleoplasmic ring
Nuclear basket
Nup160 Nup85
Nup133 Nup37
Nup107 Sec13
Nup96 Seh1
Nup43 MEL28
Nup153
Nup50
Tpr

- FG-Nups located in the central channel of NPC (central FG-Nups) are important for barrier formation, which inhibits the passive diffusion of macromolecules through the NPC.
- Furthermore, FG-Nups can bind to nuclear transport factors, which is important for the active transport process of selected molecules.
- Structural Nups or scaffold Nups are important for the formation of the scaffold of NPC, and they can interact both with FG-Nups and transmembrane Nups.
- Transmembrane nucleoporins anchor the NPC to the nuclear membrane.


Ribosomes
Cytoplasm
ER
ONM
INM
Nesprin
NPC
LAP2
LAP1
MAN1
NPC
LBR
Emerin
BAF
BAF
HP1
BAF
MOK2
RB
GCL
SREBP1
FOS
Nuclear lamina
(lamins A, B and C)
Nucleoplasm
Chromatin




THE CELL, Fourth Edition, Figure 9.5 