

# CELLKÄRNAN

*Kap 8 i 3rd edition,  
kap 9 + fig 16.24, s. 673-675, fig 16.27 i 4th edition*  
*Chromatin:  
S. 150-151, 257-258 3rd edition,  
s166-170, 281-283 4th edition.*

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# INNEHÅLL

- cellkärnan
  - membran, nuclear lamina och porer
  - transport till och från kärnan
  - intern organisation
  - nucleolus och ribosomproduktion
  - cellkärnans struktur vid celledning

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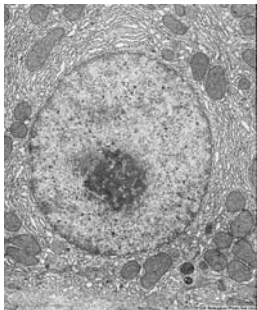
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# CELLKÄRNAN



- skiljer eukaryot från prokaryot
- eu = gott, väl ; karyon= kärna
- kärnan härbärgerar arvsanlagen
- möjlighet till bättre reglering av genexpression: bl.a. alternativ splicing, transkriptionskontroll

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## Cellkärnan

- kärnmembran - dubbelt membranlager
  - kontinuerligt med ER
- nuclear lamina
  - under inre kärnmembranlagret
  - stödjande för kärnan och fästpunkt för kromatin
- kärnporer
  - för selektiv transport av större molekyler
- nucleolus

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## Cellkärnan

(C)

Outer membrane    Inner membrane  
Perinuclear space    Smooth endoplasmic reticulum

Ribosomes    Nuclear pore complex    Nuclear lamina    Nucleolus    Chromatin    Rough endoplasmic reticulum

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## Kärnmembranet

- en barriär
- bara små **icke-laddade** molekyler kan diffundera genom ett fosfolipid-dubbellaager
- yttre membran har ribosomer
- inre membran har kärnspecifika proteiner

Small uncharged molecules:  $O_2$ ,  $CO_2$ ,  $H_2O$ ,  $N_2$ , Ethanol, Glucose

Large polar molecules and ions:  $H^+$ ,  $Na^+$ ,  $Ca^{2+}$ , Amino acids (e.g., alanine),  $Cl^-$

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## Nuclear lamina

- nätverk under kärnmembranet stödjer kärnan
- glest nätverk in i kärnan
- bildar fästpunkter för kromatin
- laminer – intermediärfilament typ V

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## Kärnpör-komplex

- 120 nm i diameter (=stor!)
- består av 50-100 olika proteiner i ryggradsdjur
- de enda ställen små polära molekyler, joner och makromolekyler kan passera in till /ut ur kärnan (<9 nm)
- kontrollerar passage av molekyler

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## Molekylär trafik genom kärnporer

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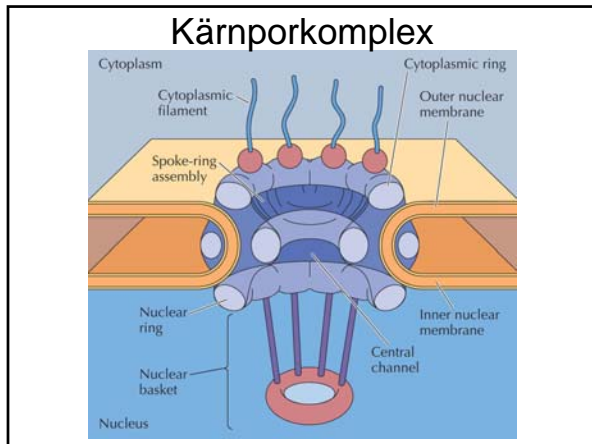
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### Selektiv transport av proteiner

- proteiner som behövs i kärnan importeras selektivt
- nuclear localization signals

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### Selektiv transport av proteiner

- Ran – litet GTP-bindande protein
- karyopheriner – importiner och exportiner
- importiner känner igen nuclear localization signals
- exportiner känner igen nuclear export signals
- importen sker i 5 steg

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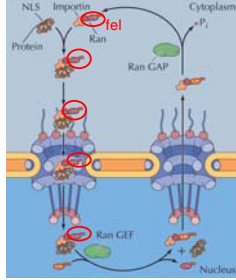
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## Proteinimport till kärnan

Nya rön, **RanGDP** släpper importin i cytoplasman och åker in via separat väg



(gamla boken)

- Importin binder "protein"
- Importin/"protein" går in i nukleus
- Importin/"protein"  **binder Ran-GTP i nukleus**
  - "protein" släpper
- Importin/RanGTP exporteras
- GTP defosforyleras av GAP
  - **Importin släpper från RanGDP** och är tillgängligt på nytt för nästa "protein"
- **RanGDP importerats separat** (via NTF2, eget importprotein)
- GDP byts mot GTP i RAN via GEF

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## Ran GTP/GDP cykel driver import

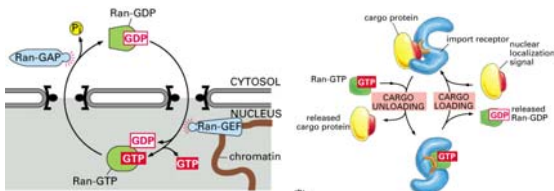


Figure 12-15. Molecular Biology of the Cell, 4th Edition.

Figure 12-17 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

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## aktuell modell

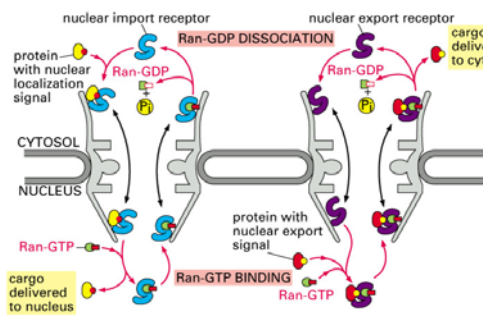


Figure 12-16. Molecular Biology of the Cell, 4th Edition.

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### Reglering av proteinimport

- när proteiner ska importeras till kärnan regleras
- inhibitoriska proteiner binder till och maskerar nuclear localization signal
- fosforylering nära nuclear localization signal hindrar import

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### Transport av RNA

- transkription av DNA till RNA sker i kärnan
- RNA exporteras ut ur kärnan för att translation till protein ska kunna ske
- RNP-komplex (=ribonukleotid-protein-komplex)
  - mRNA i komplex med c:a 20 olika proteiner
  - rRNA binder ribosomala proteiner i kärnan, exporteras som pre-ribosomala partiklar
  - tRNA – exportproteiner ej kända
  - snRNA åker ut ur kärnan, hämtar proteiner

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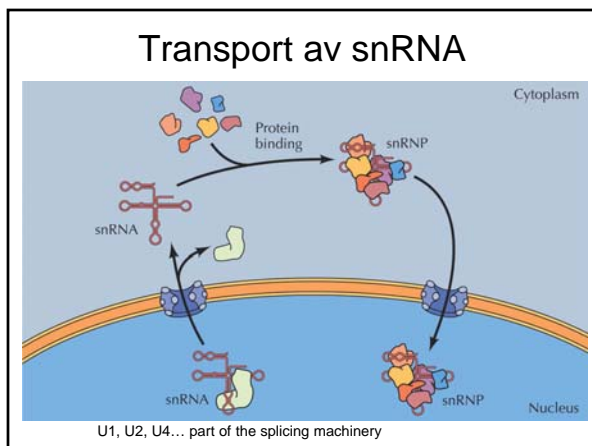
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## INTERN ORGANISATION AV KÄRNAN

- kärnan har intern organisation
- genetiska materialet organiserat
- specifika funktioner hos kärnan lokaliserade till specifika områden
- kromatin basen för kärnans inre organisation

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## Kromatin

(B)

Nuclear envelope

Interchromosomal domain

Chromosome territories

1 µm

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## I kromatin ligger DNA lindat runt nukleosomer (histon-komplex)

H4 tail

H2B tail

H3 tail

H2A tail

H4 tail

H3 tail

(A)

(B)

Figure 4-32. Molecular Biology of the Cell, 4th Edition.

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## Kromatin

**INTERFAS-cell**  
**eukromatin**  
 – tillgängligt för transkription i varierande grad

**heterokromatin**  
 – mycket kondenserat  
 – inaktivt  
 – konstitutivt heterokromatin  
 – fakultativt heterokromatin

S. 150-151, 257-258 3rd edition, s166-170, 281-283 4th edition.

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**heterokromatin**   **Eukromatin**

- **Eukromatin**
  - 30nm fibrer, loopar och hyperacetylerade regioner
  - Kan dekondenseras och transkriberas
- **Heterokromatin**
  - Tätpackat, associerat med ytterligare "packnings-proteiner"
  - resistent mot transkription och dekondensering (sker dock vid replikation)
  - Heterokromatin-position ärvs oftast vid celledelning

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Utryckta regioner är mer dekondenserade,  
 "tysta" regioner av eukromatin är hårt packade (heterokromatin mkt hårt packade)

**Påverkas av:**

- Kromatin-remodellerande komplex
- Histon-modifierande komplex
  - Acetylering (reversibel)
  - Metylering (irreversibel)
  - Fosforylering (reversibel)
  - Ubiquitinerig (reversibel)
- DNA bindande proteiner

Figure 4-44. Molecular Biology of the Cell, 4th Edition.

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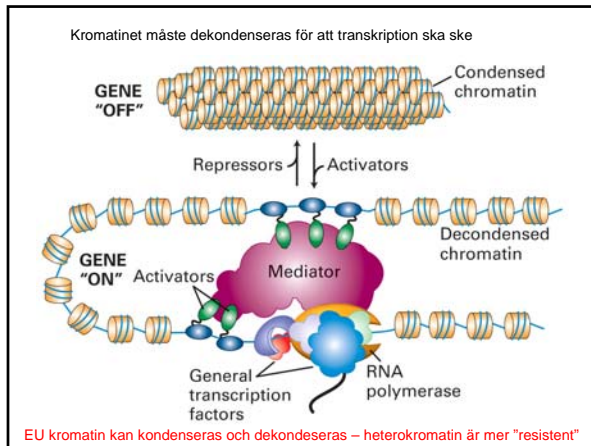
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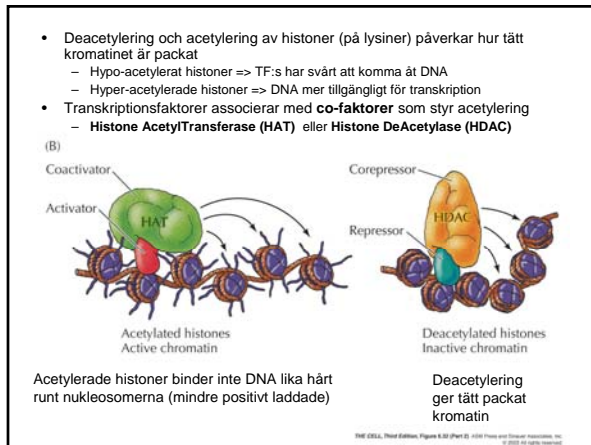
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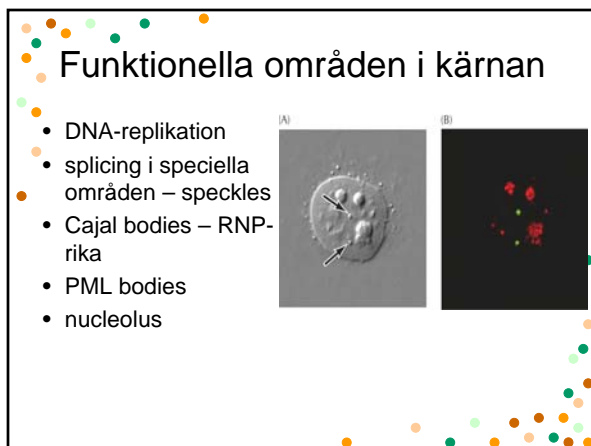
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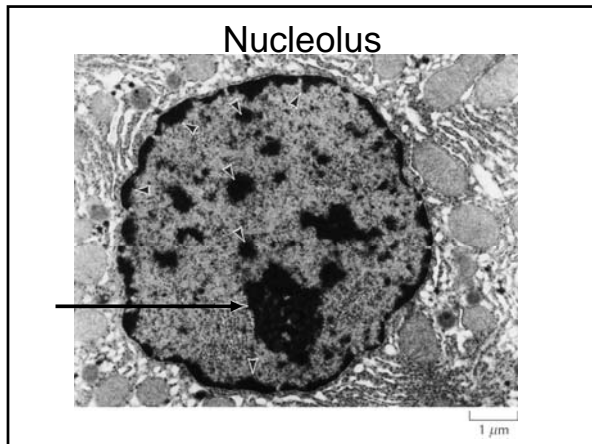
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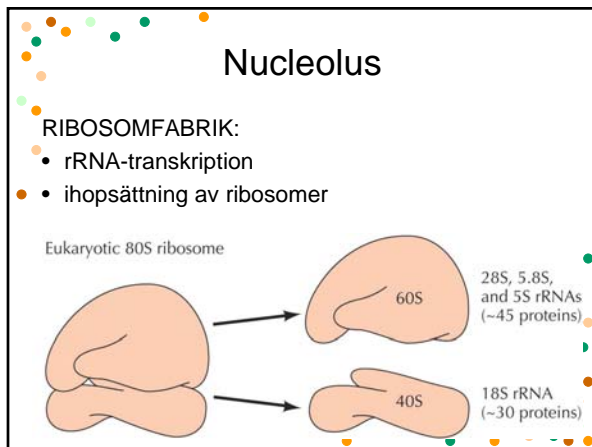
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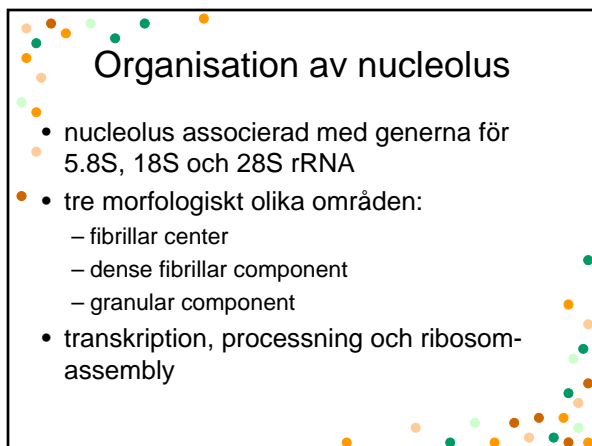
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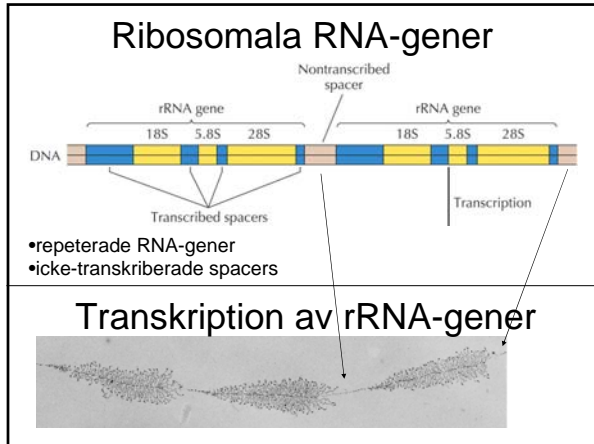
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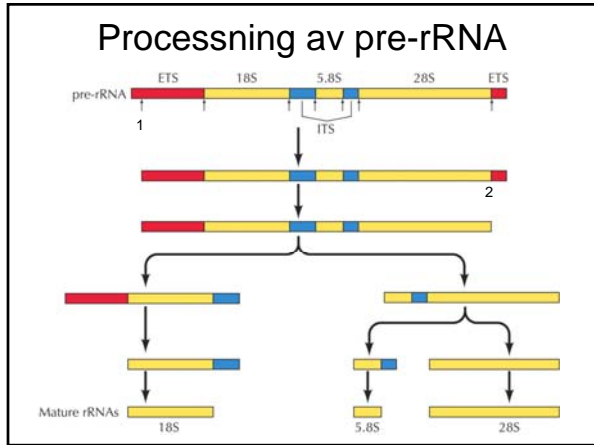
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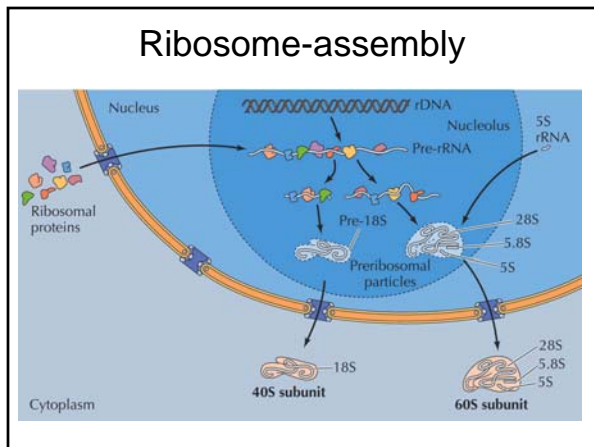
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## KÄRNANS STRUKTUR VID CELLDDELNING

- öppen eller stängd mitos
- kärnmembran
- kromosomkondensation
- reformering av kärnor

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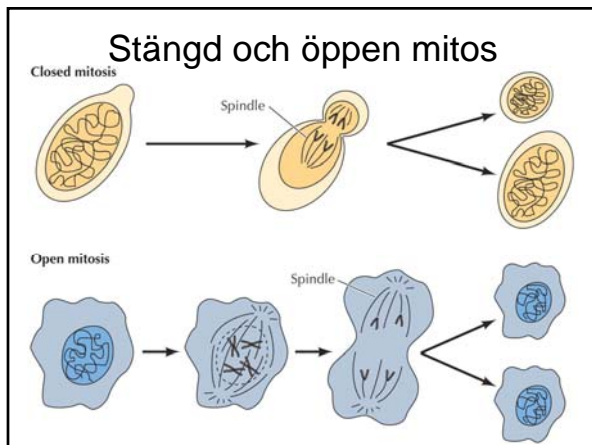
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## Kärnhöljet vid celldelning

- kärnporkomplexen dissocierar
- nuclear lamina fosforyleras
- dissocierar till fria dimerer av lamin
- kärnmembranet fragmenteras, bildar vesiklar

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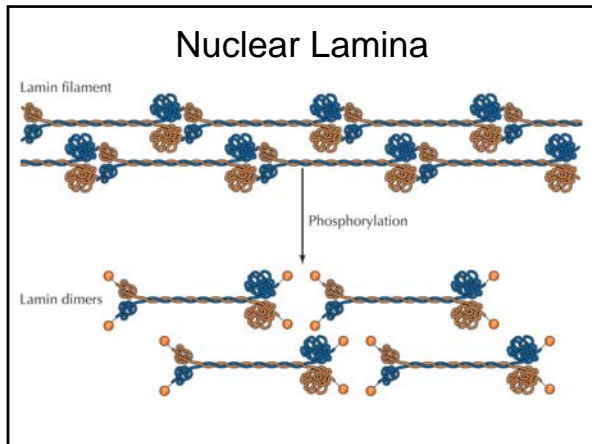
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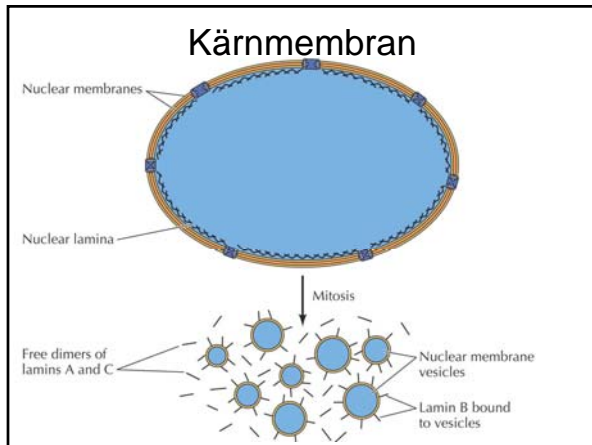
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### Kromosomkondensation

- H3 fosforyleras vid mitos
- kondensin – ett komplex av 5 proteiner
- 2 strukturella subenheter
- 3 regulatoriska subenheter – fosforyleras av kinaser, bl.a. Cdc2

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### Återskapande av interfaskärna

- inaktivering av Cdc2 (nedbrytning av cyclin B)
- reformering av kärnhöljet
- kromosomdekondensering
- selektiv import av kärnproteiner mm genom kärnporer

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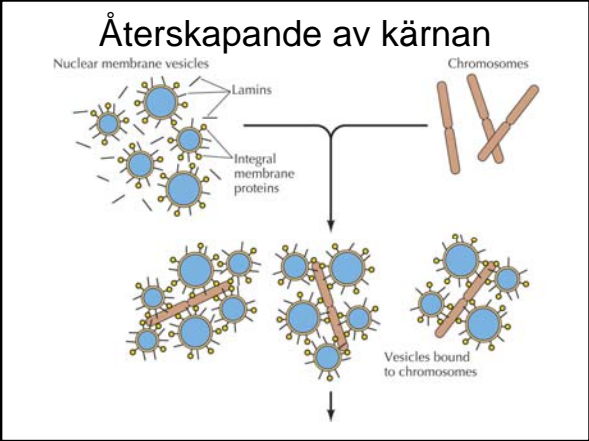
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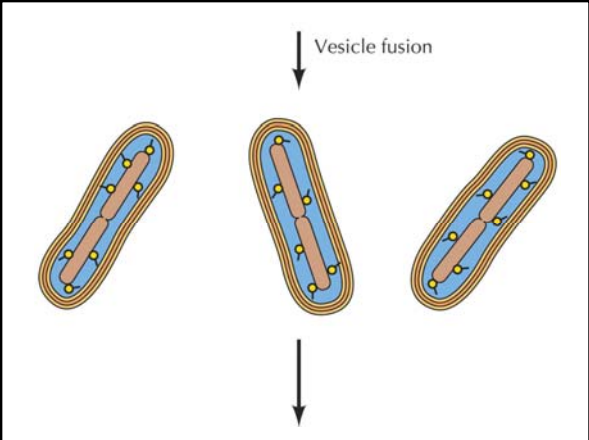
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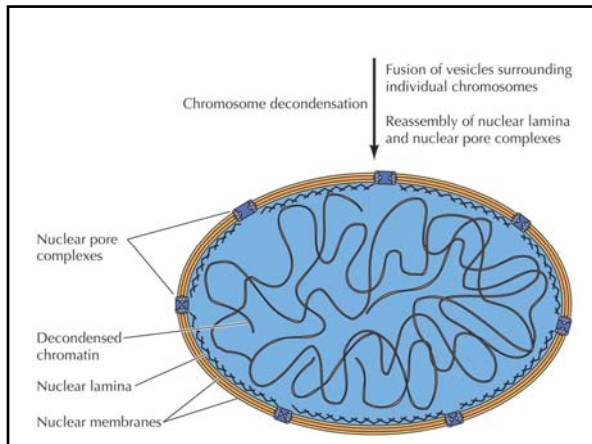
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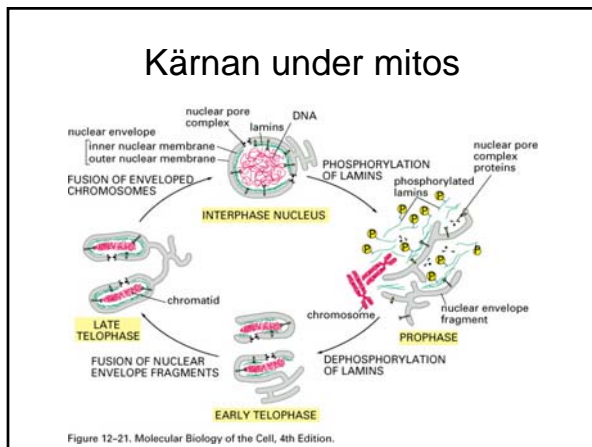
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## SAMMANFATTNING

- cellkärnan
  - hölje och transport till och från kärnan
  - intern organisation och ribosomproduktion
  - Chromatin
  - Kärnan vid celledelning

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