# Fysikken bag hverdagens materialer.

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# Oversigt

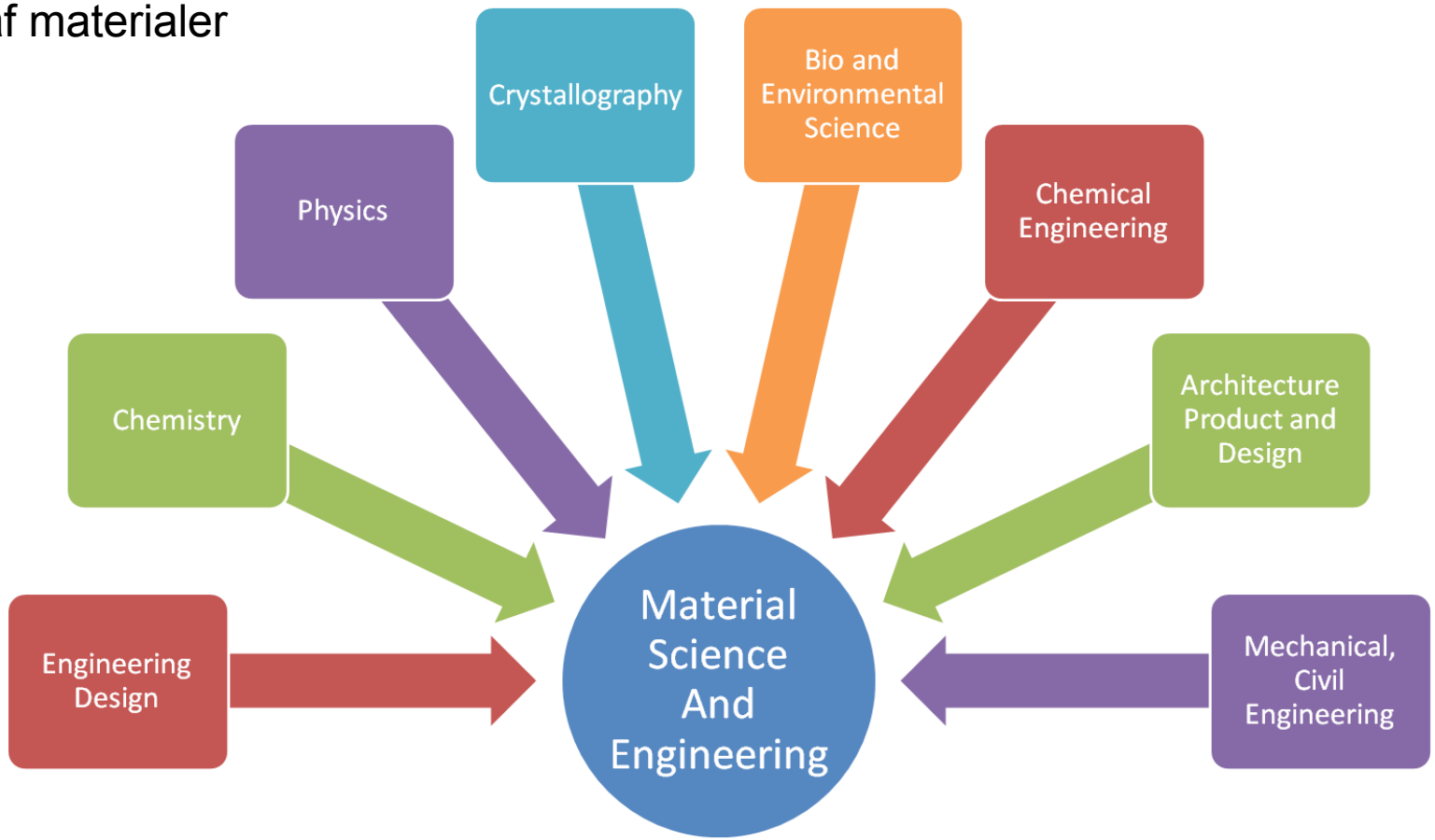
- Intro hverdagens materialer (temperatur, brownsk bevægelse)
- Surfaktanter (hydrofob/hydrofil, overflade spænding, selv-samling)
- Polymerer (elasticitet, gel overgang)
- Colloider (stabilitet emulsioner)
- Væsker/glas (viskositet, dynamik)
- Biologiske materialer

# Materialevidenskab

Materialevidenskab er studiet af

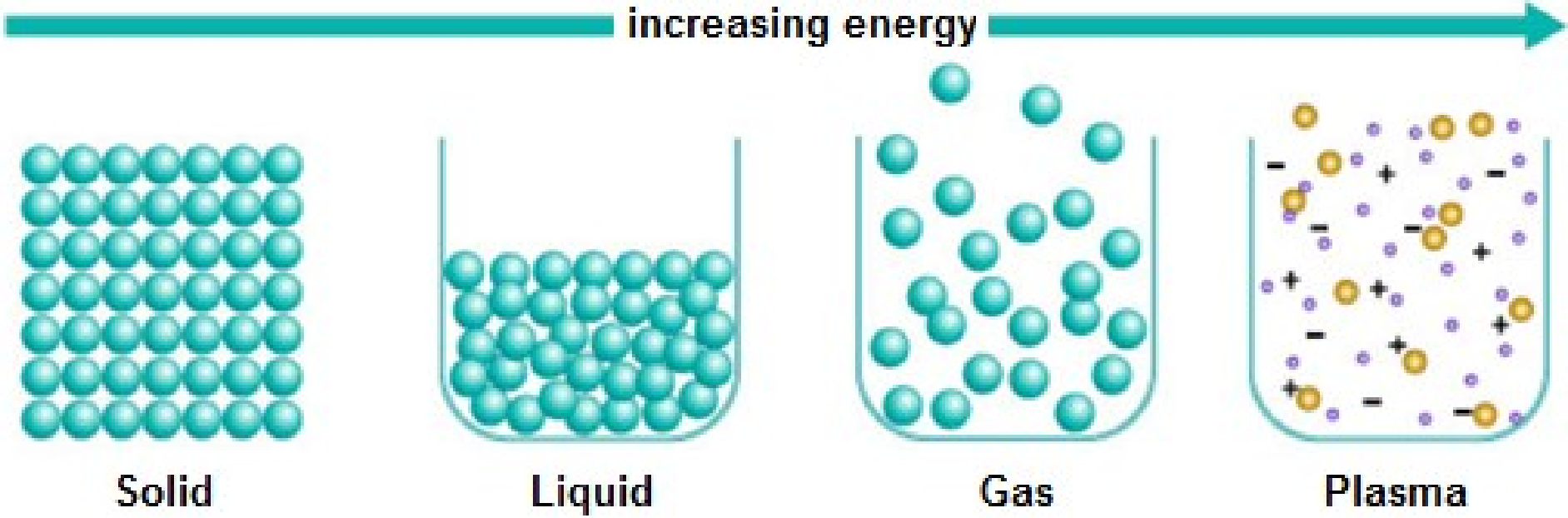
- Struktur og vekselvirkning mellem molekylære byggesten
- Forståelse af materialers egenskaber
- Design af materialer

Materialer dækker her både over væsker og faste stoffer.

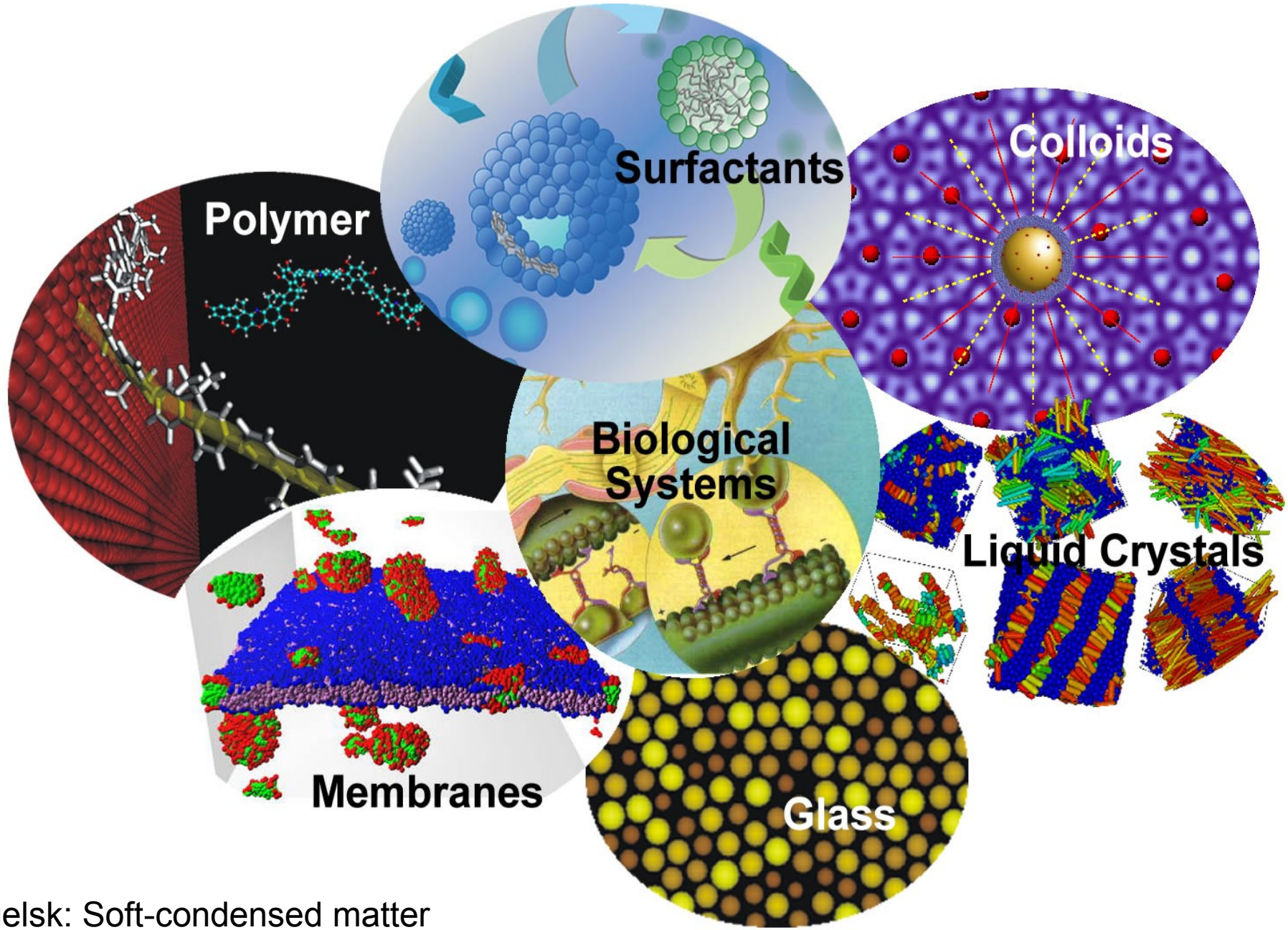



Og mange mange flere...

# Tilstandsformer

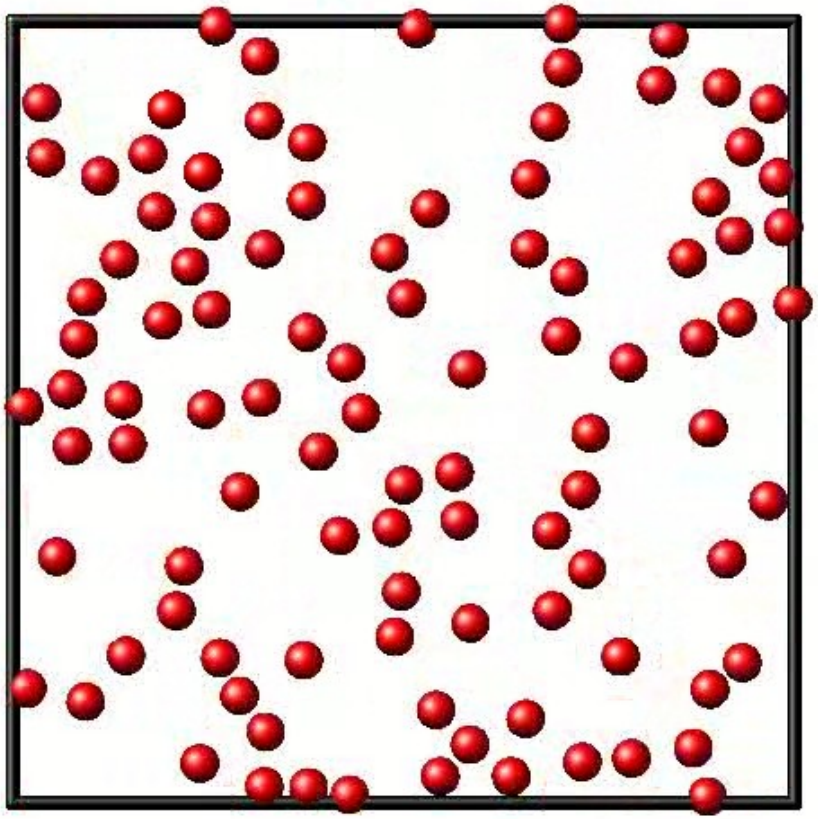


# Hverdagsmaterialer

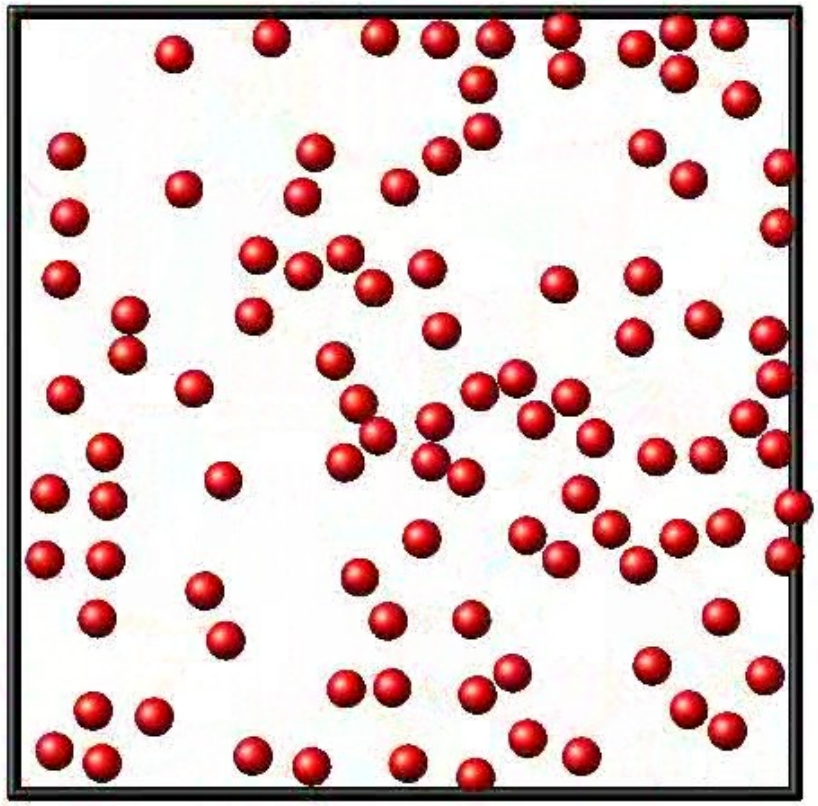



Engelsk: Soft-condensed matter

# Temperatur



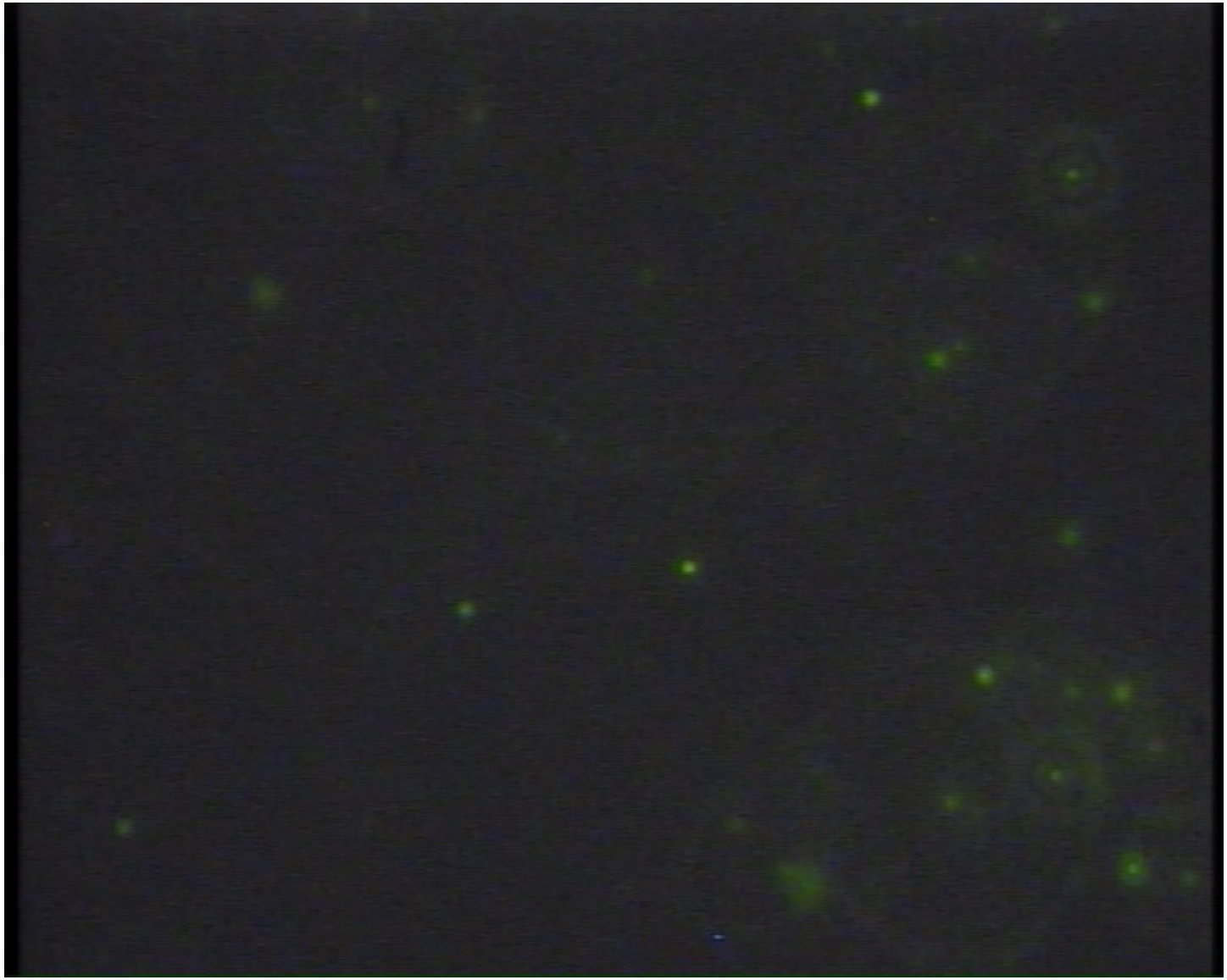
T lav



T høj

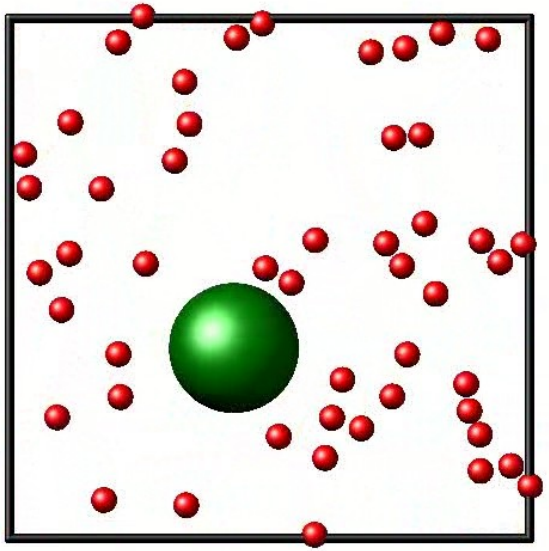
$$<E_{kin}> = \frac{1}{2} m <v^2> = \frac{1}{2} k_B T$$

# Brownsk bevægelse



Eksperiment

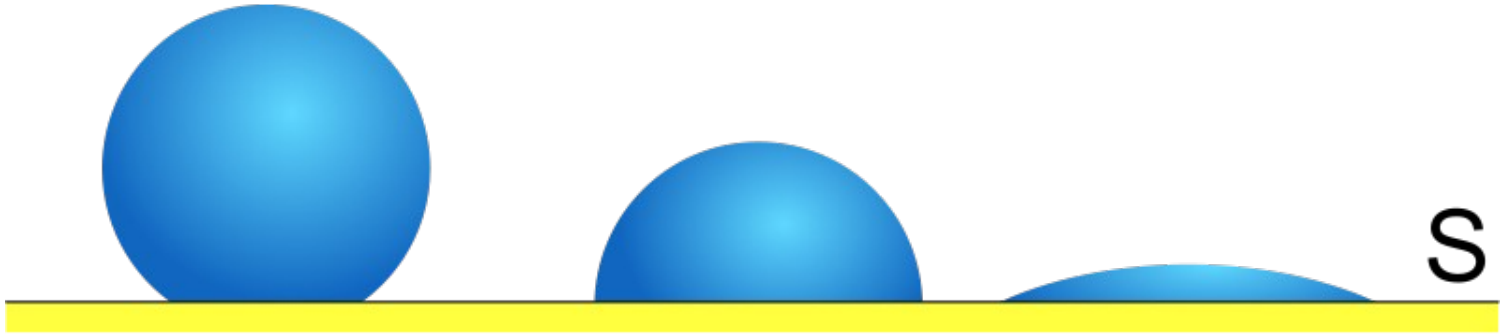
Simulation



# Hydrofob/hydrofil

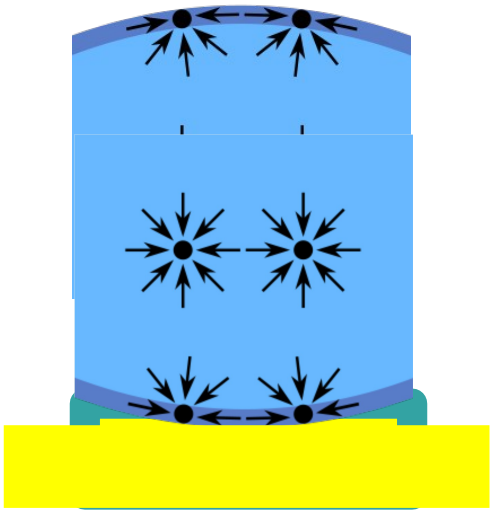
Energibidrag
fra kontraktfladen

$$E=\gamma A$$



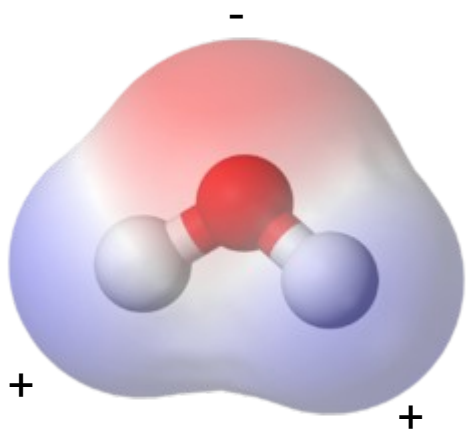

Hydrofob:
Høj overflade spænding

Hydrofil:
Lav overflade spænding

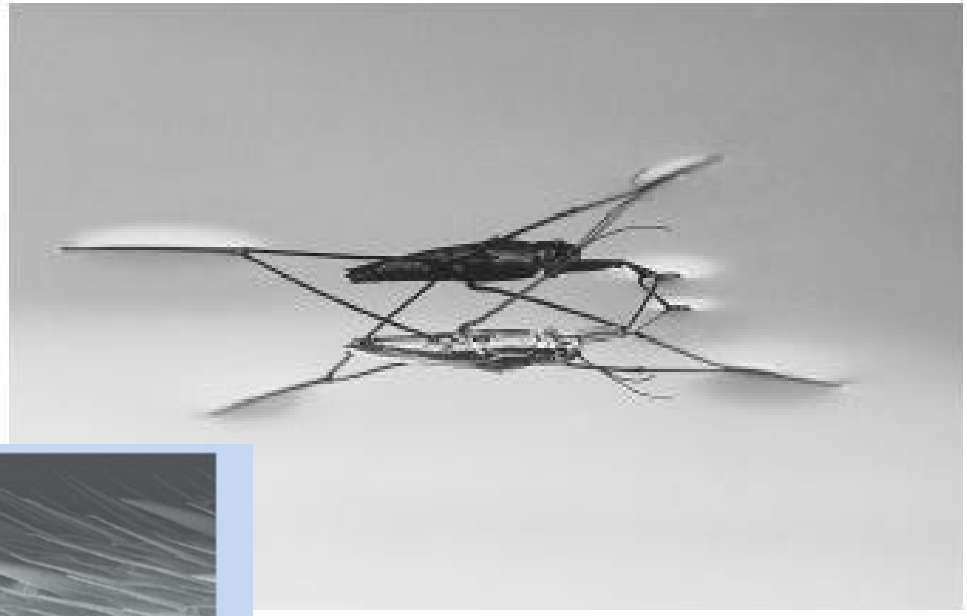


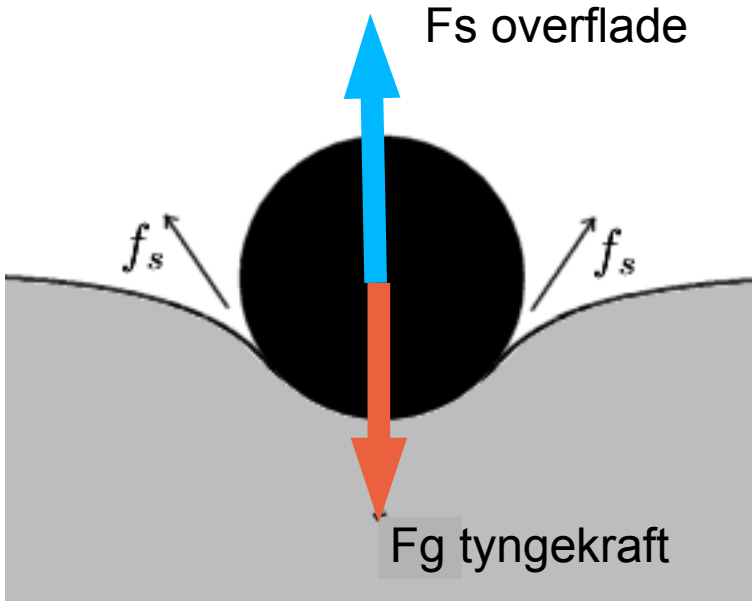
Færre molekylære velsekvirkninger ved overflader end for molekyler inde i væsken.

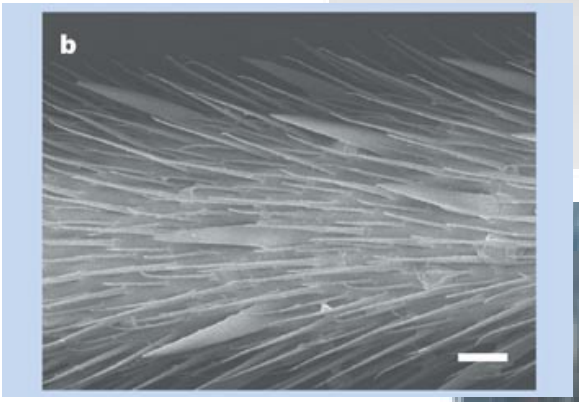
Derfor har molekylerne typisk højere energi ved grænsefladen.



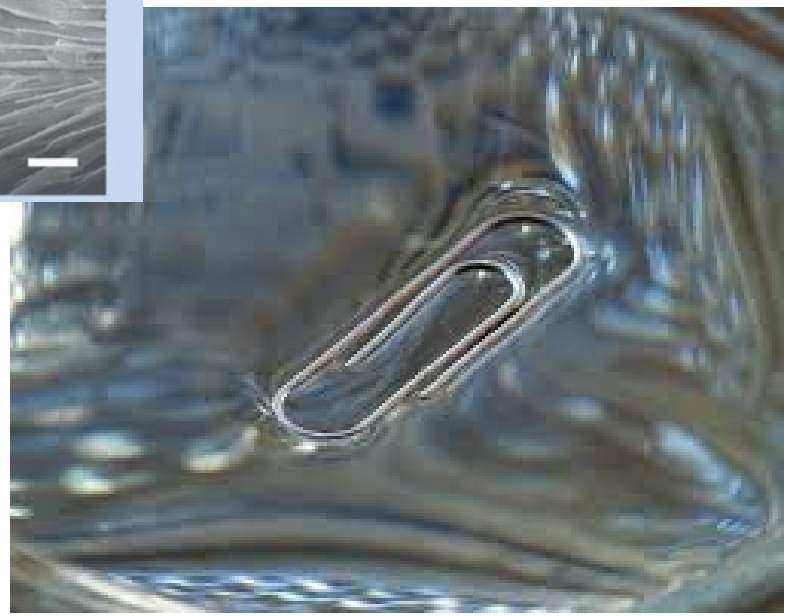
# Gå på vand!

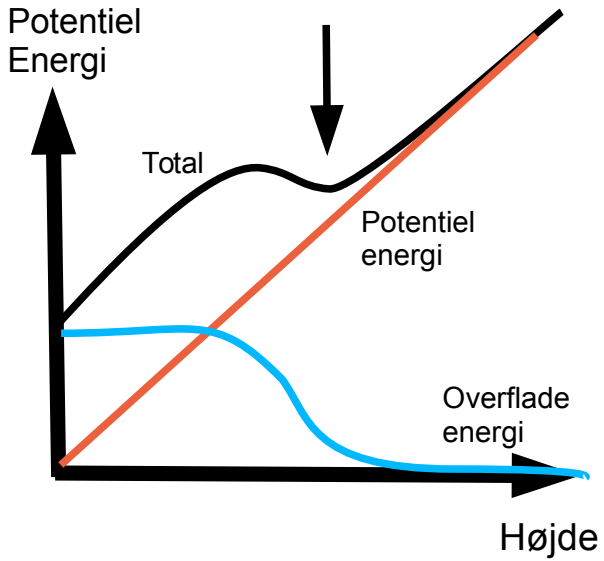





Øg overflade arealet!



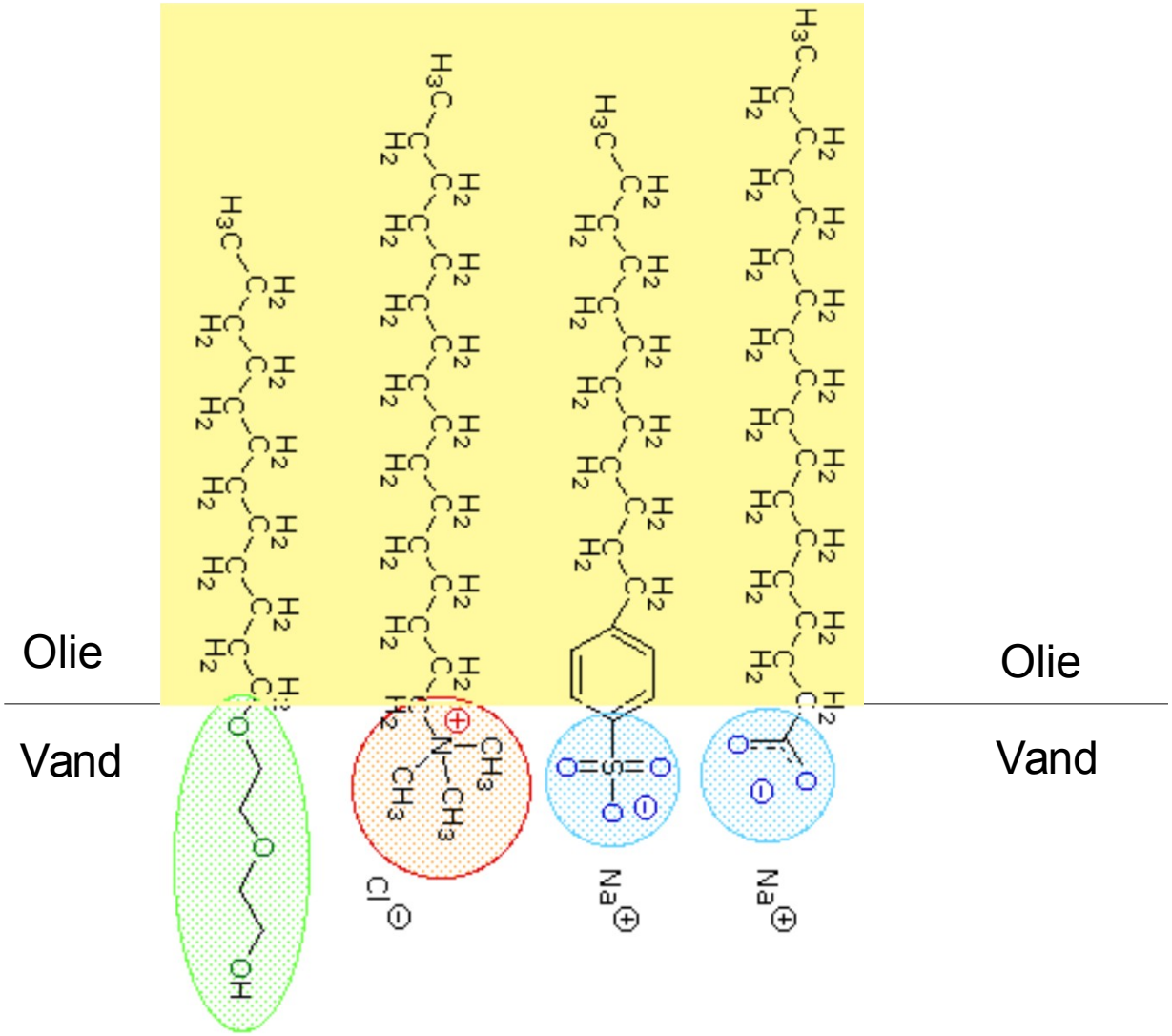


# Superhydrofob


Kilde youtube: The SECOND Official Ultra-Ever Dry Video - Superhydrophobic

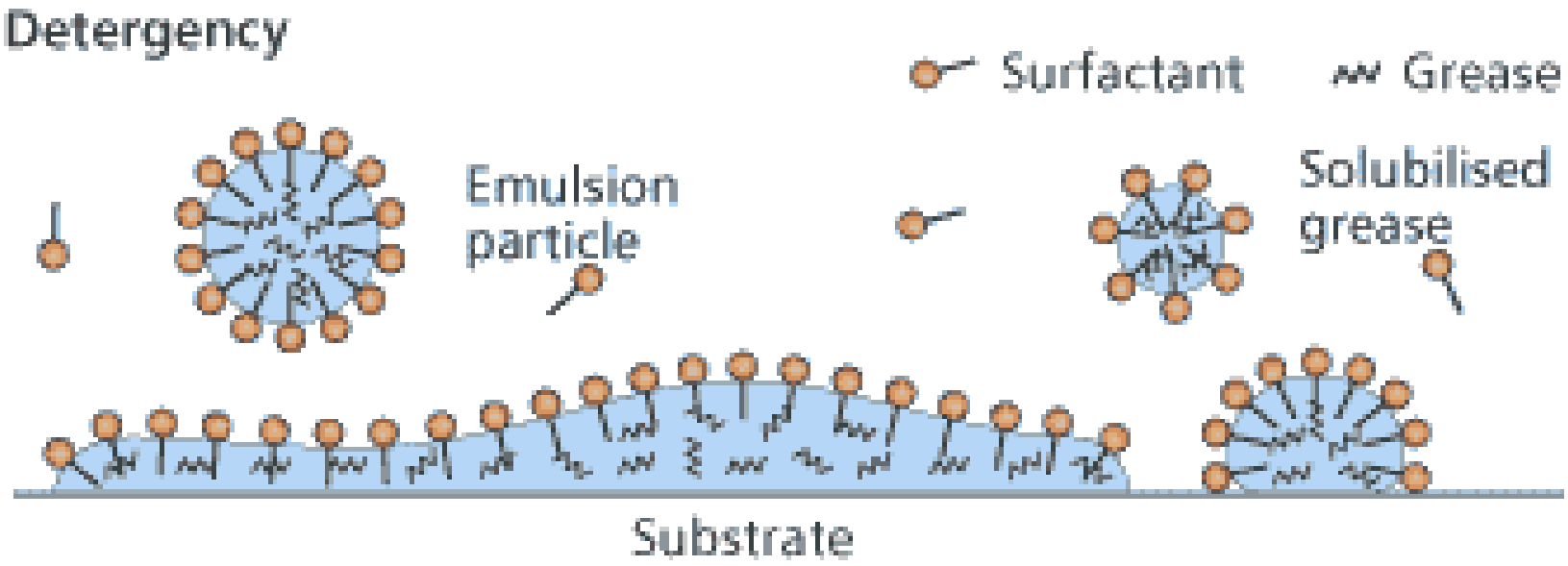
# Surfaktanter

Surfaktant = SURface Aktive AgeNTer, dvs. Molekyler, der ændre egenskaber af overflader.

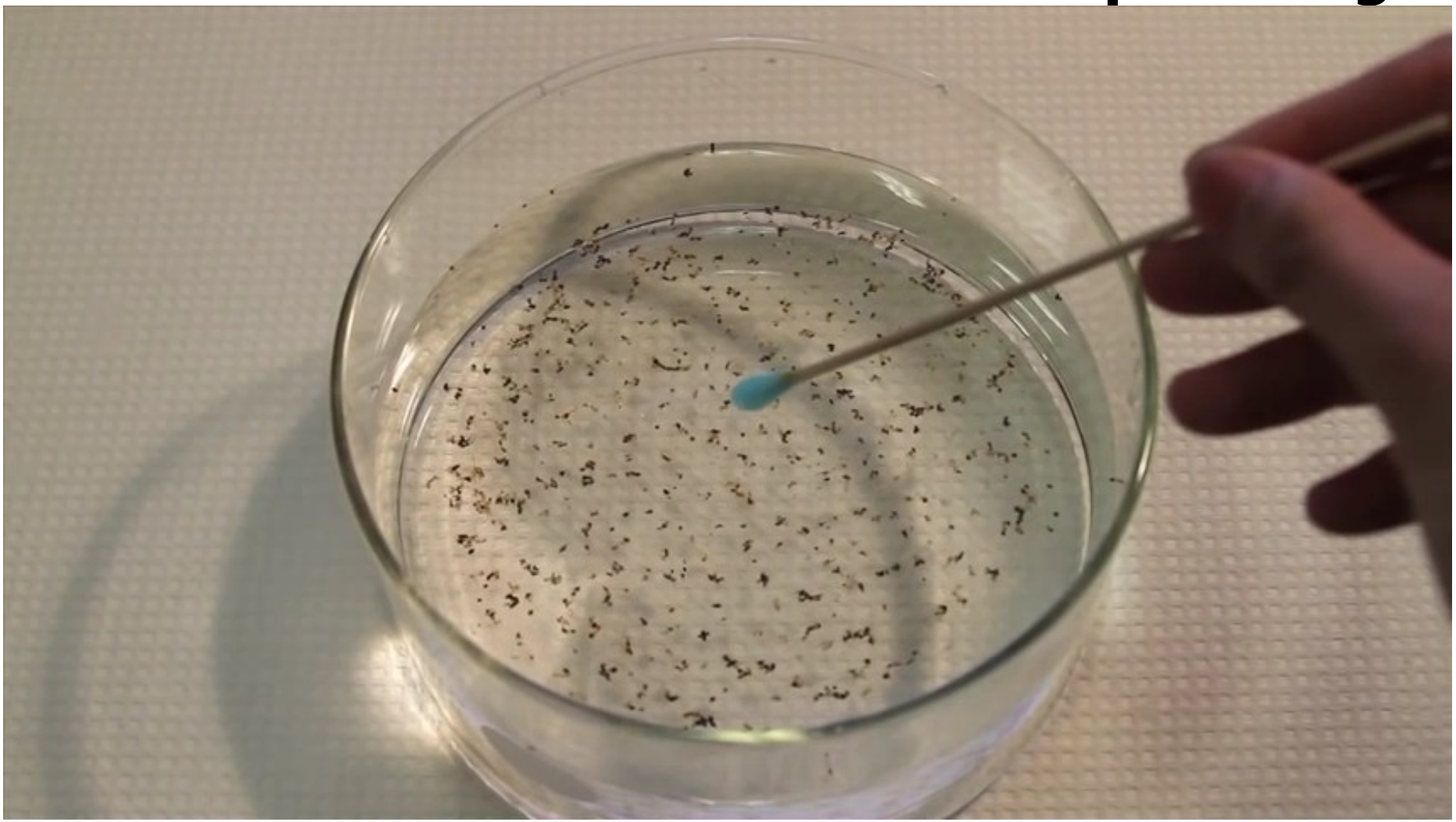


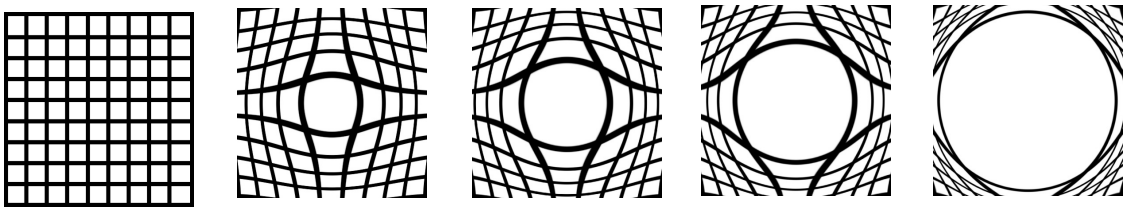

Produkter: Sæbe, Shampoo, vaskemiddel, opvaskemiddel, ...

# Anvendelse: Opvask



# Surfaktanter sænker overfladespænding

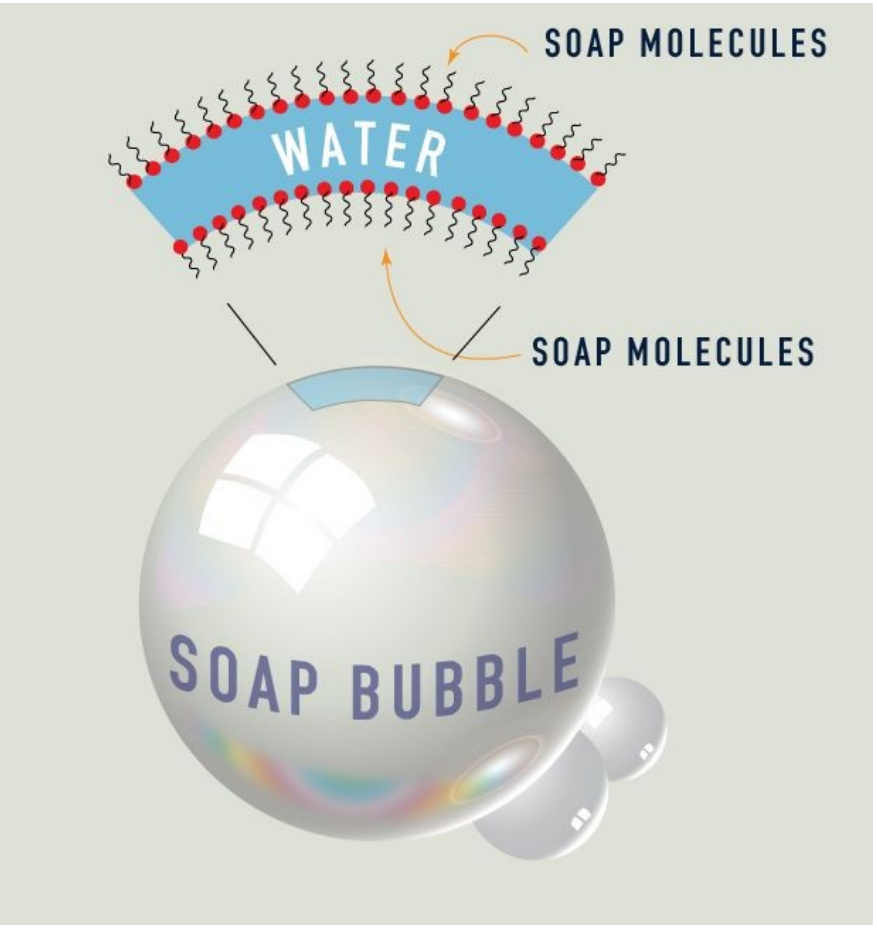


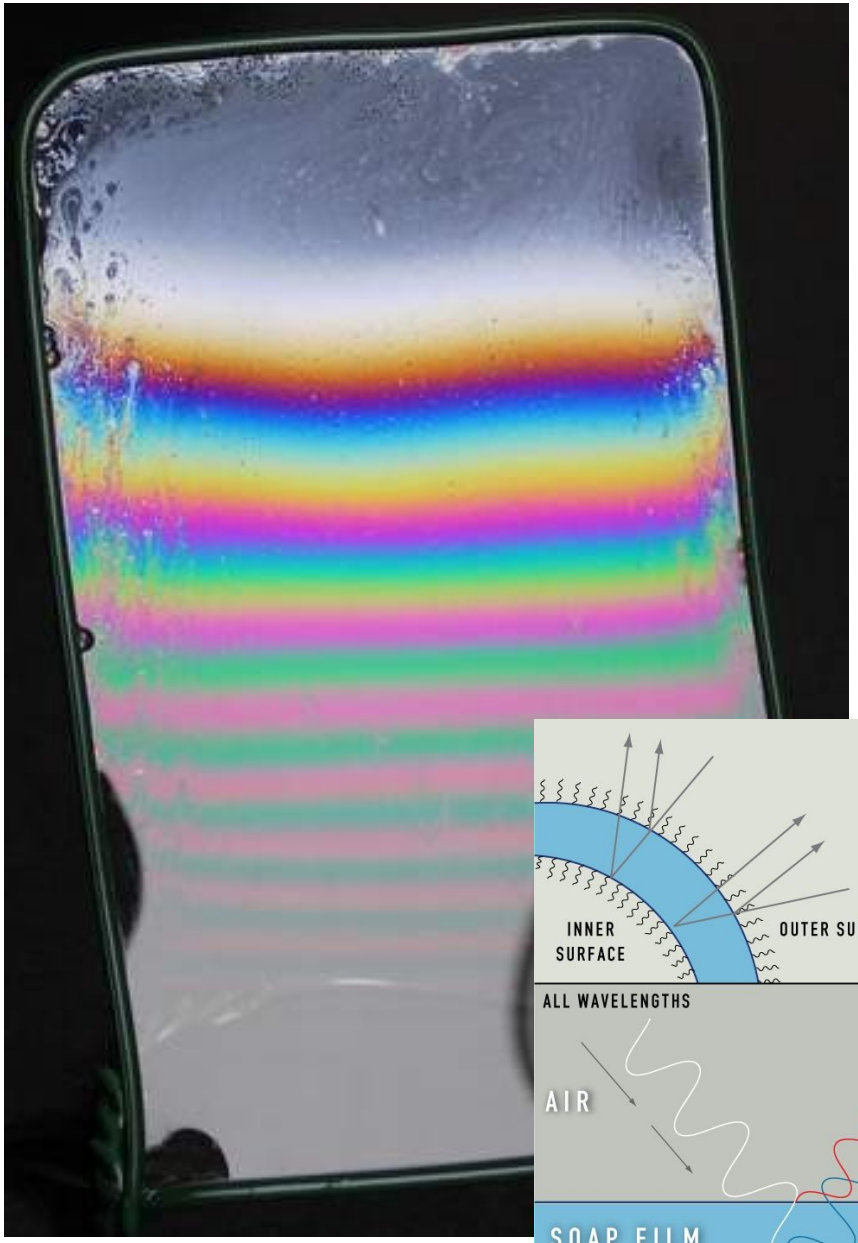


Kilde youtube: The marangoni effekt: how to make soap boats

Opskrift:
Vand
Opvaskemiddel

# Sæbebobler



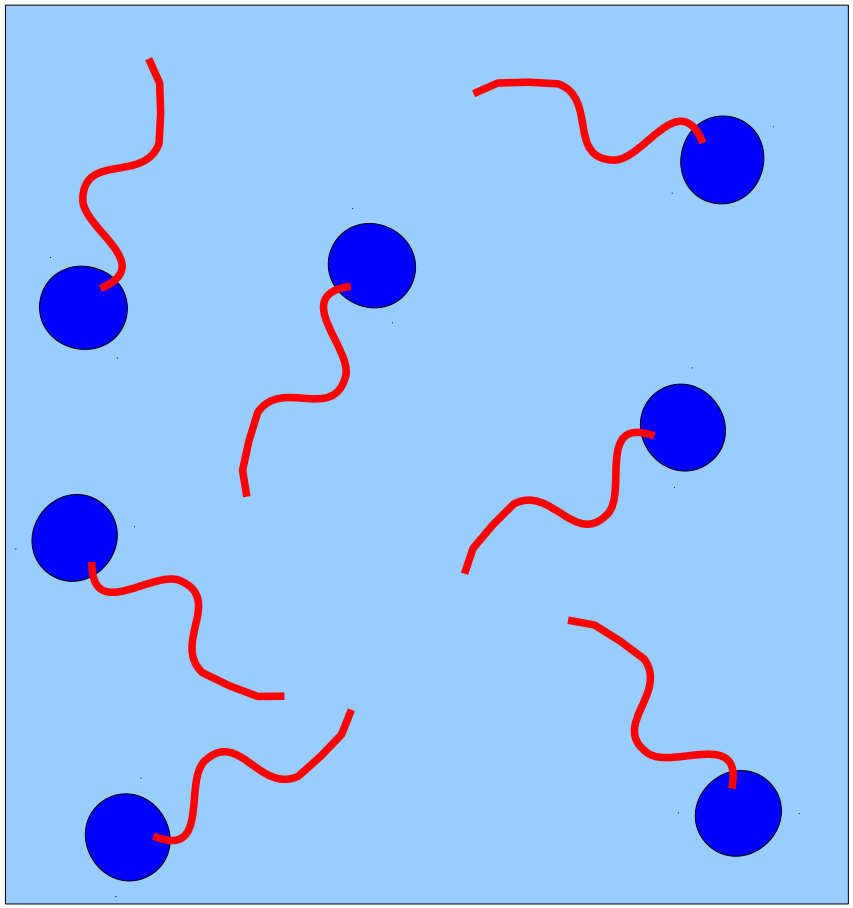



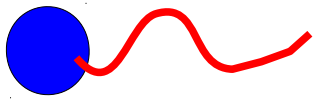
Interferens




**Opskrift**:
Vand
Opvaskemiddel
Glycerin

# Selv-bygning





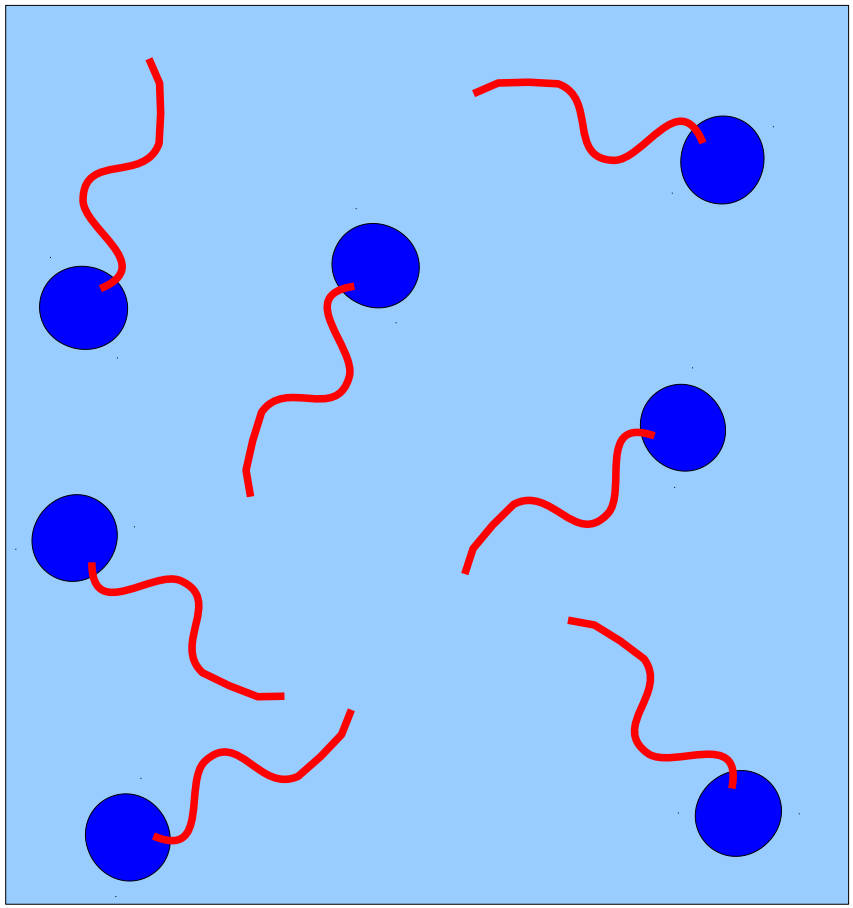
hydrofil hydrofob

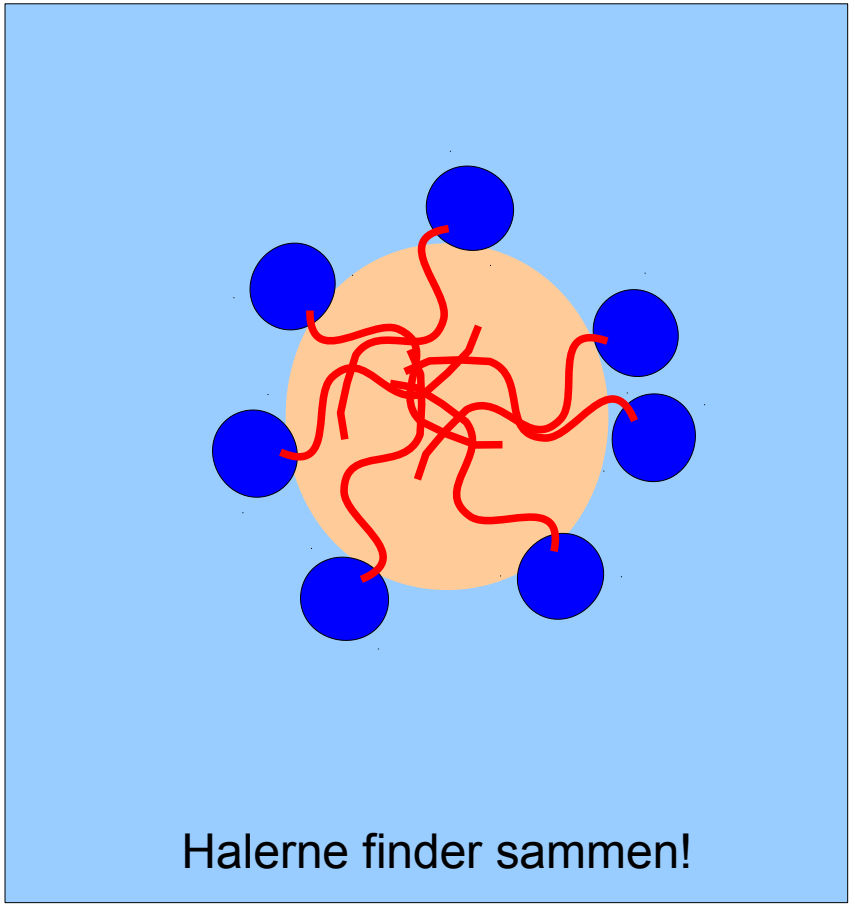
Surfaktanter I opløsning.

Halerne er stadig I kontakt med vand,
Det kan de ikke lide.

Hvad kan surfaktanterne gøre ved det?

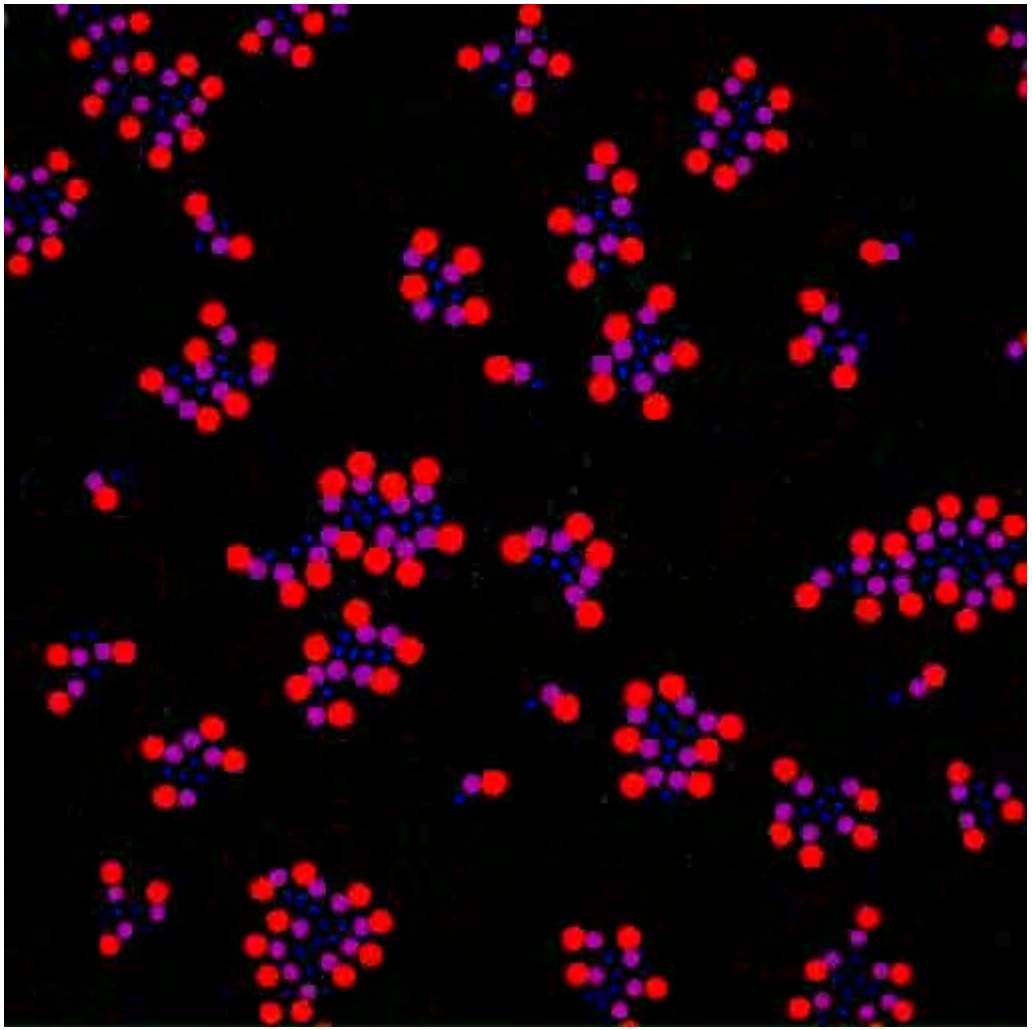
# Selv-bygning

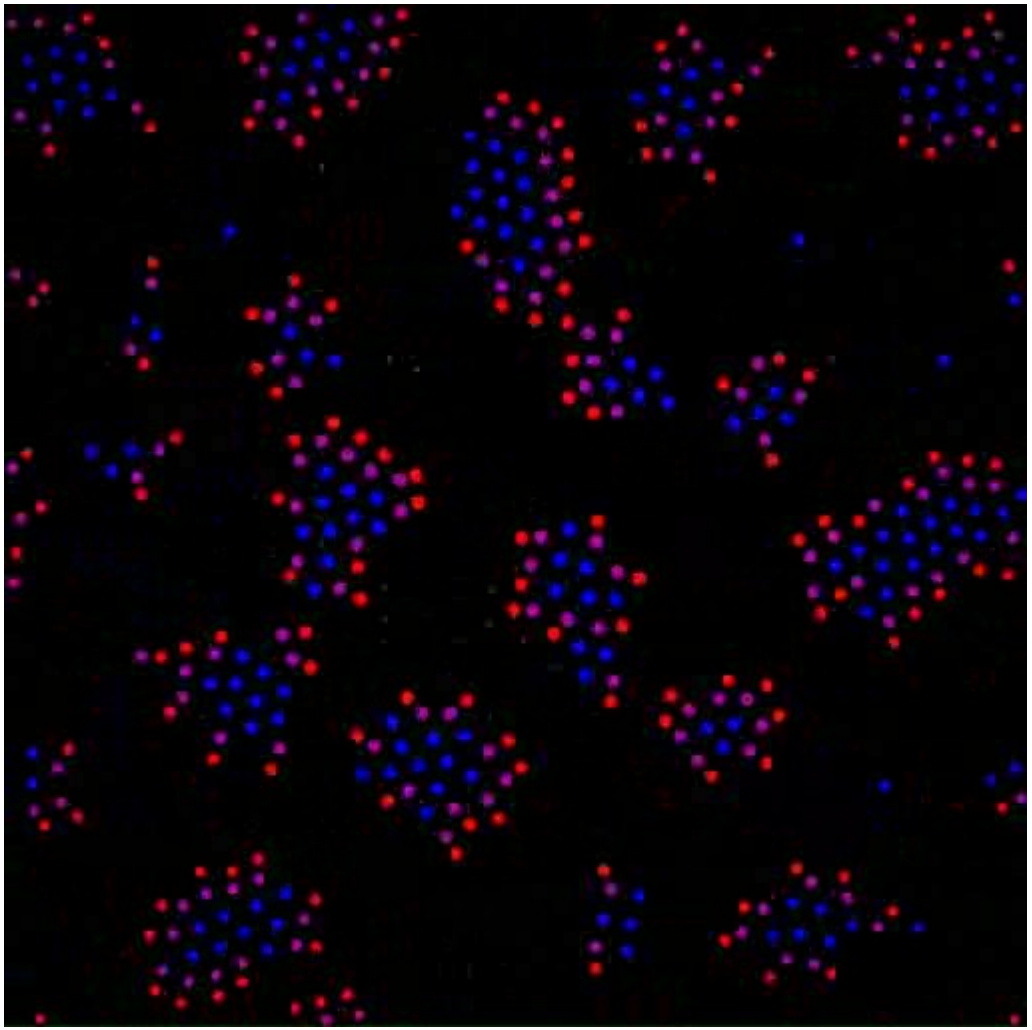


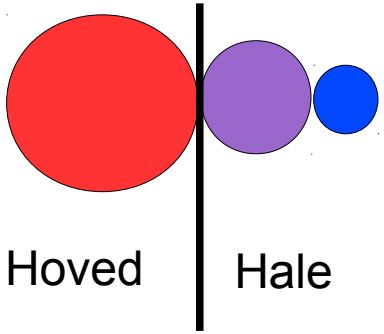


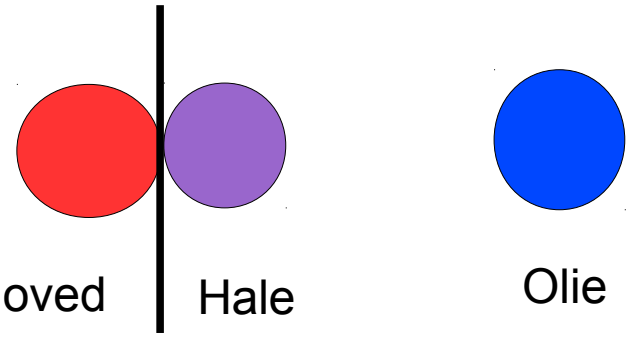

Molekylære legoklodser! Bygger selv strukture på det molekylære niveau.

# Simulation af surfaktanter

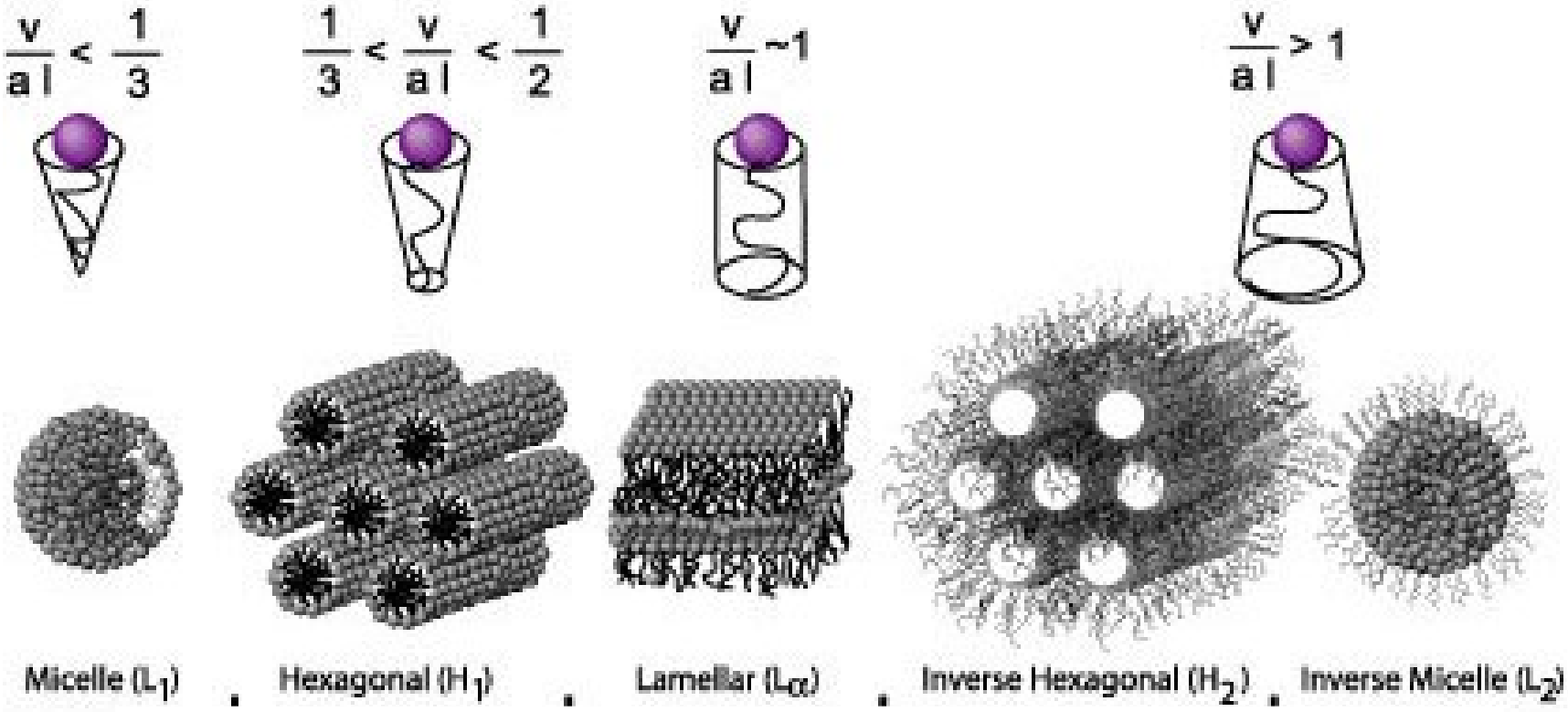


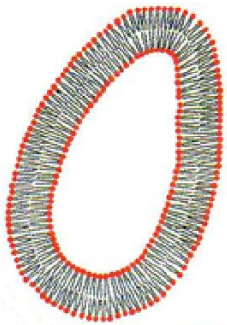




# Self-byggede strukturer



Vesikel

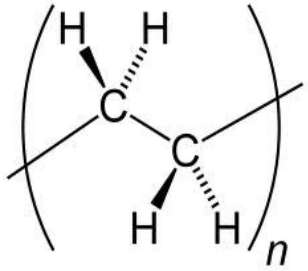
# Selv-bygning / Emergens

Hvor mange X skal man have for at have en Y?

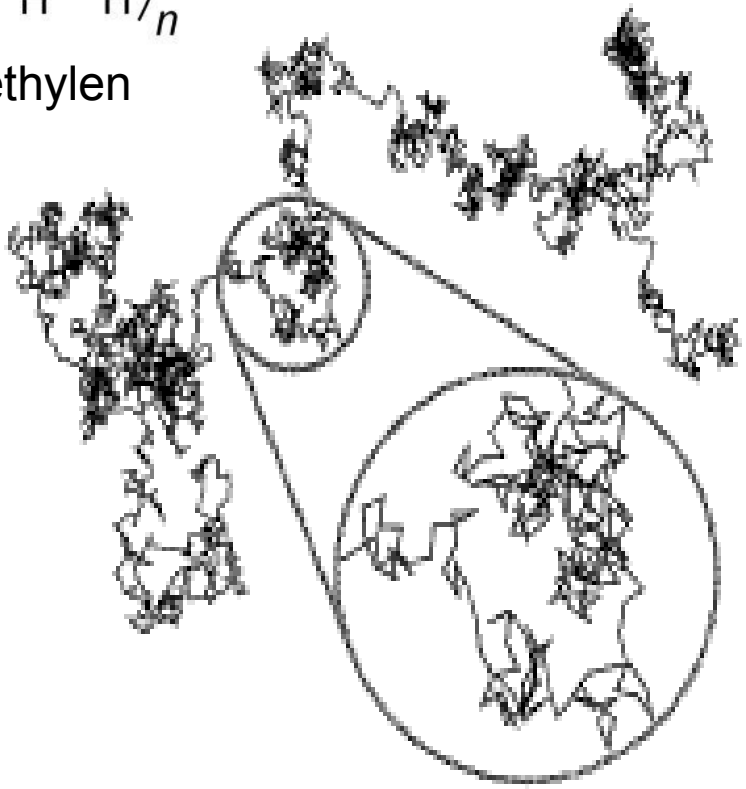

Helheden er mere end summen af komponenterne!

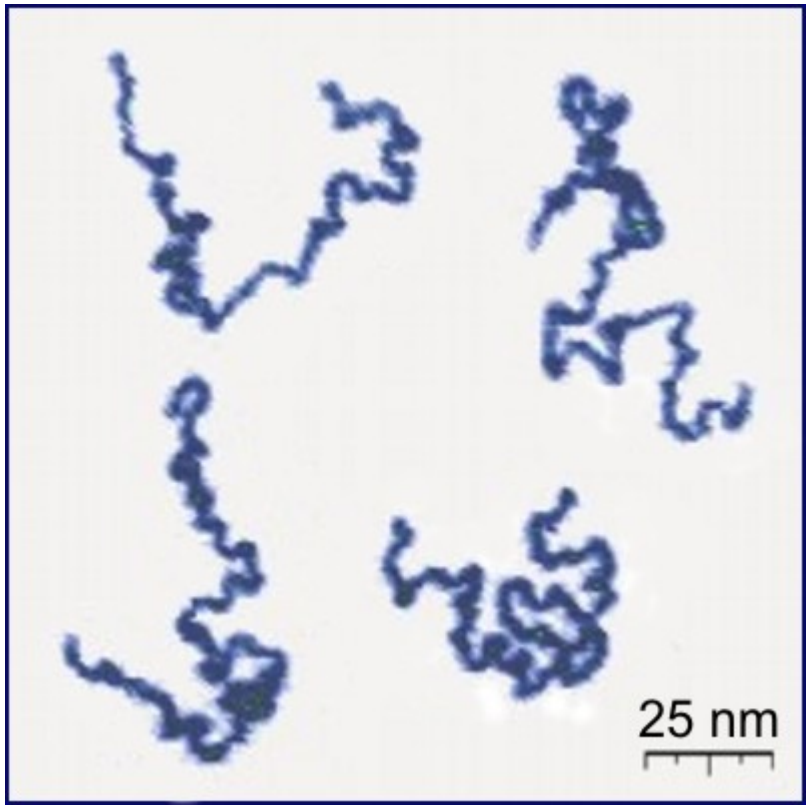
# Polymere

Poly = mange,
meros = dele



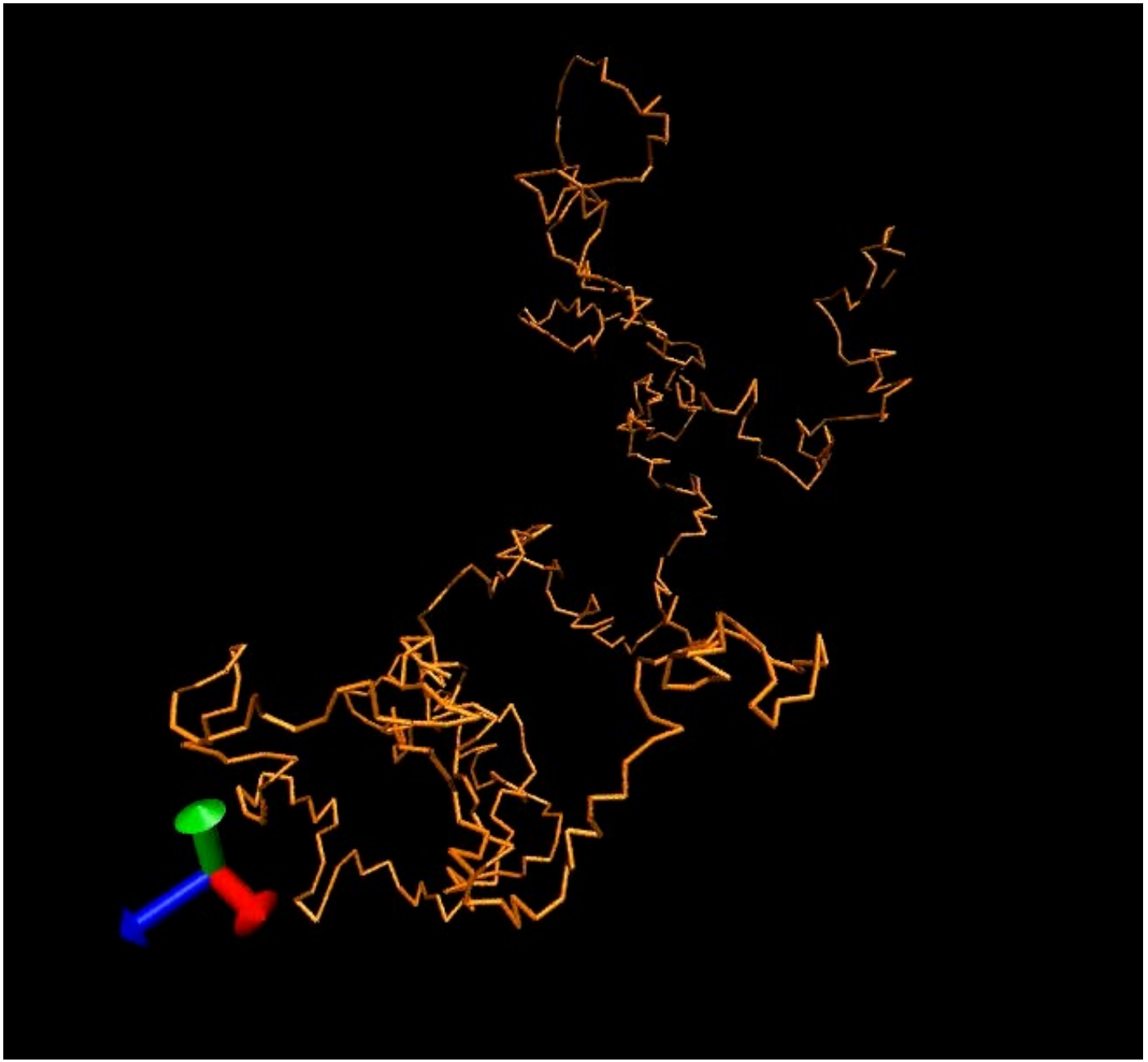

polyethylen






Atomic-Force mikroskop billed af polymere på en overflade. Bredde ~ 0.4nm, længde 204nm (Kilde: Wikipedia)

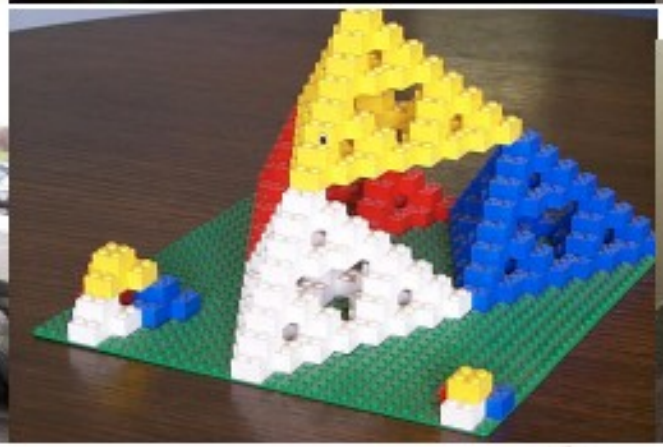
# Brownsk bevægelse



# Anvendelser



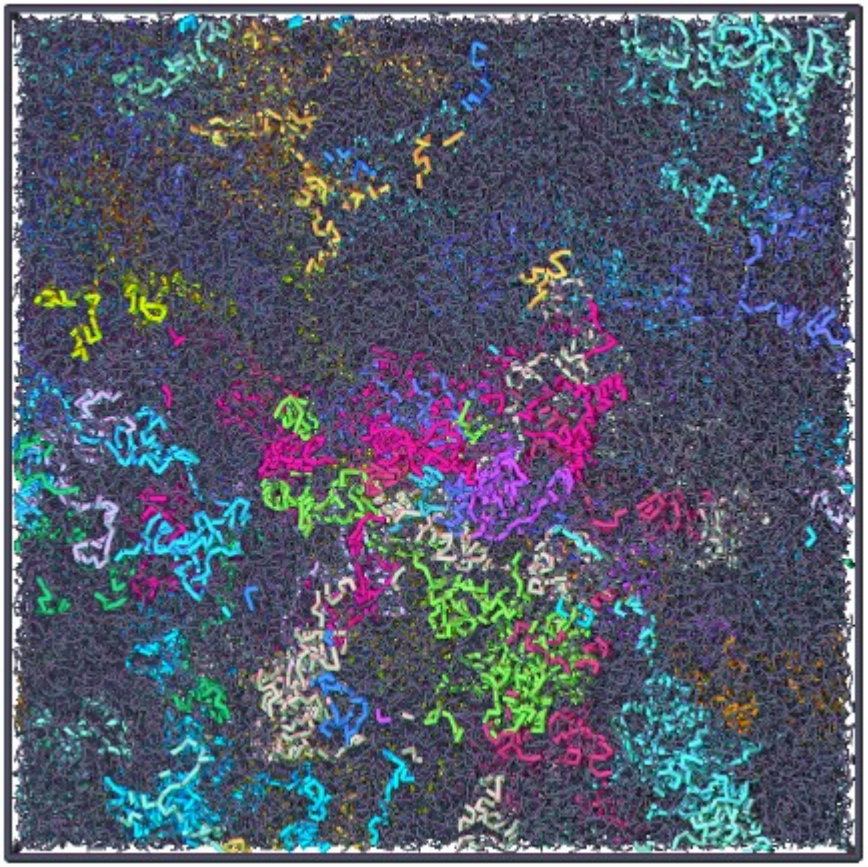


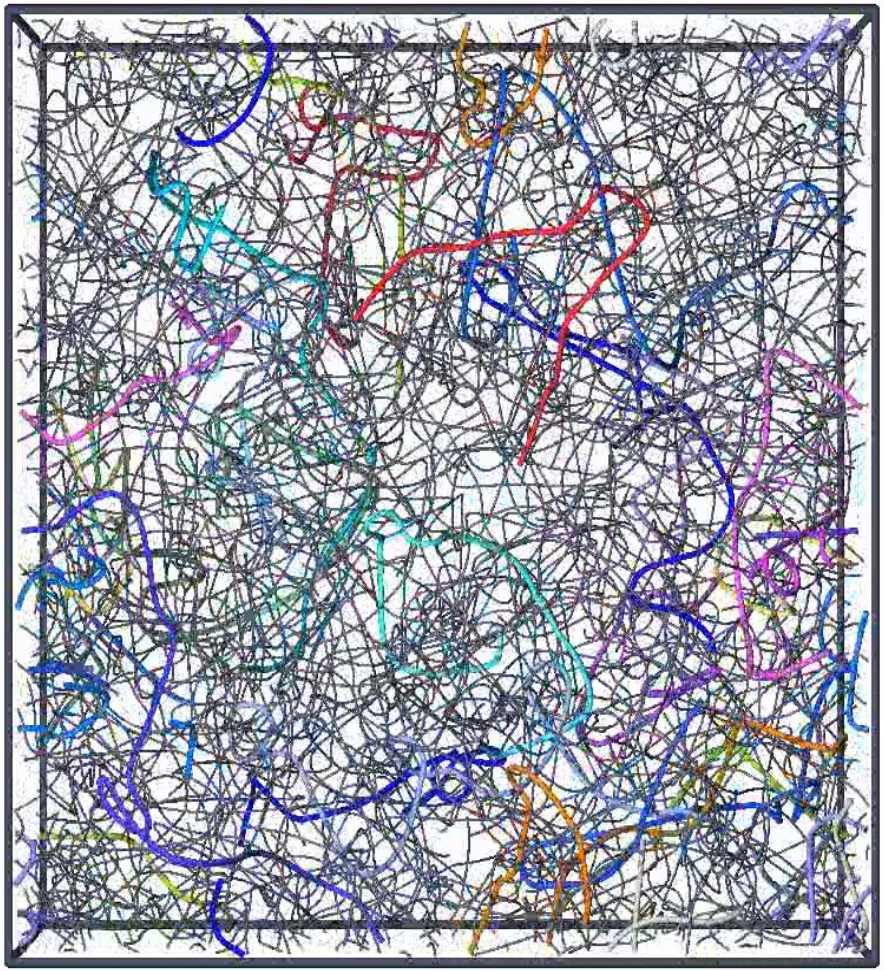




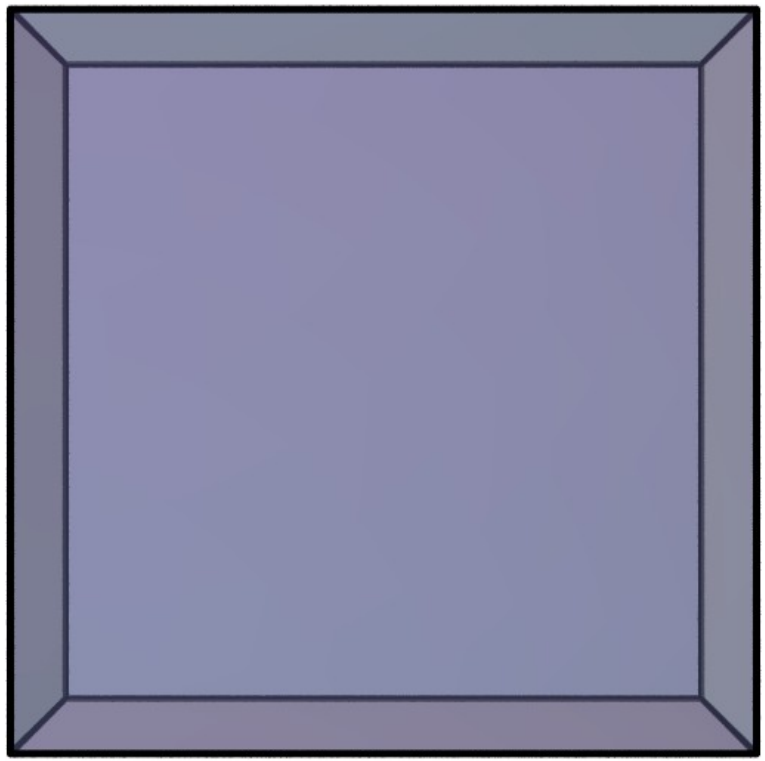

For at nævne nogle få...

# Gummi: Høj tæthed

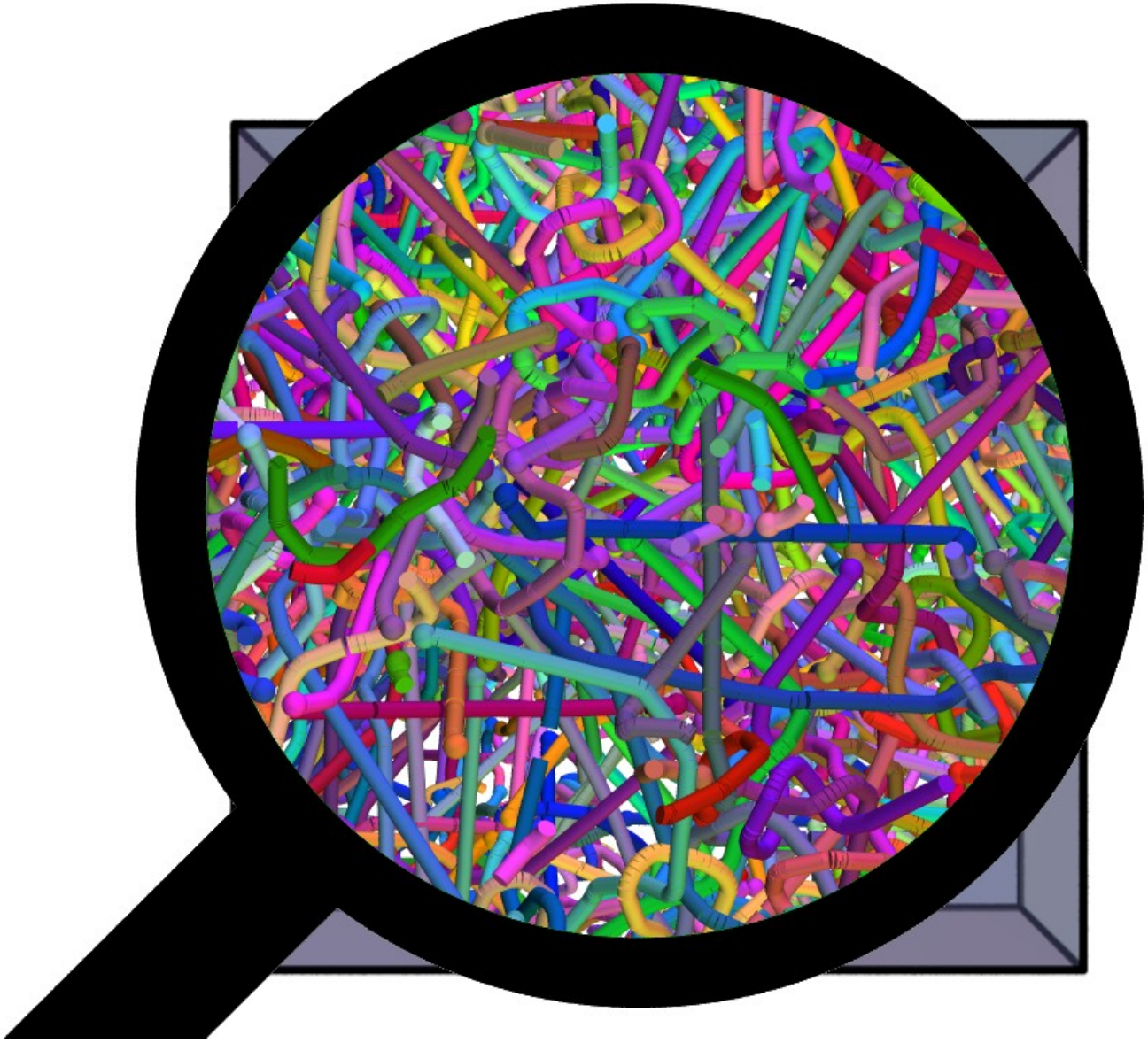




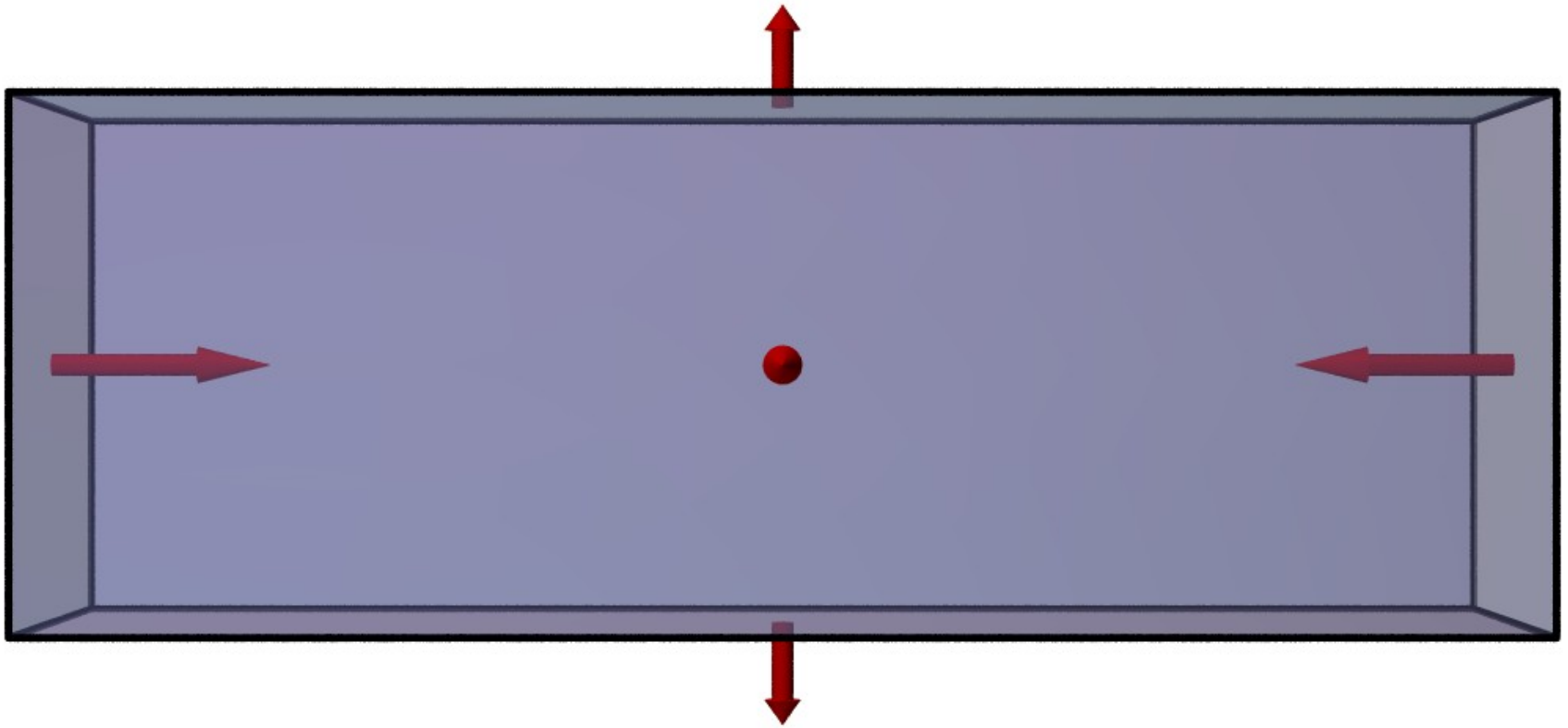
# Gummi



# Gummi



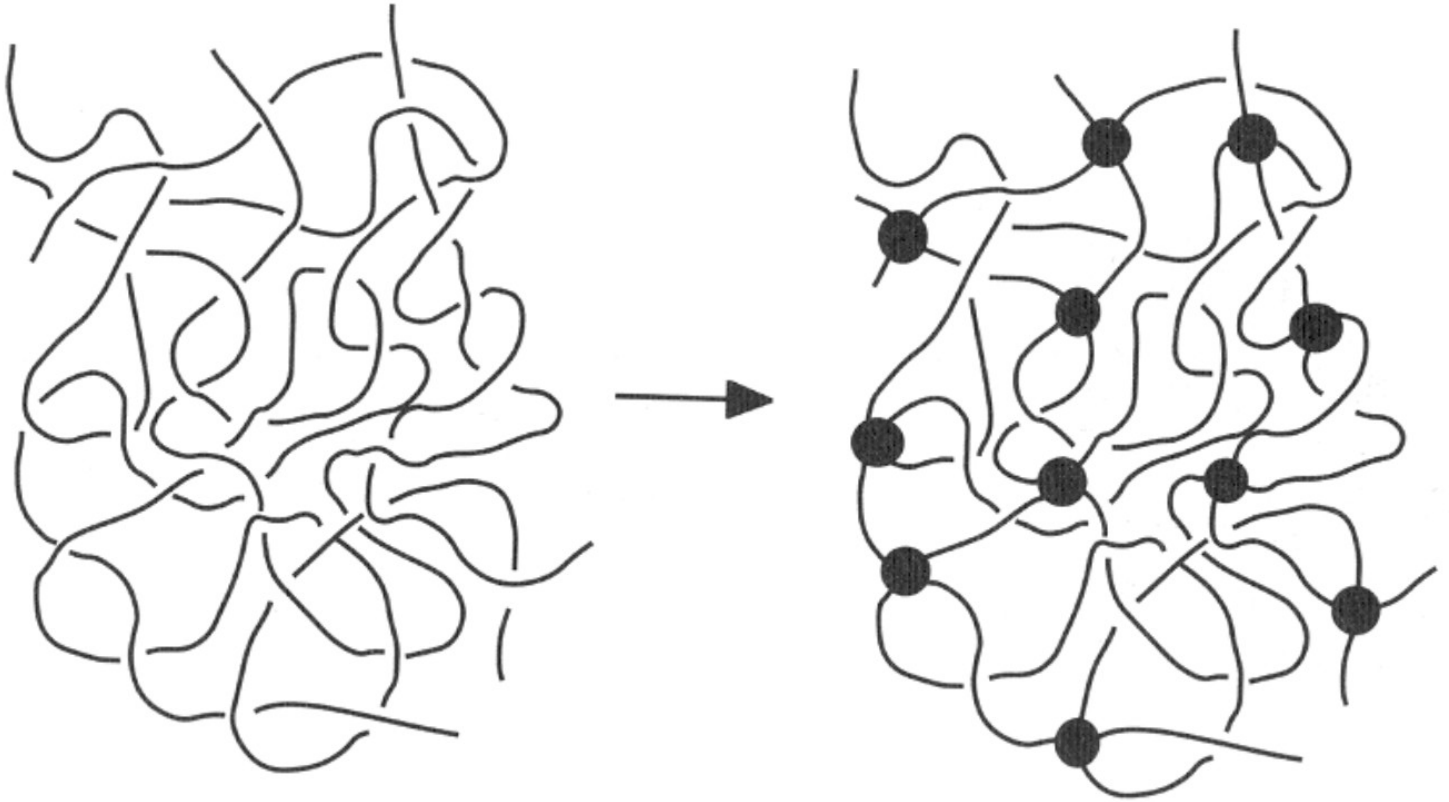
# Gummi



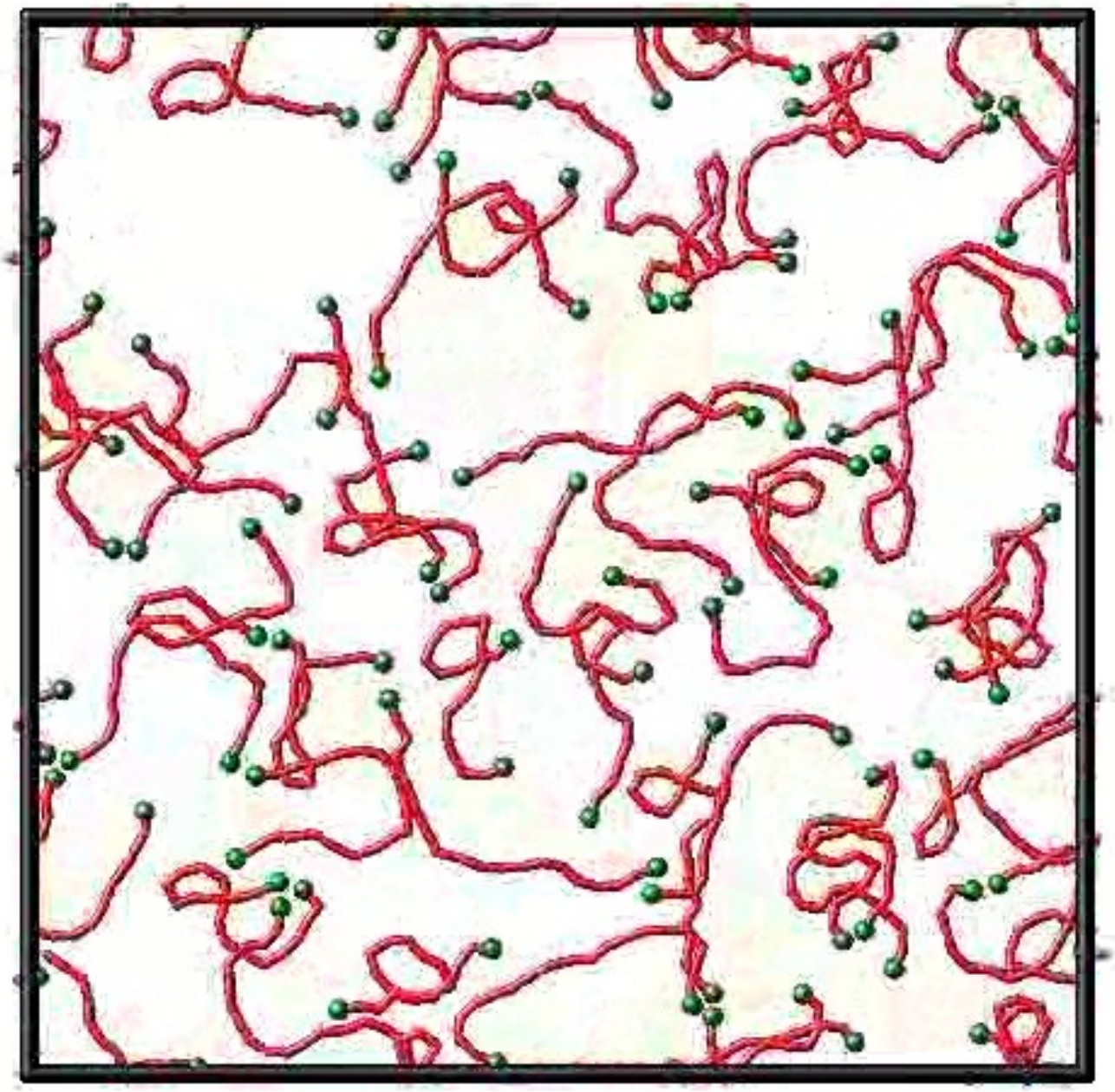
Gummi kan trækkes x10 fordi molekylerne er fleksible! Shape-memory material.

# Geler

Lavere tæthed af polymerer. Krydslænkes

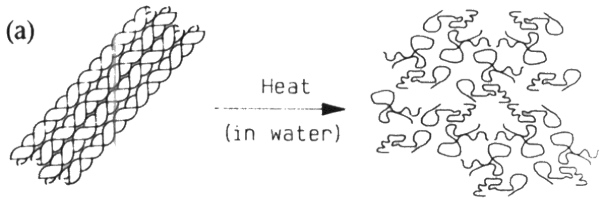


# Gelation



# Polyakryl

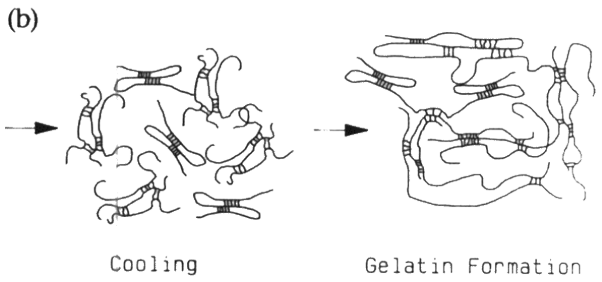
Superabsorberende materialer, nyttig i f.eks. bleer!




Vingummi opskrift:

Bland Gelatine+smag +varmt vand

Hæld væsken I forme og køl ned.

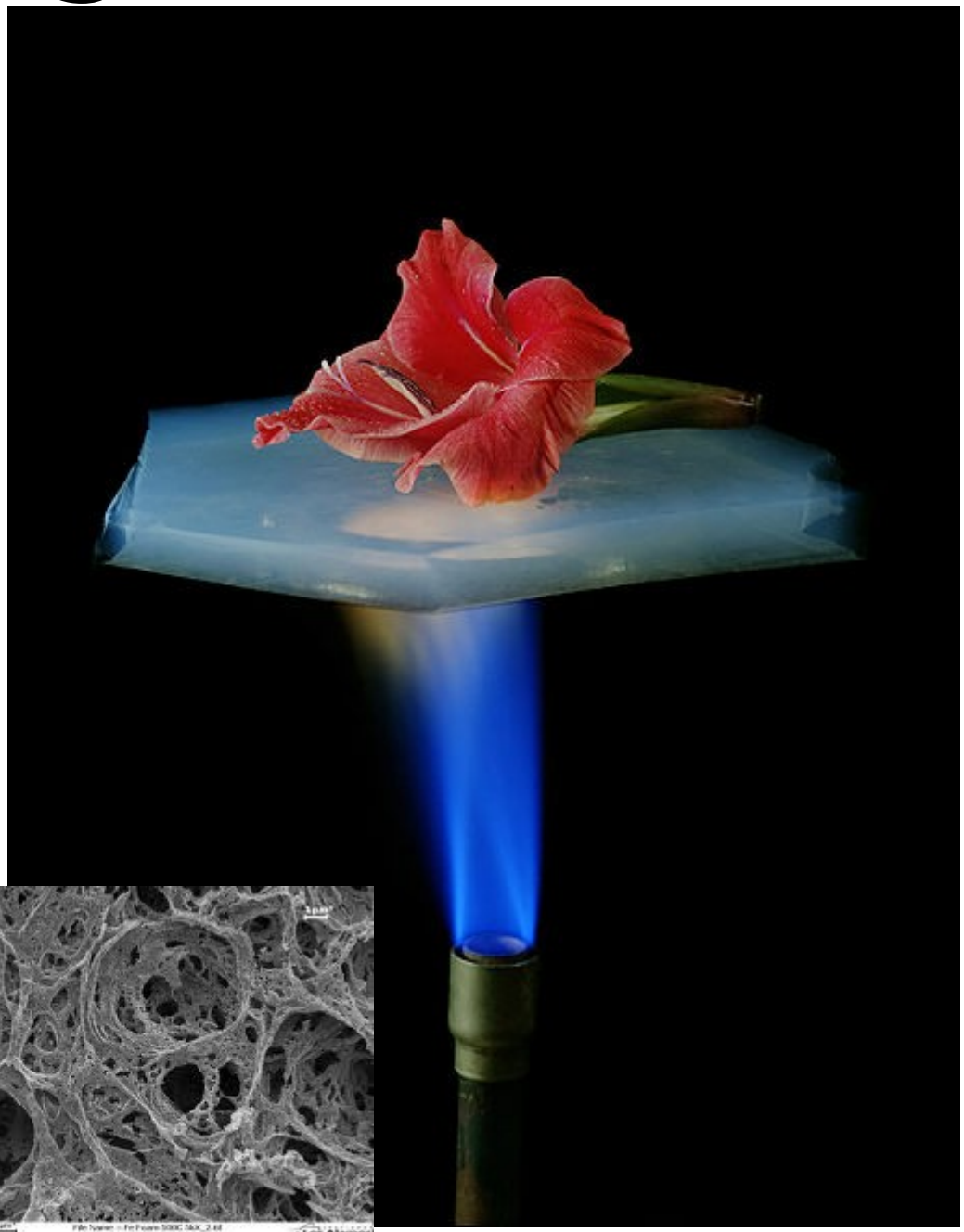


# Viskoelastisk materiale

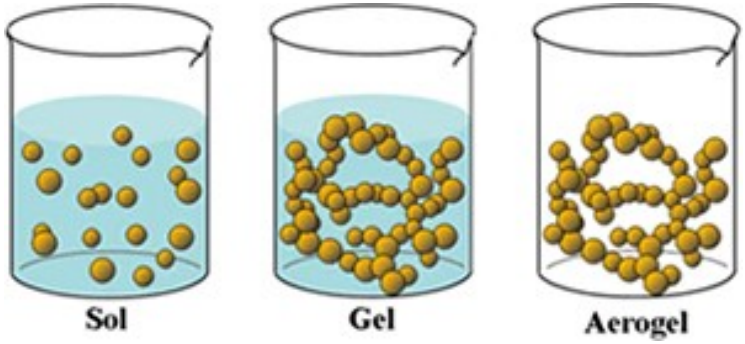
# Colloider

| Opløsning af X i medium Y, og størrelsen af X typisk er 1mn-1um. | Gas | Væske | Fast |
|---|---|---|---|
| Gas | - | Skum: Piskefløde, baberskum | Aerogel, flamico, Pimpsten |
| Væske | Væske aerosol: Tåge, hairspay | Emulsioner: Mælk, Mayonaise | Gel: Agar, vingummi, budding. |
| Fast | Fast aerosol: røg, is i skyer | Sol: Blæk, blod, Maling | Fløde is |

# Aerogel

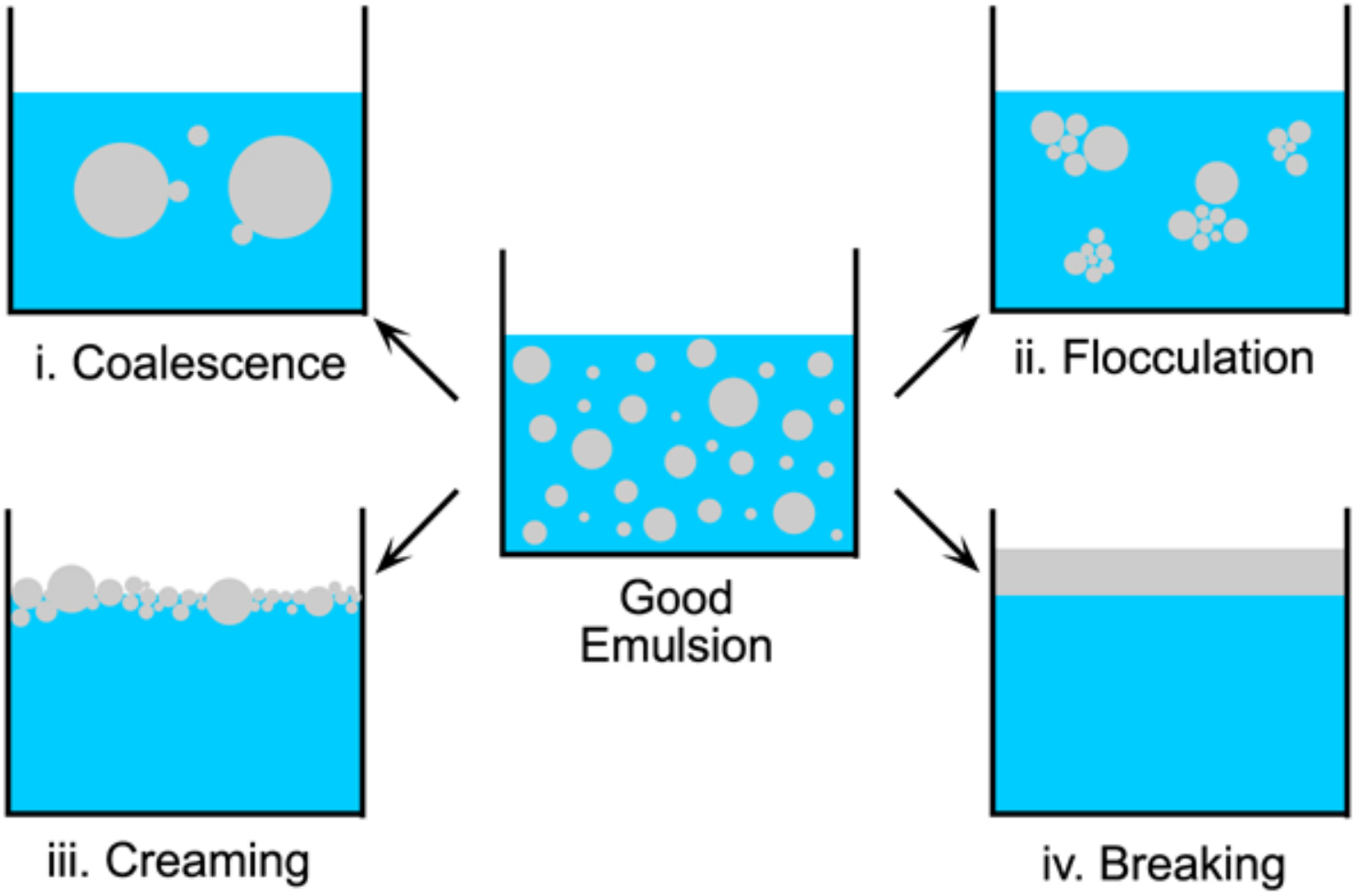


Ultralet materiale  99.98% luft
Tæthed 2 g/m^3  (luft vejer 1,2 g/m^3)
Polymer netværk af $SiO_2$

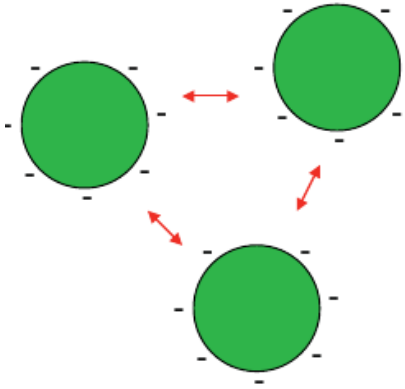


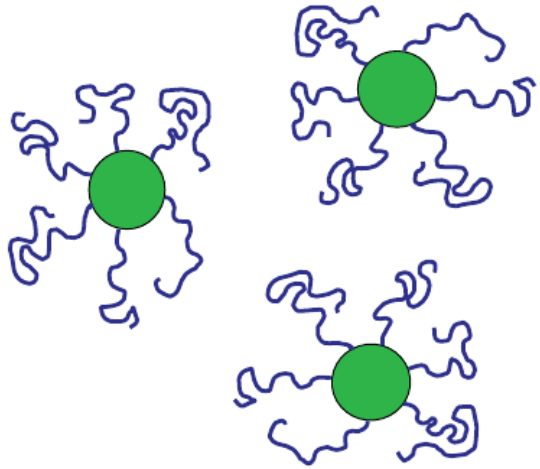
# Emulsion stabilitet

Emulsion: Væske opløst I væske.




Stabilisering:





# Emulsioner

**Mayonaisse**:

25% Vand f.eks. citron saft / eddike
75% Olie f.eks oliven olie
Surfaktant i form af æggeblomme.

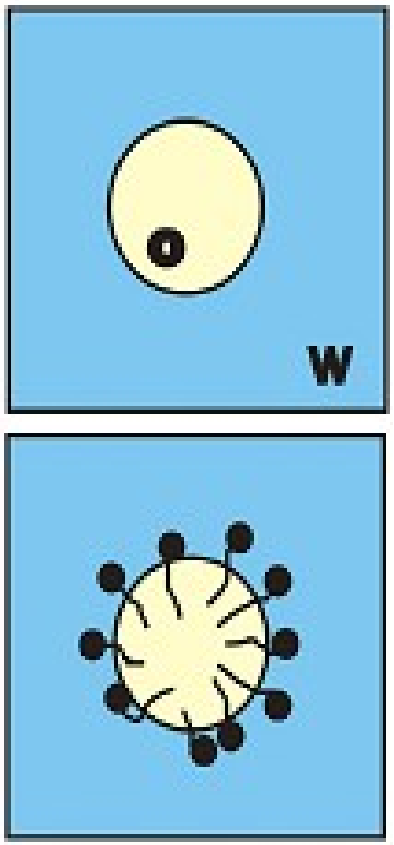
**Opskrift:**

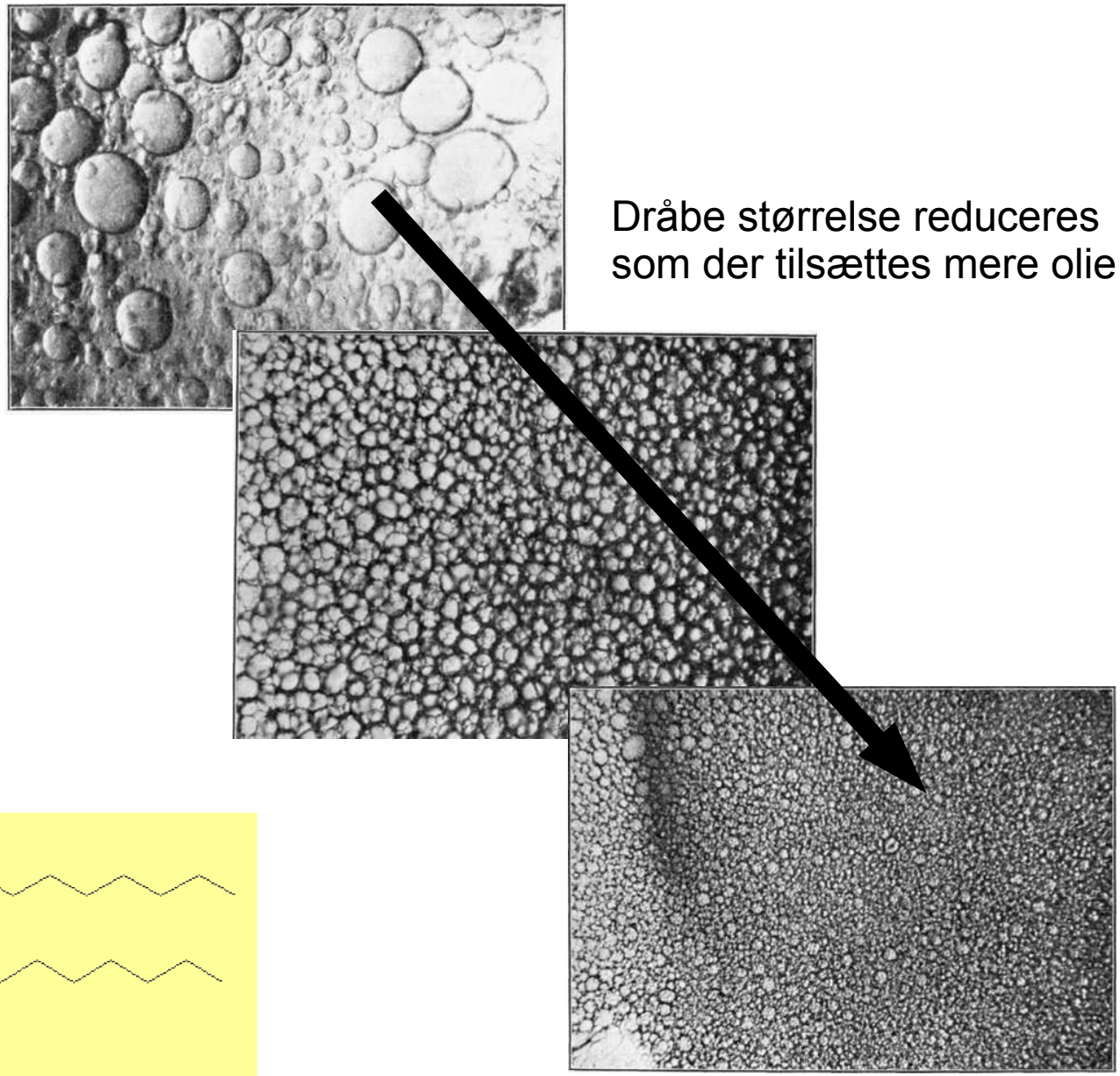
Start med at bland æg + eddike.
Tilsæt olie gradvist under omrøring.

Salt+peber til sidst.

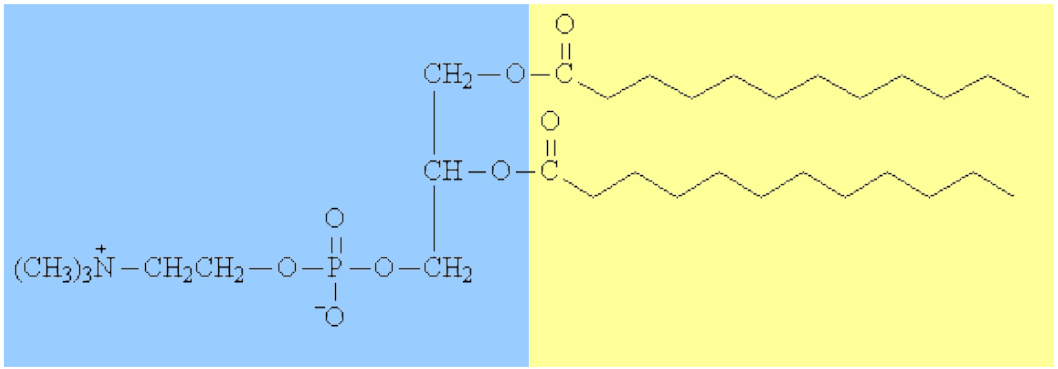
Vigtig alle ingredienser skal have samme temperatur.

# Mayonaisse



Dråbe størrelse reduceres som der tilsættes mere olie.

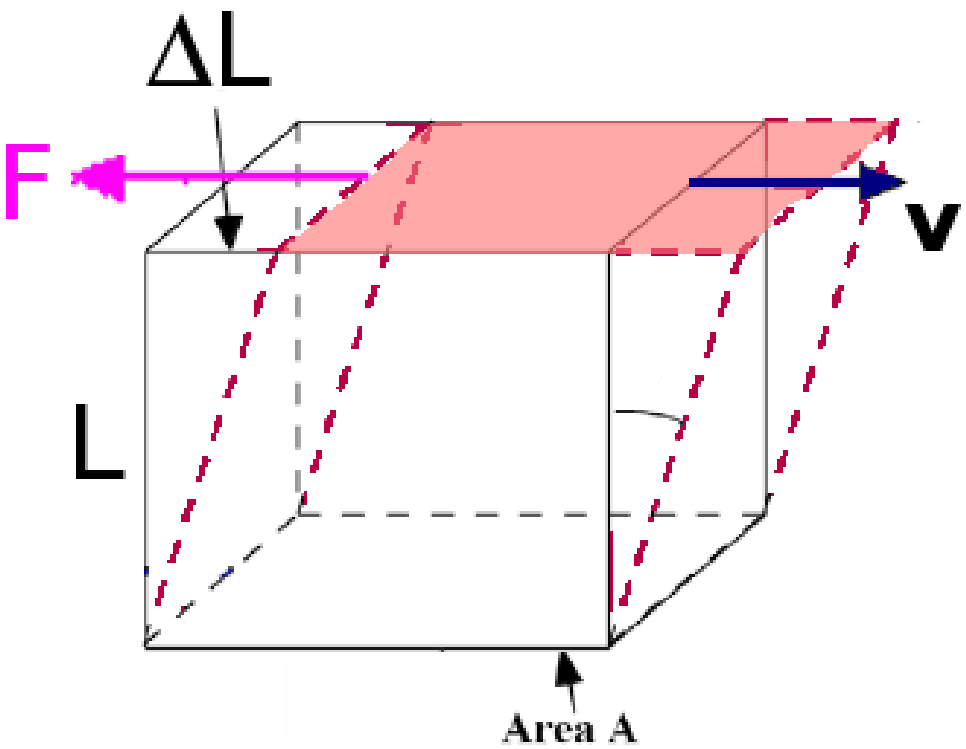


Phosphatidylcholine (lecithin)

Kilde: chestofbooks.com/food/science 200X

# Viskositet

F = viscositet V A/L




| Væske | Viscositet mPa s |
|---|---|
| Helium | 0.0033 (4K) |
| Luft | 0.0179 (15deg) |
| Vand | 1.00 (20deg) |
| Honning | 10000 (20deg) |
| Glycerin | 1420 (20deg) |
| Glas (smelte) | $10^6$ (700deg) |
| Tjære | $30x10^6$ (20deg) |
| Glas | $10^{21}$ - $10^{24}$ |

# Seje væsker

Tjære dråbe eksperimentet. Queensland universitet.

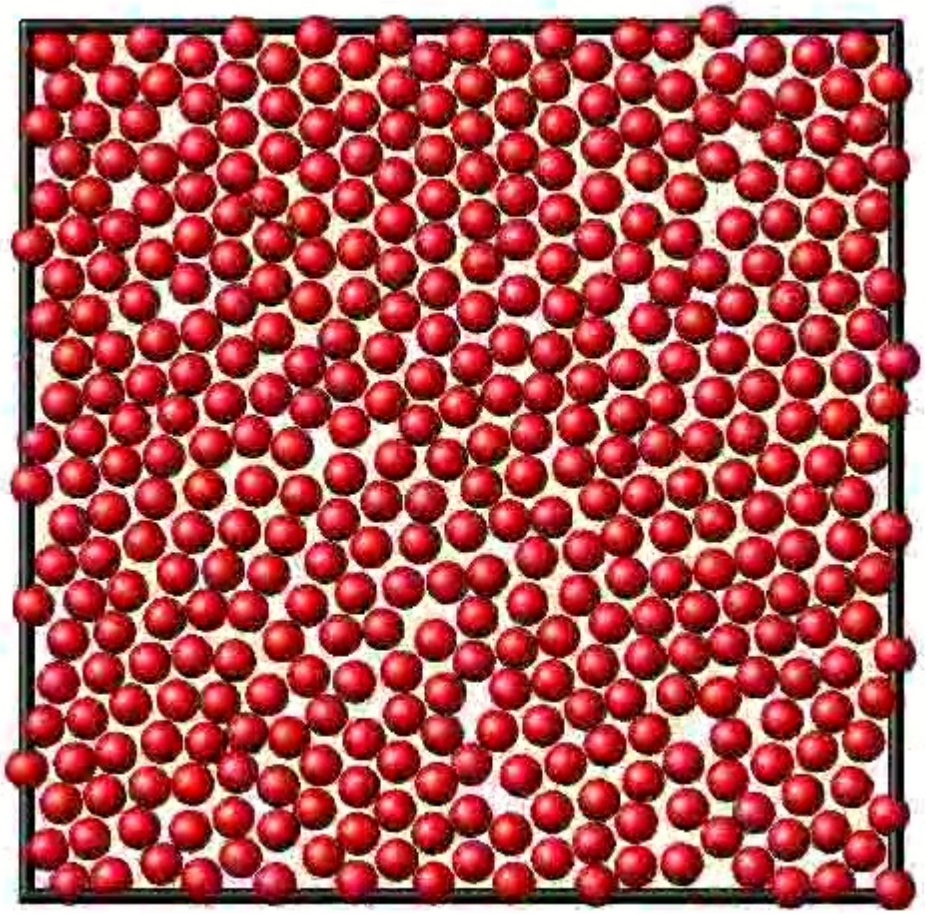
9 dråber er faldet siden det startede I 1930.

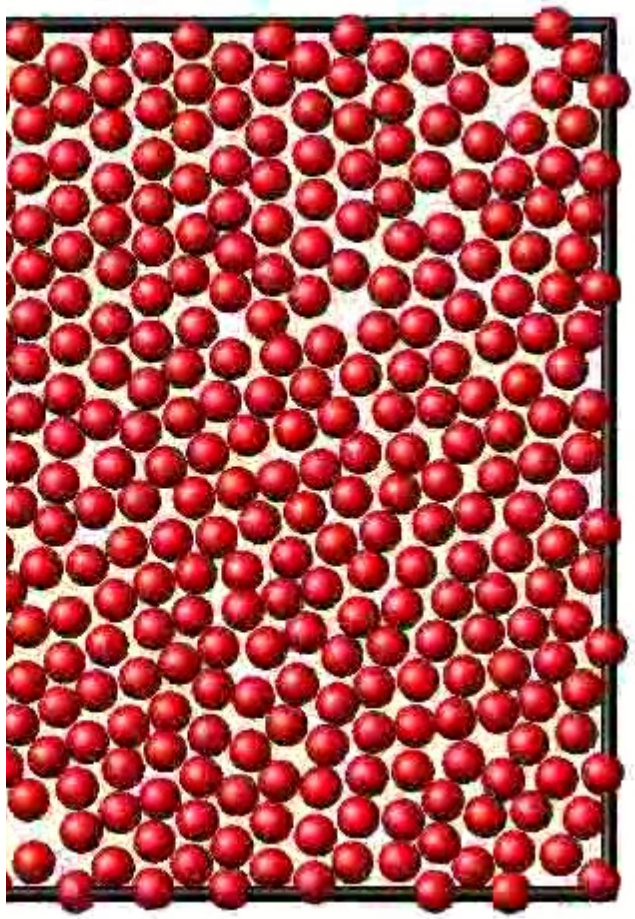
Tjære er en blanding af mere end 200 typer af lange polymere.

Time lapse film over et 1år.

http://smp.uq.edu.au/content/pitch-drop-experiment

# Krystal / glas





Langsom nedkøling

Ultrahurtig nedkøling

Glas har strukturen fra væsken, men er fråsset. Ingen dynamik.

# Fast OG Flydende

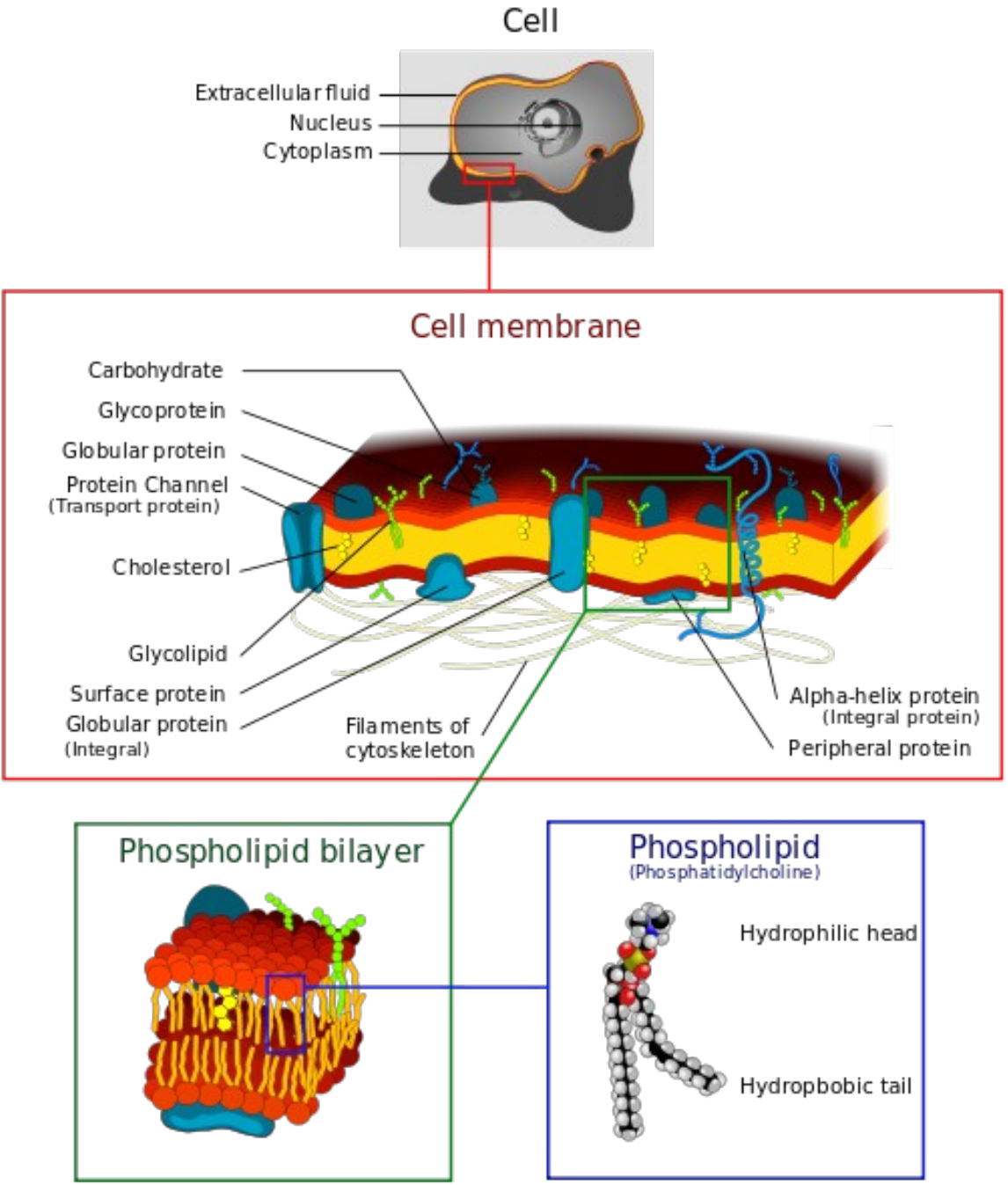
Kilde youtube: A pool filled with non-newtonian fluid

**Opskrift**:
Vand
Kartoffelmel

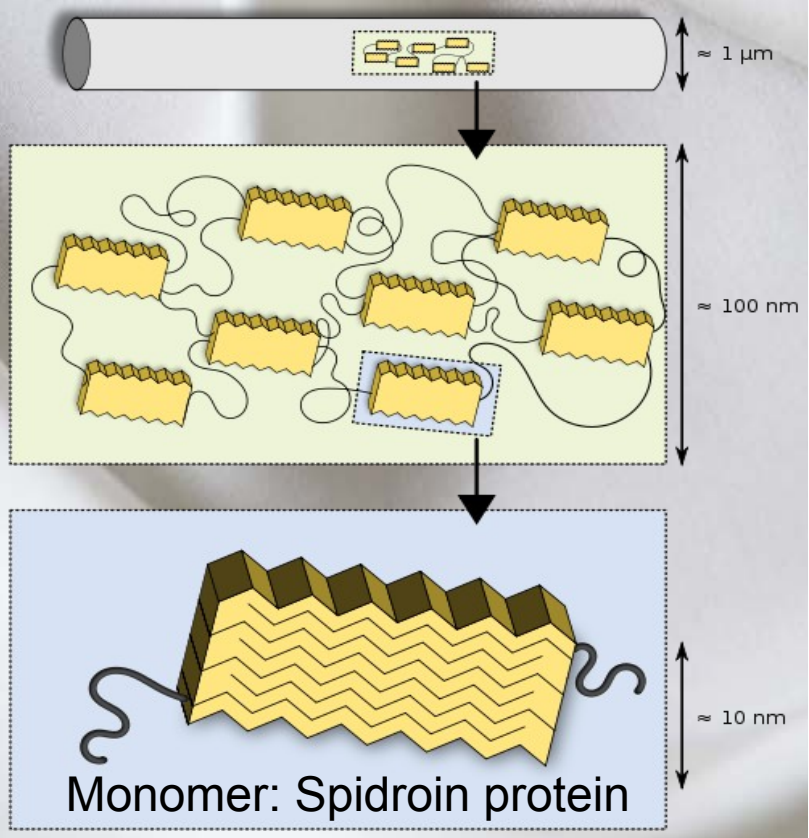
# Fast OG flydende

# Fast OG flydende

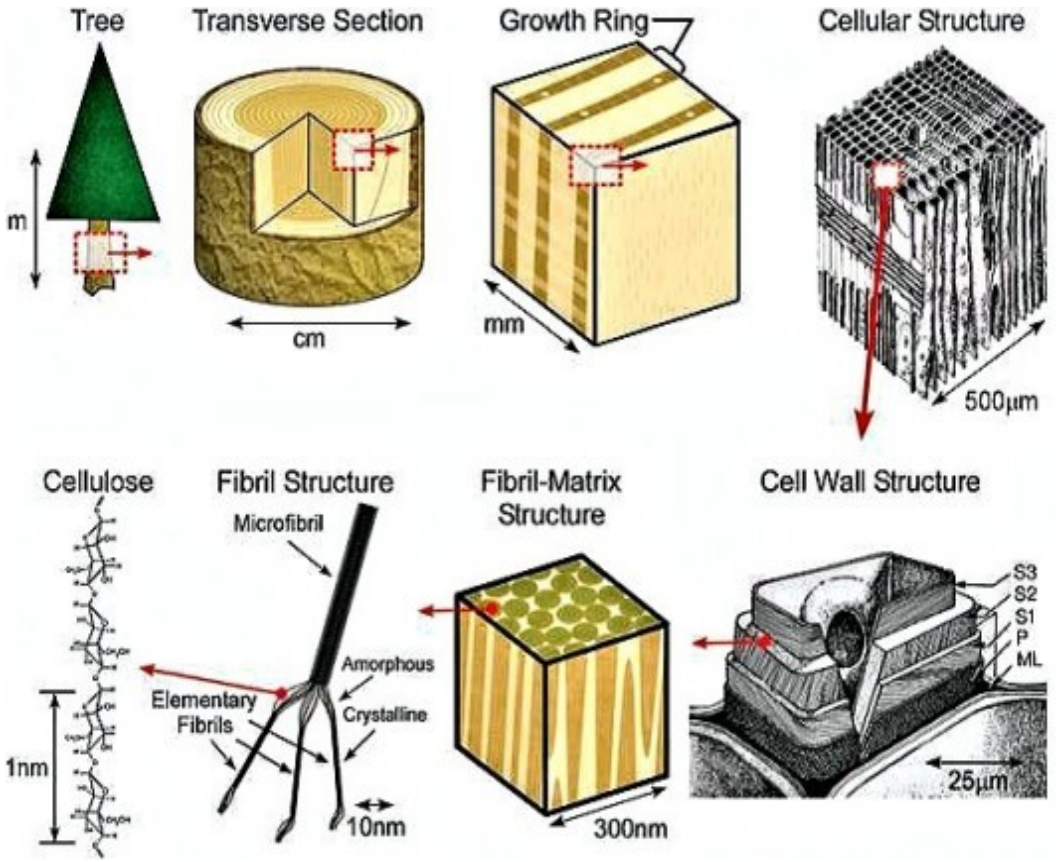
# Biologiske Materialer




# Naturlige polymere: Silke

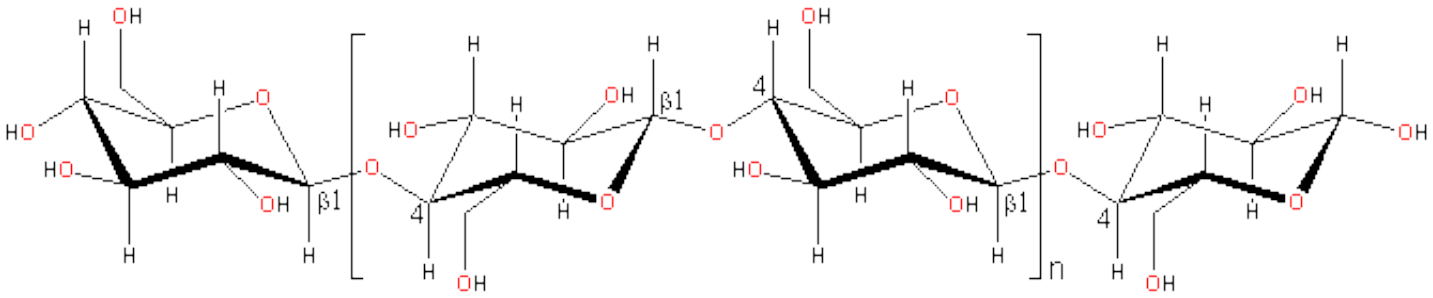


# Naturlige polymere: Cellulose

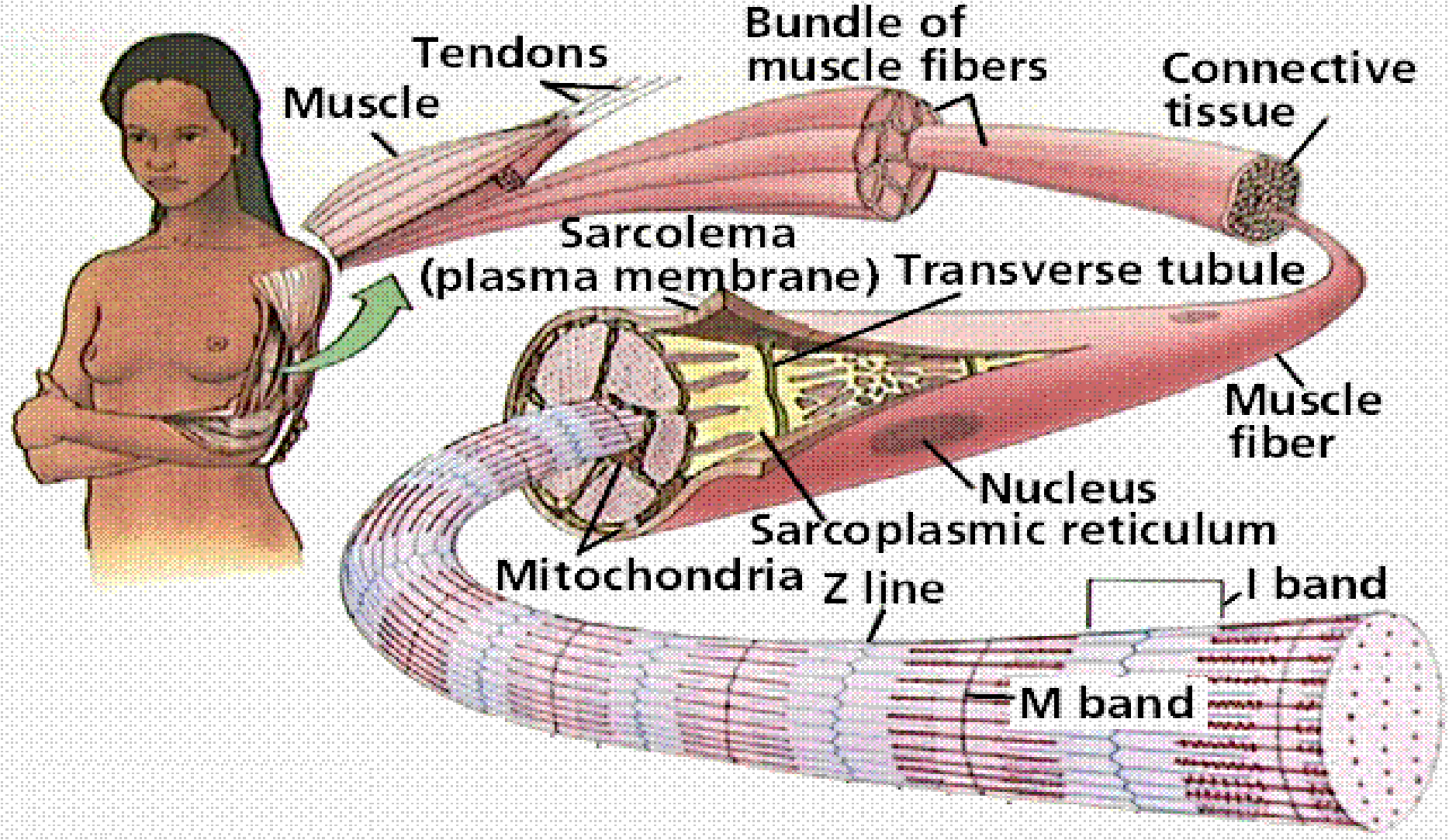



50% af vægten af træ er cellulose

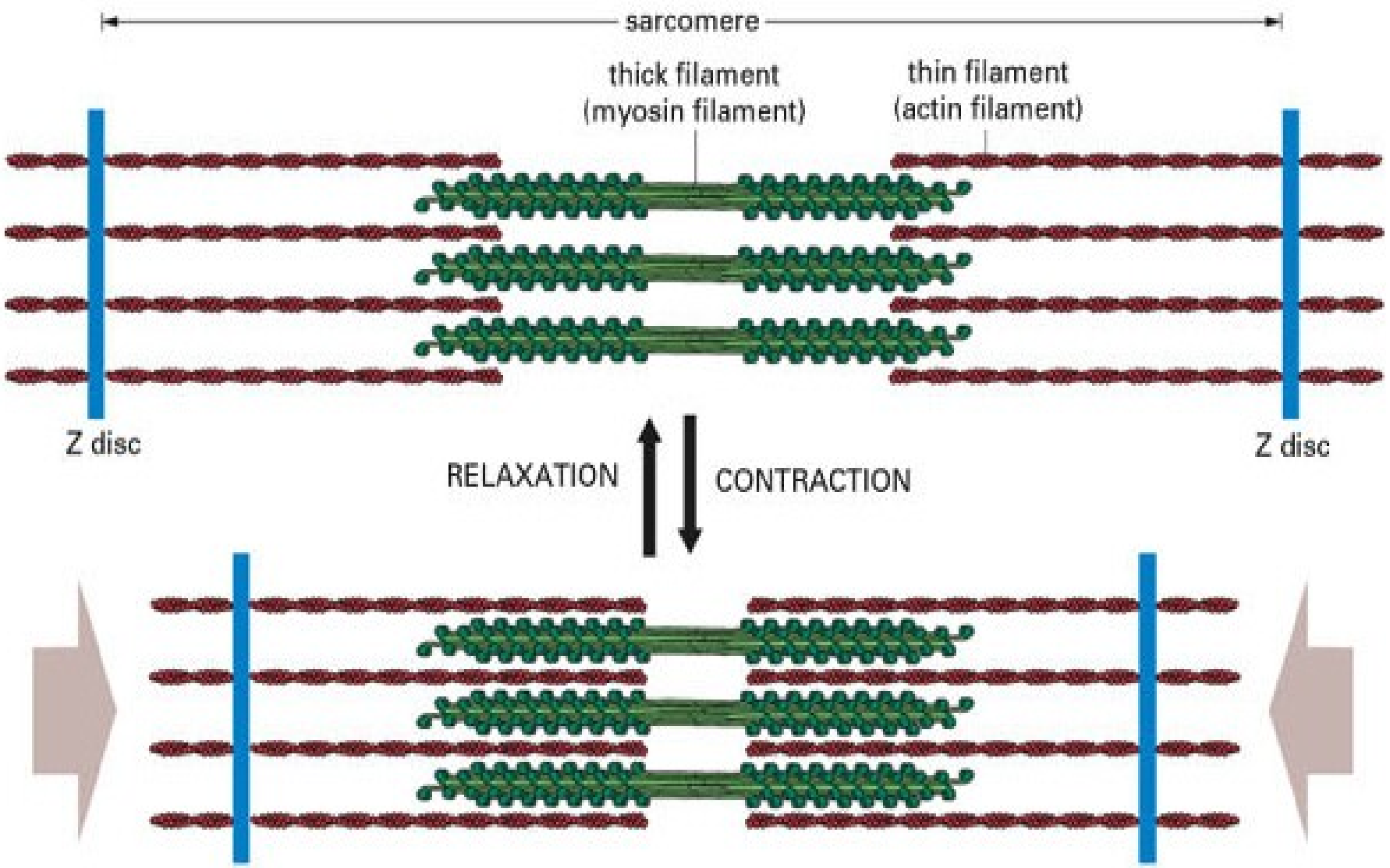
90% af vægten af bomuld er cellulose.

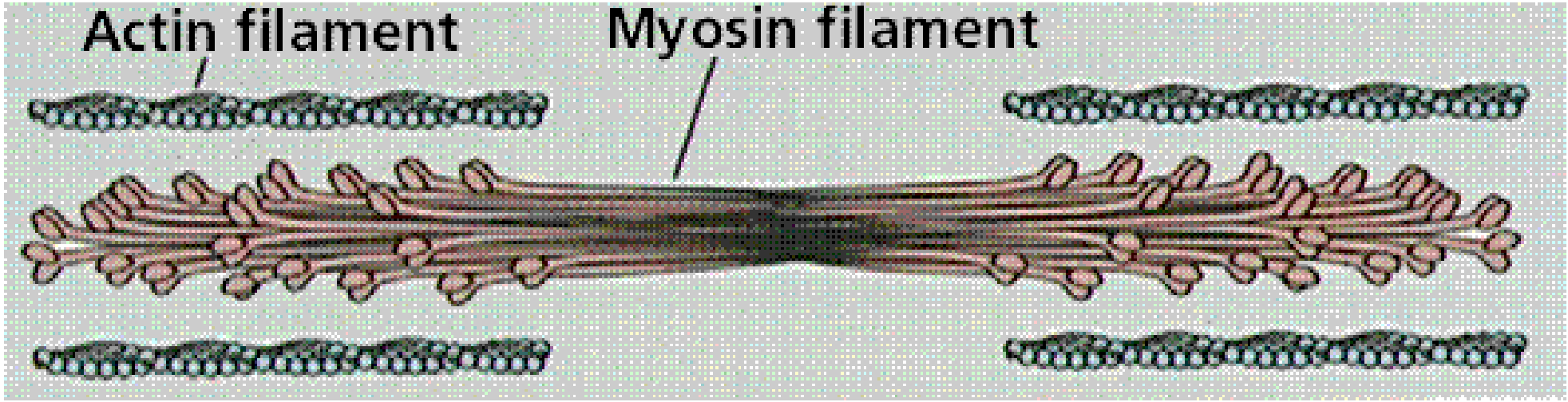
# Muskler

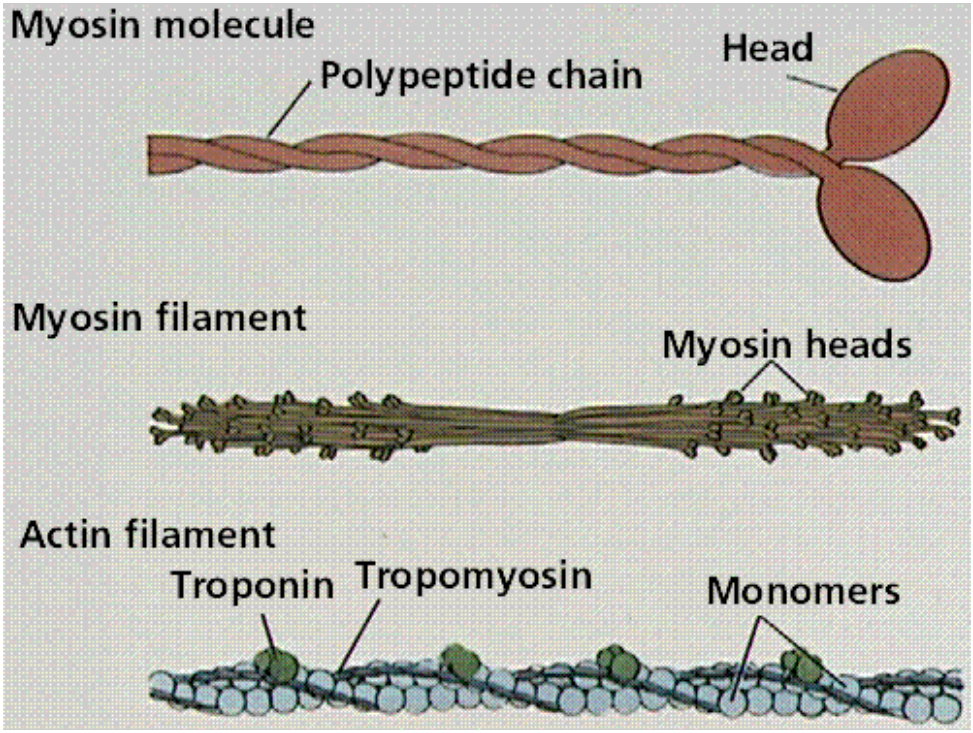

Tendons
Muscle
Bundle of muscle fibers
Connective tissue
Sarcolema (plasma membrane)
Transverse tubule
Muscle fiber
Nucleus
Sarcoplasmic reticulum
Mitochondria
Z line
I band
M band

# Muskler


sarcomere
thick filament
(myosin filament)
thin filament
(actin filament)
Z disc
Z disc
RELAXATION
CONTRACTION

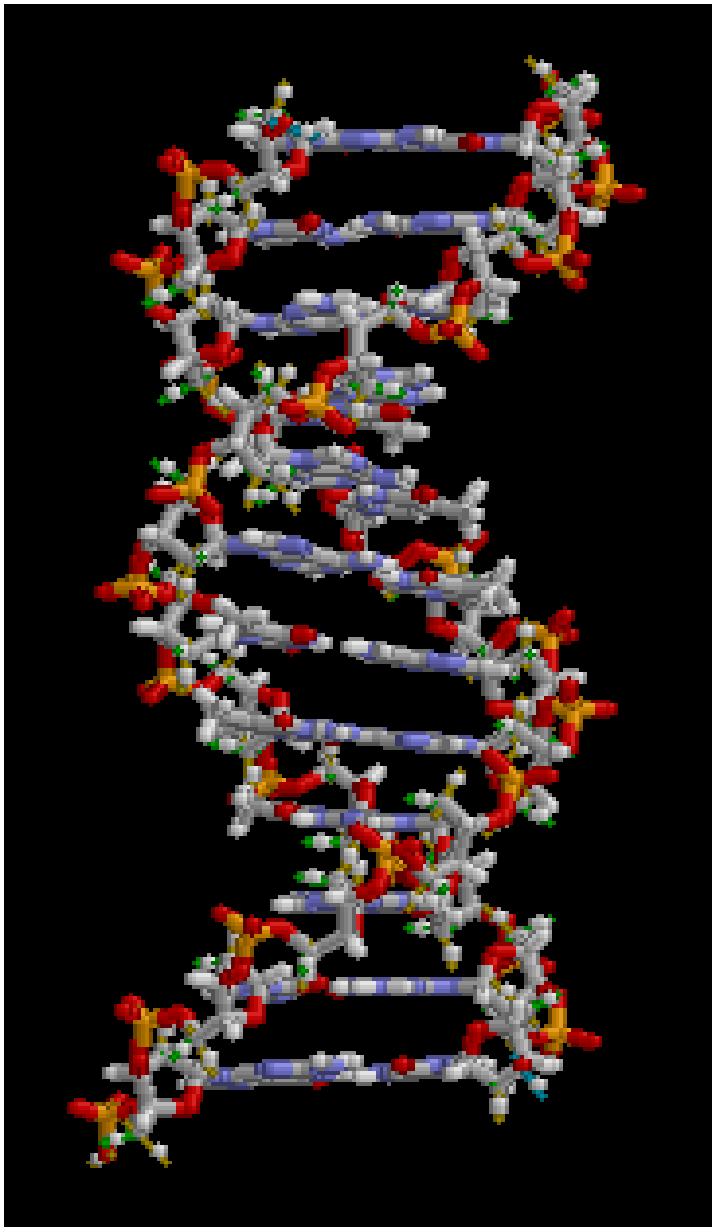
# Muskel

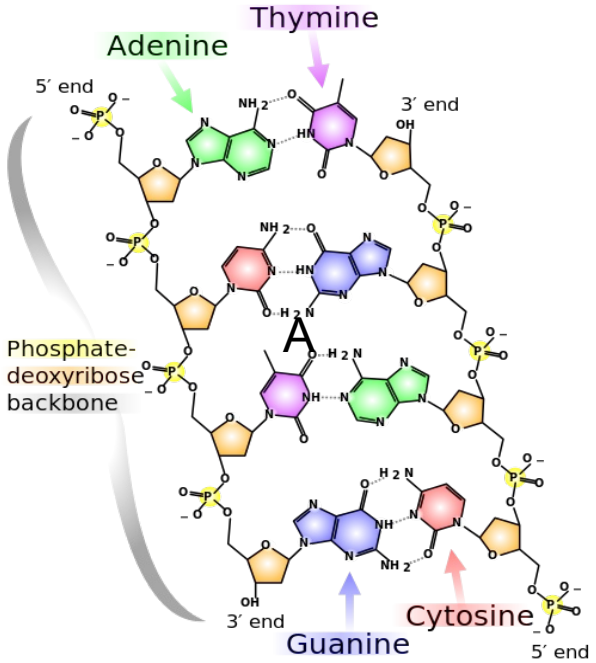

Actin filament
Myosin filament


Myosin molecule
Polypeptide chain
Head
Myosin filament
Myosin heads
Actin filament
Troponin
Tropomyosin
Monomers

# Muskel

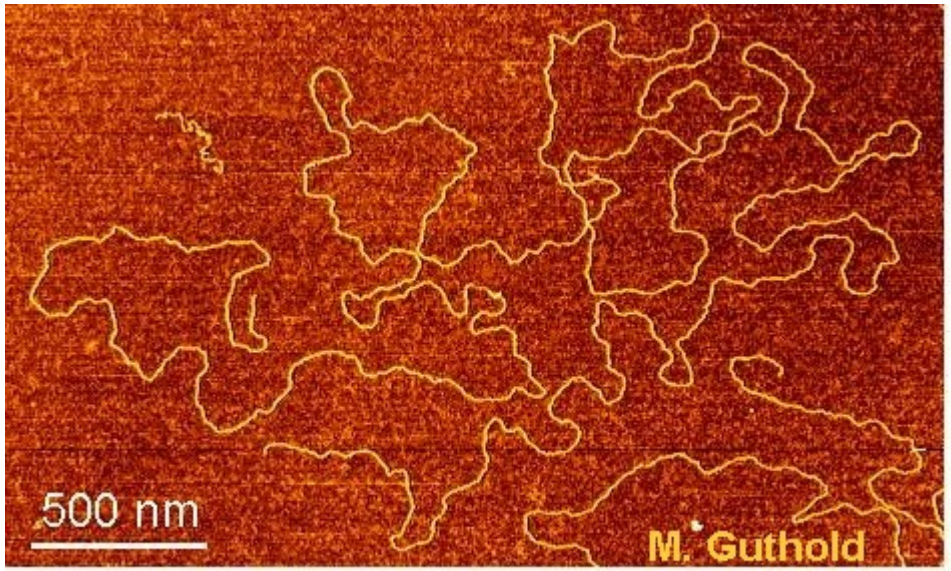
# DNA





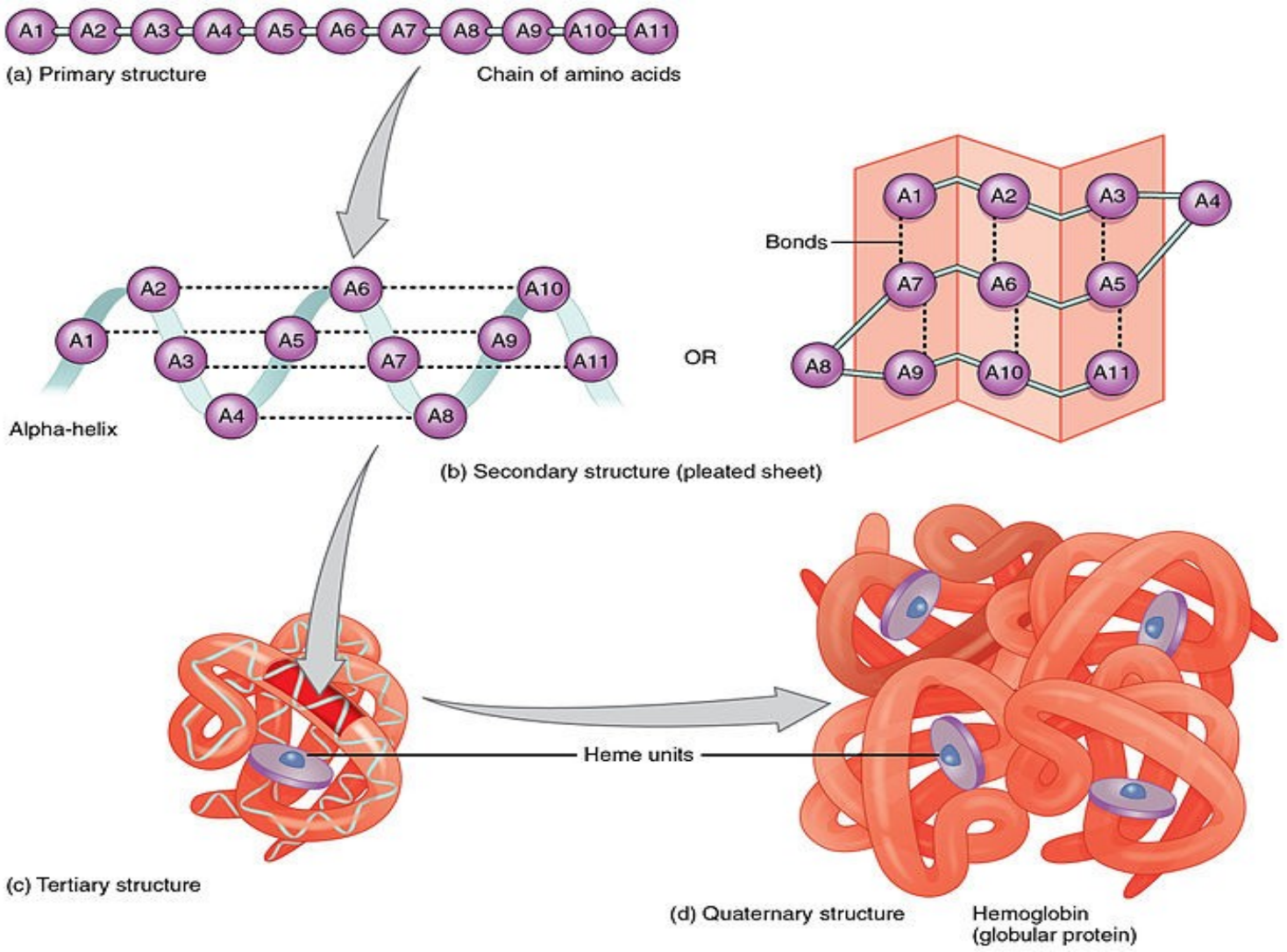

Polymer bestående af adenin, thymin, cytosin, guanin.

Menneske:
ca. 5 cm DNA I hvert kromosom x 46 kromosomer = 2 m.



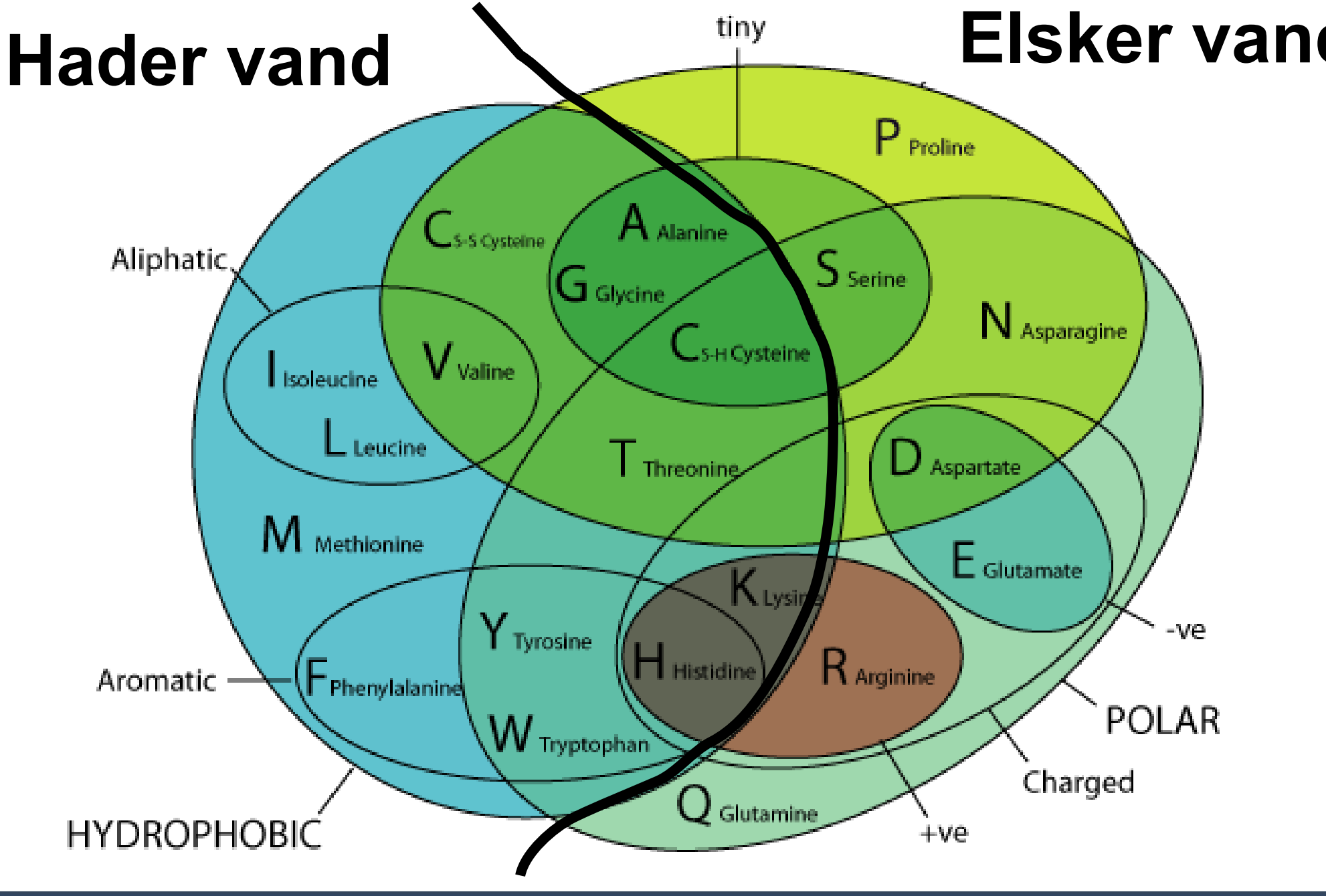

AFM billed 16um langt DNA λ-DNA

# Proteiner

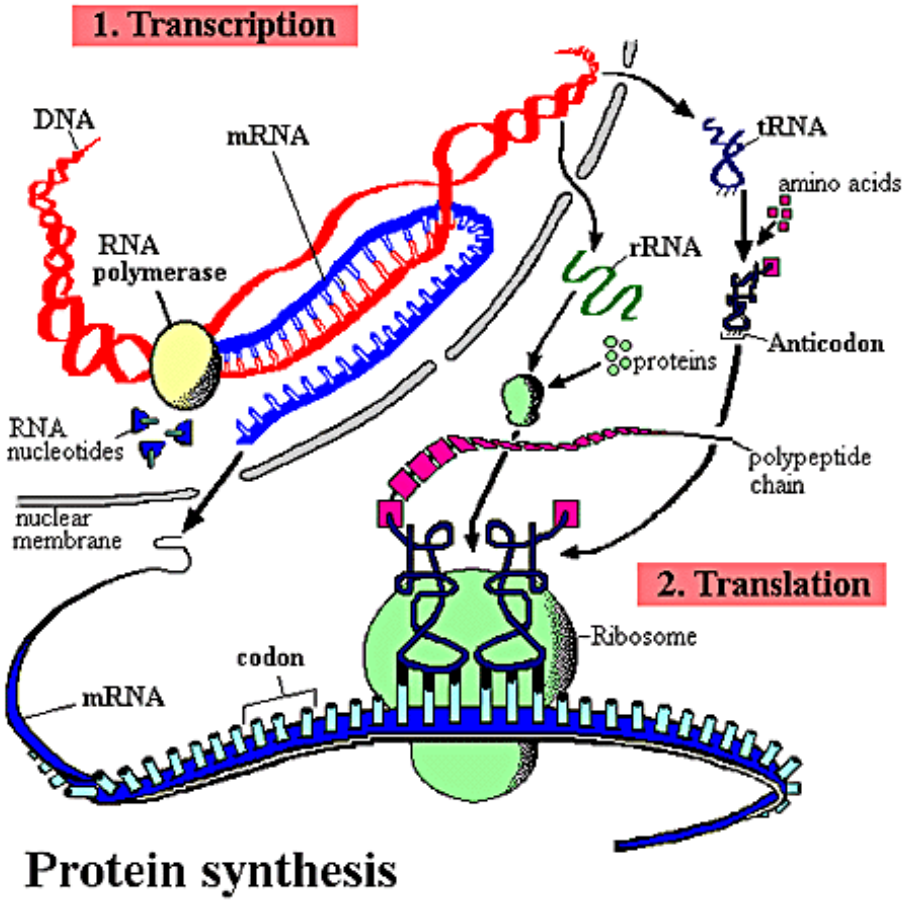



Sekvens af aminosyrer (20) bundet sammen med peptid bindinger.

# Aminosyrers forhold til vand



# Biologiens Central Dogma



Protein synthesis

**DNA**:
Information I base sekvens
ACATACACAACAACCACA

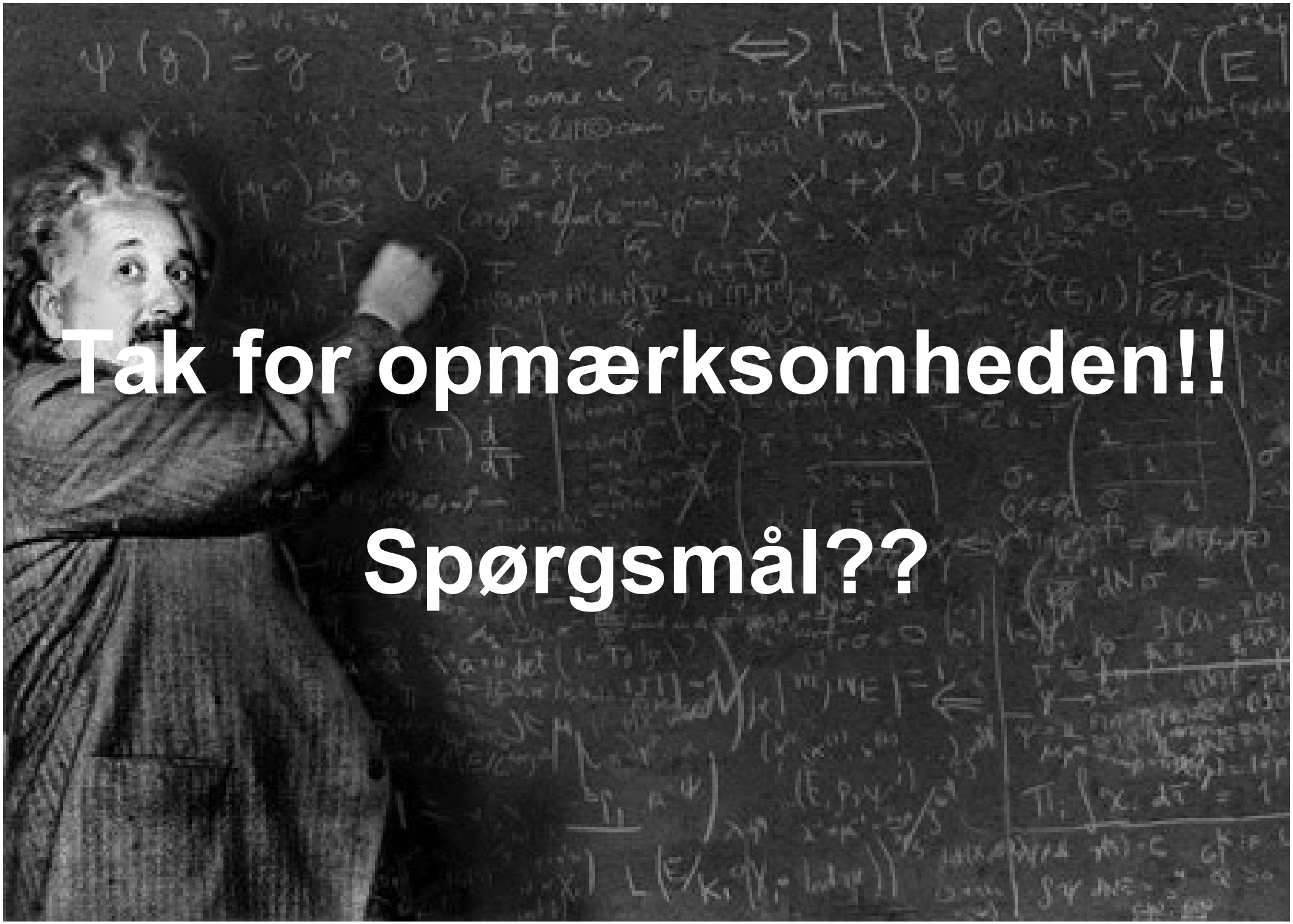
↓ biologi

**Protein**
Aminosyre sekvens
MGHFTEEDKATITSLWGKVN

↓ selv-bygning

Foldning af protein med specifik 3D struktur.

"Livets lego" klodser bygges vha. selv-bygning!


Tak for opmærksomheden!!
Spørgsmål??