biomechanics

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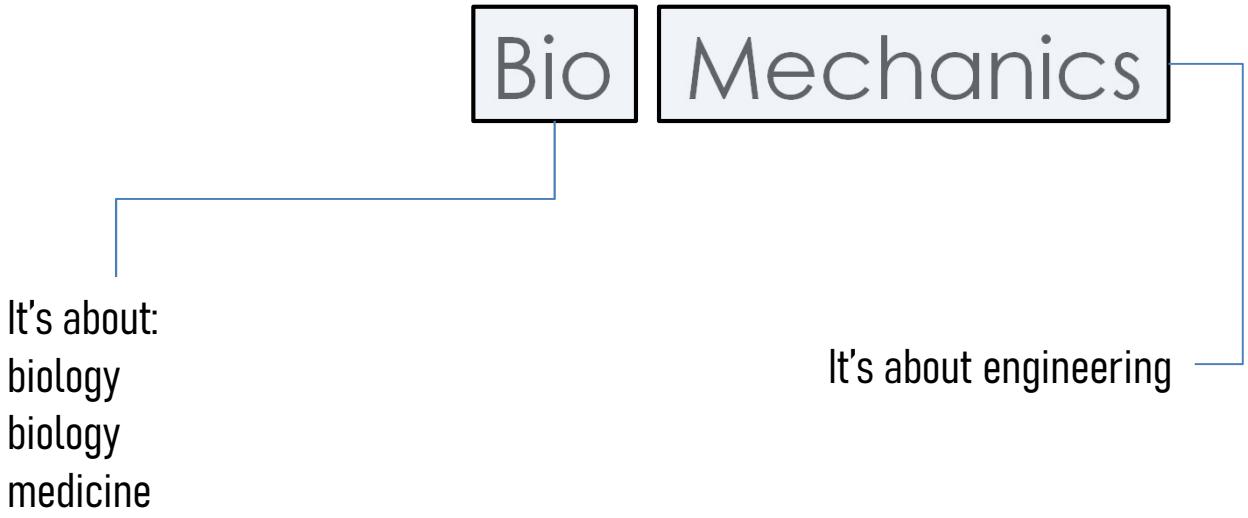
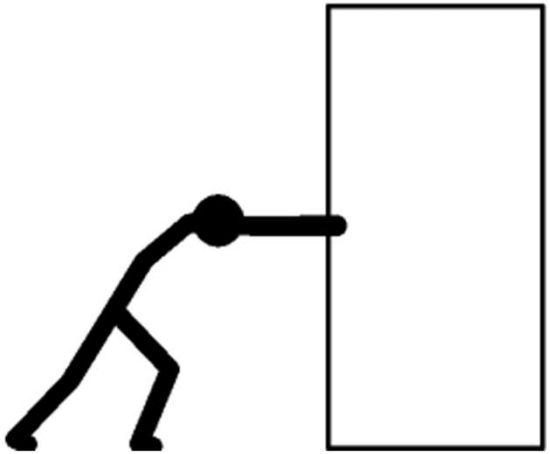

Bio
Mechanics
It's about:
biology
biology
medicine
It's about engineering

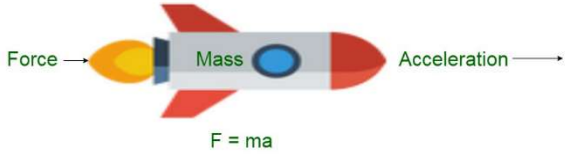
- **Biomechanics** is the study of the **structure**, **function** and **motion** of the mechanical aspects of biological systems, at any level from whole organisms to organs, cells and cell organelles, using the methods of **mechanics.**
- **Biomechanics** is a branch of **biophysics.**
- Biomechanics uses the principles of mechanics to explore **biological problems**.

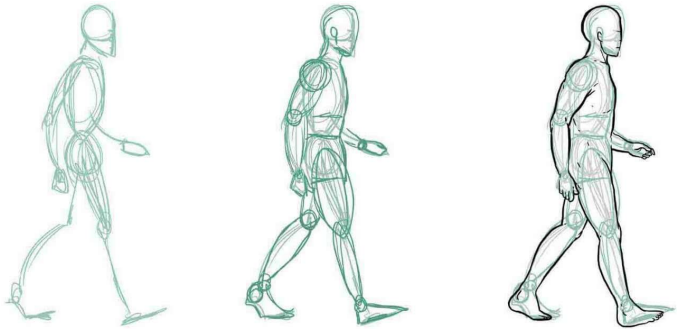
- **Mechanics** is a branch of physical science that deals with energy and forces and their effect on bodies

Pushing heavy object

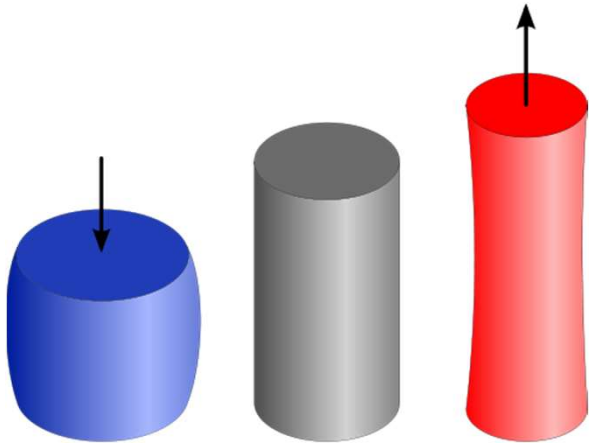


Mechanics is a branch of physical science that deals with energy and forces and their effect on bodies



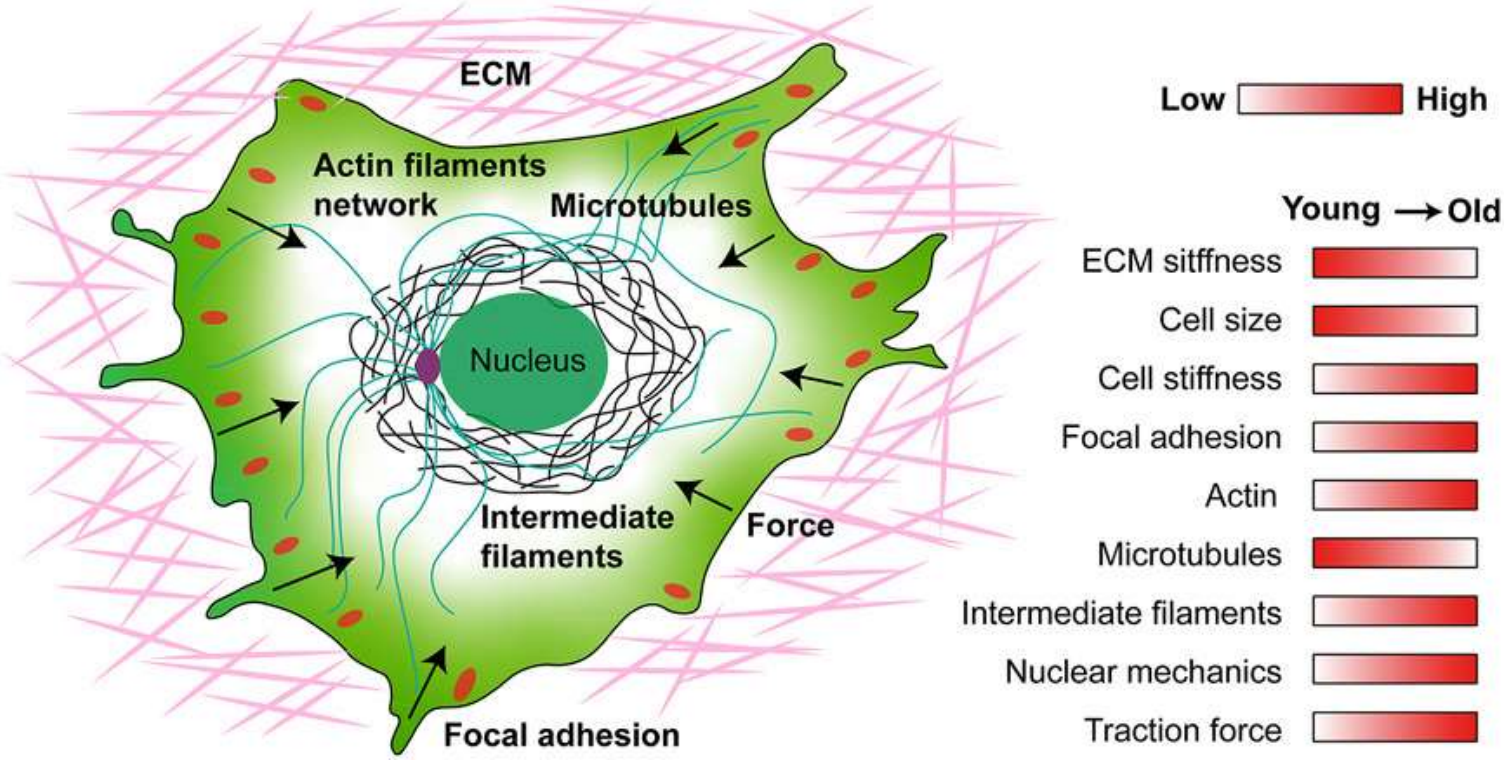


Dynamics



Mechanical behavior of materials

Applications in biology,
biomedical nanotechnology,
and medicine



Applications in biology,
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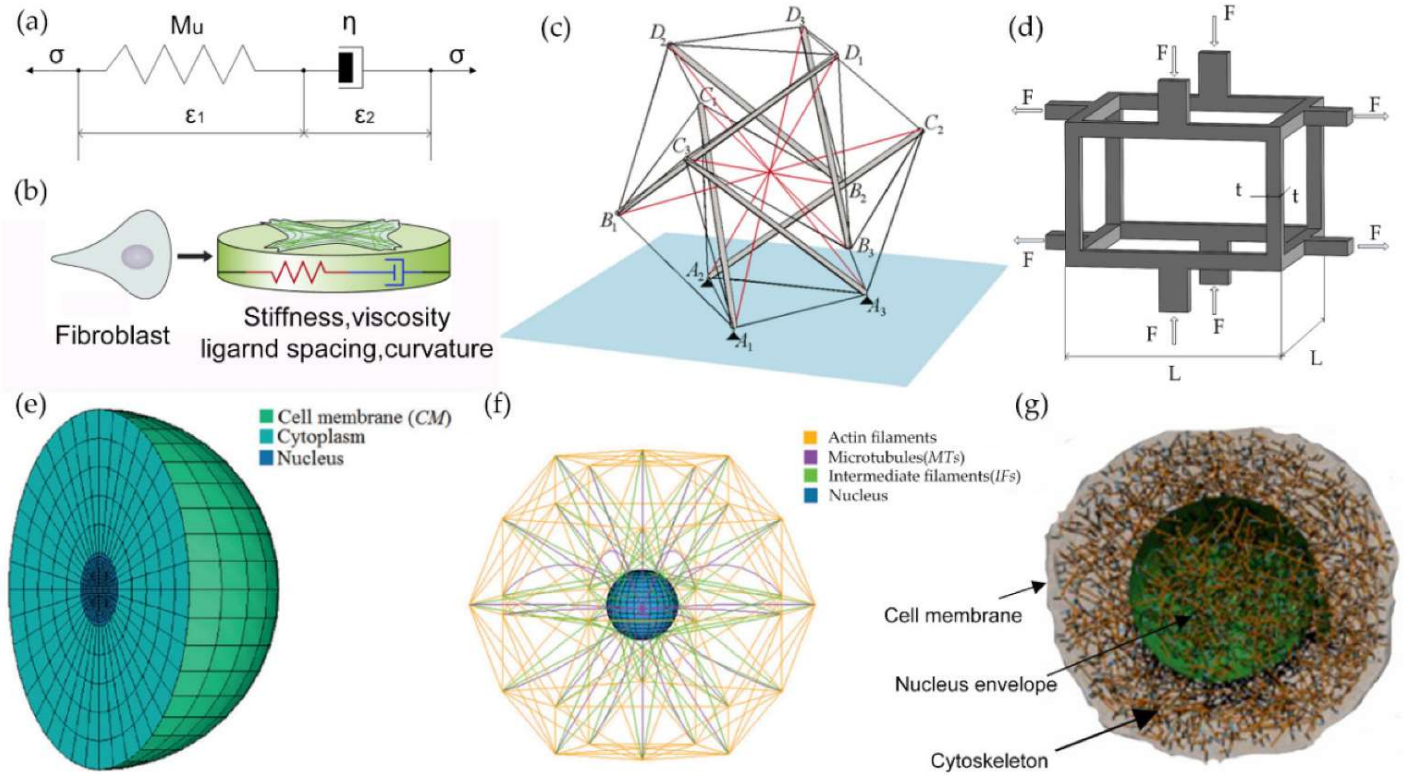

Applications in biology,
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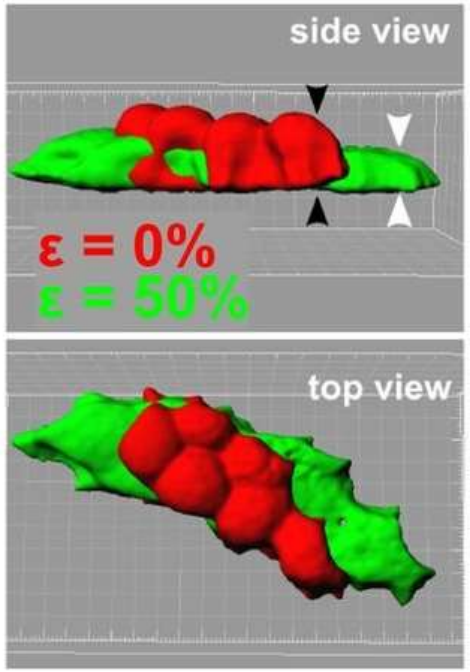
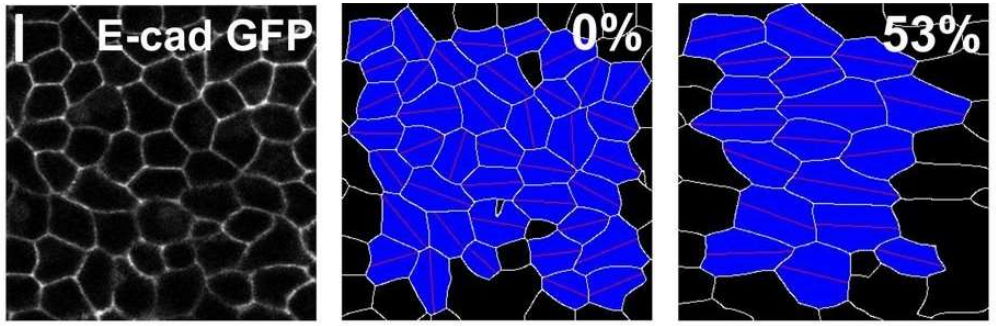
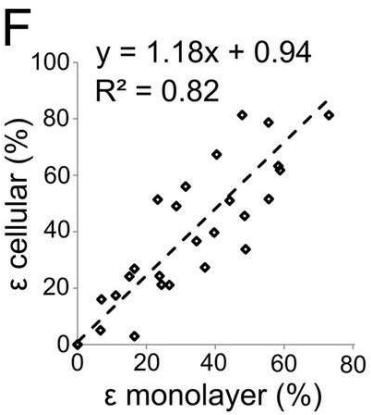
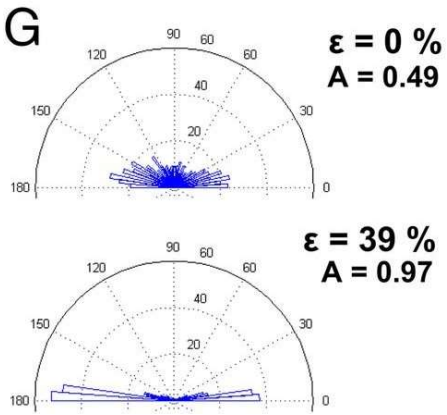


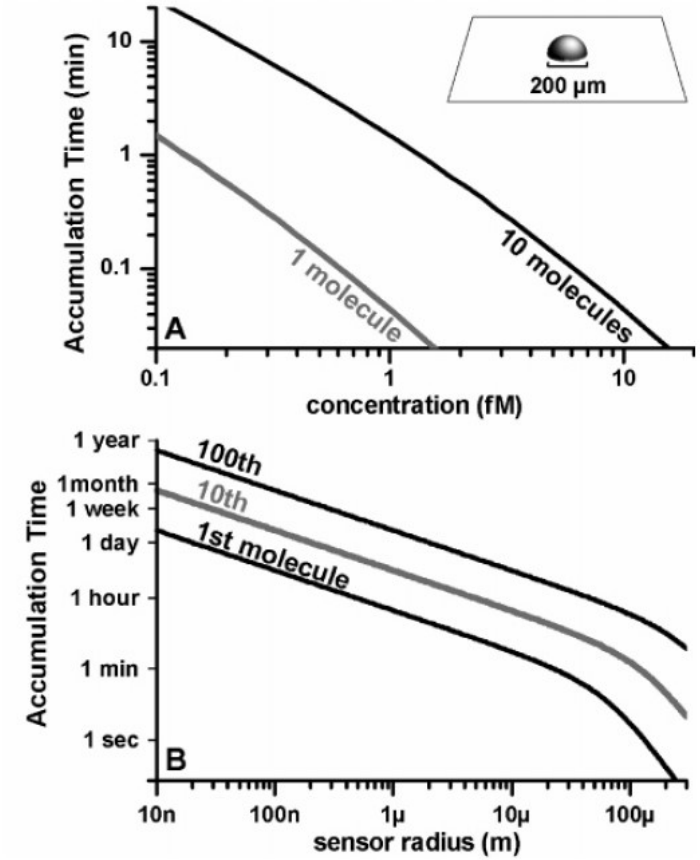




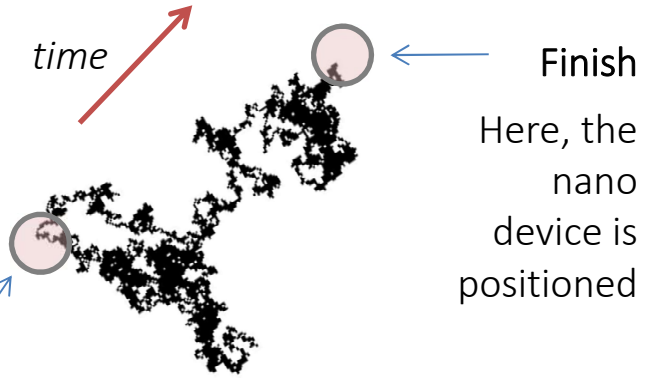


Applications in biology, biomedical nanotechnology, and medicine

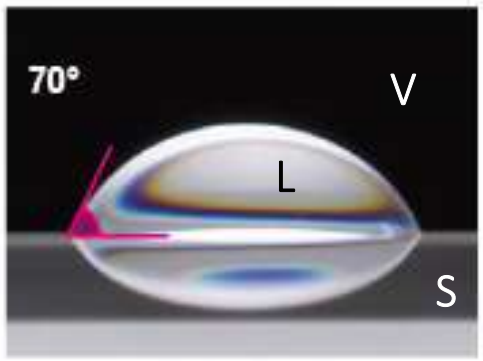
1 - EARLY DETECTION



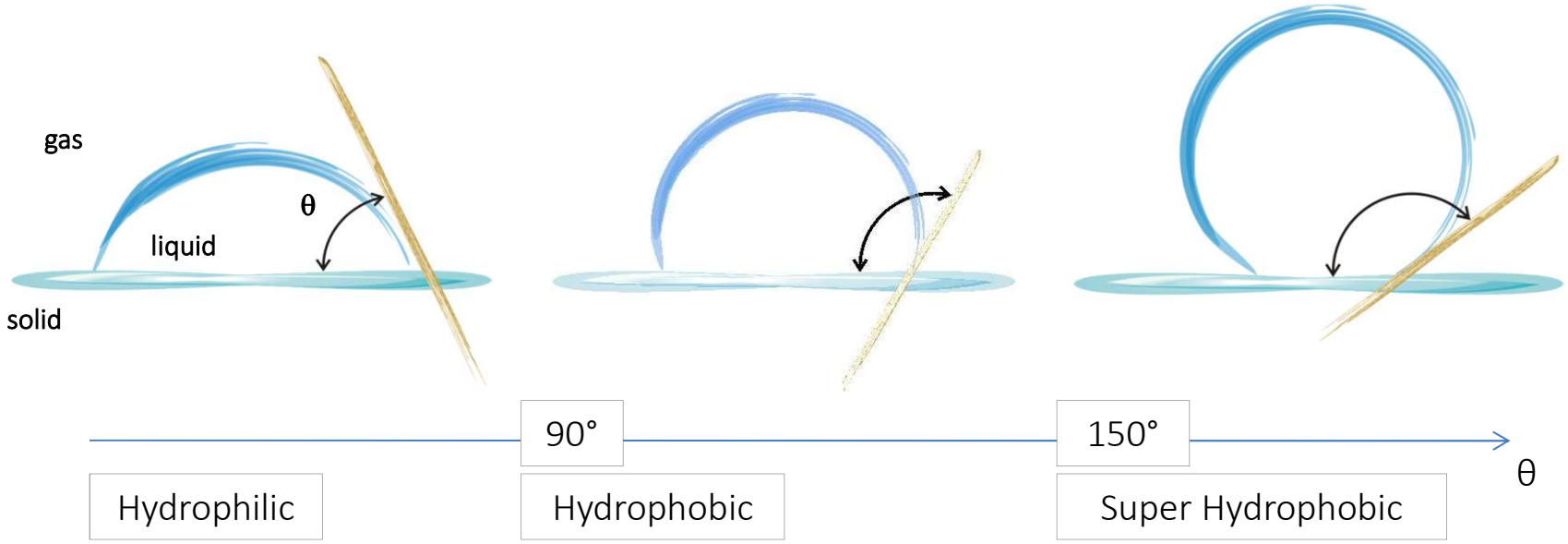
Nevertheless, driven by sole **diffusion**, a molecule may take impractical time scales to reach the active sites of the device.



Applications in biology, biomedical nanotechnology, and medicine

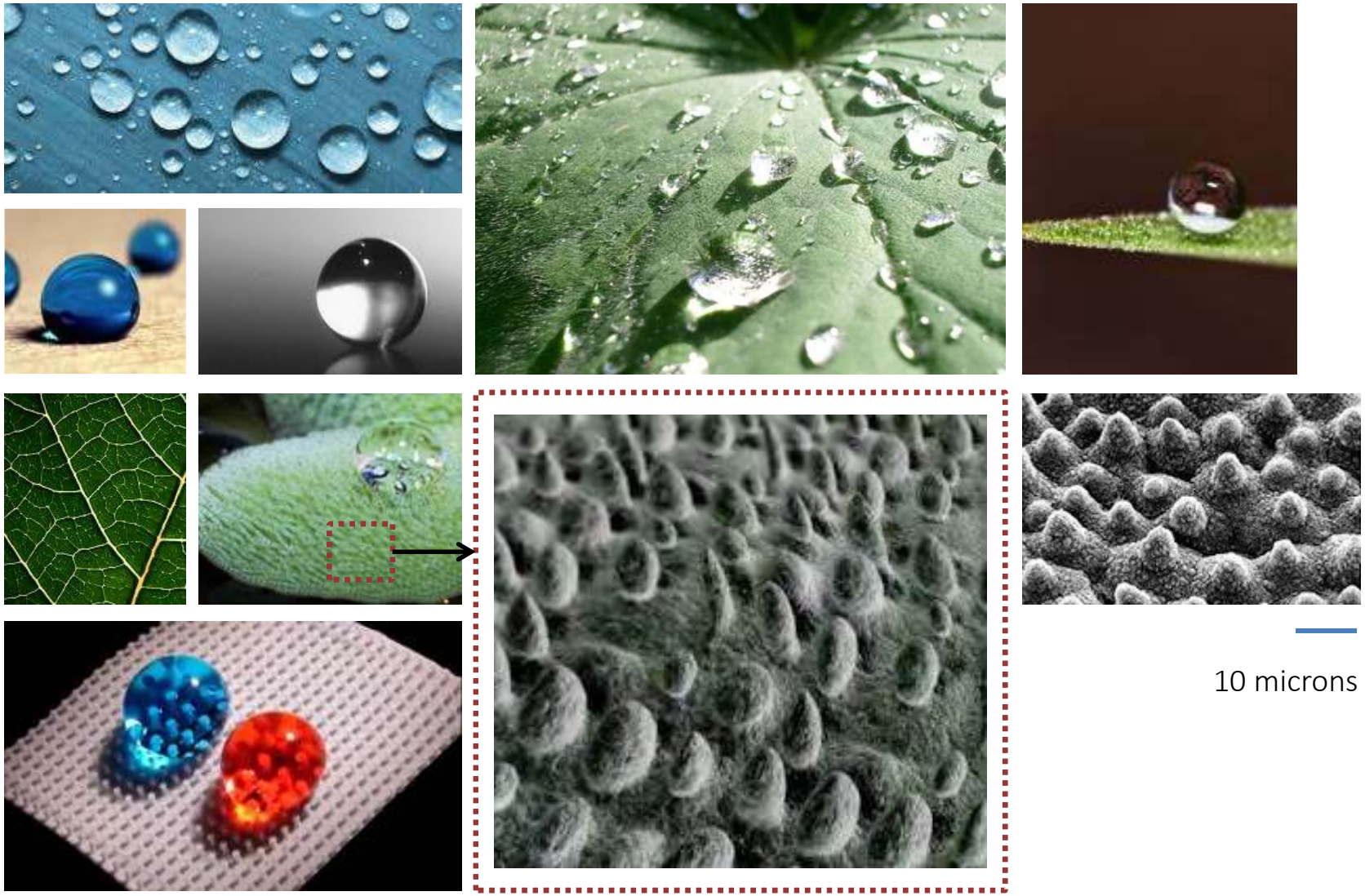


The **contact angle** is defined as the angle between the solid-liquid and the liquid-gas interface at the contact line where three immiscible phases meet



Applications in biology, biomedical nanotechnology, and medicine

1 - EARLY DETECTION



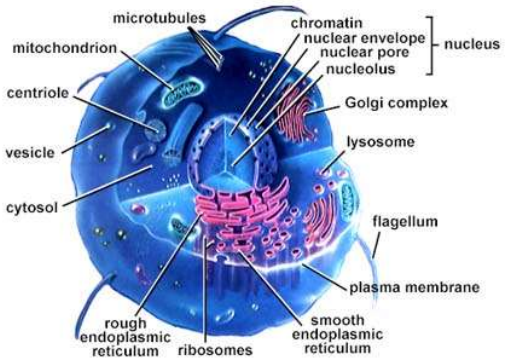
10 microns

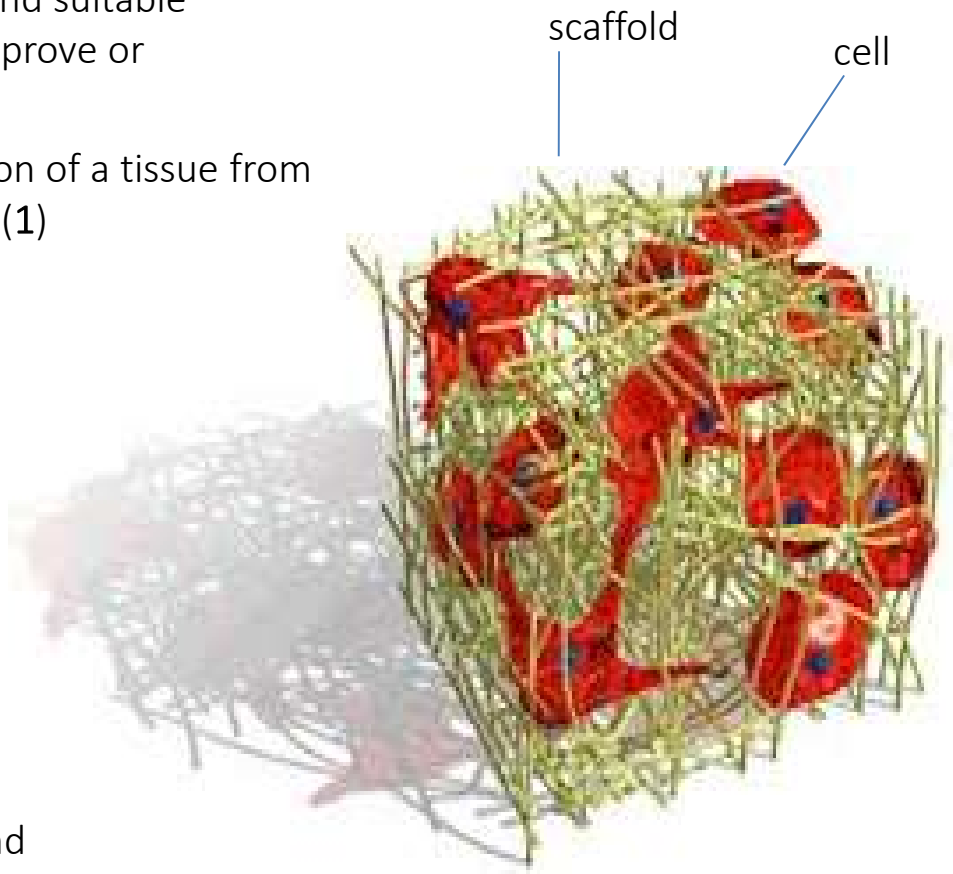
Applications in biology, biomedical nanotechnology, and medicine

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions

The scaffold functions for guiding the formation of a tissue from dissociated implanted cells *in vitro* and *in vivo* (1)

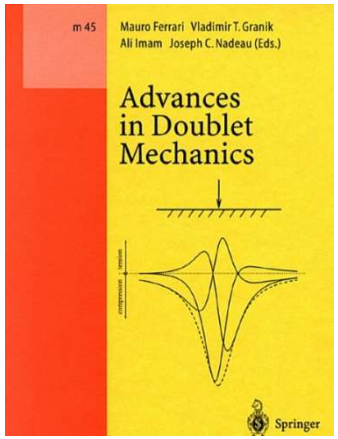
Cells as building blocks (2)

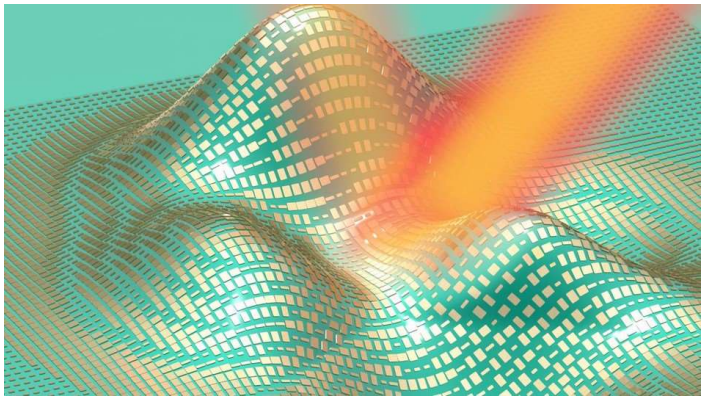


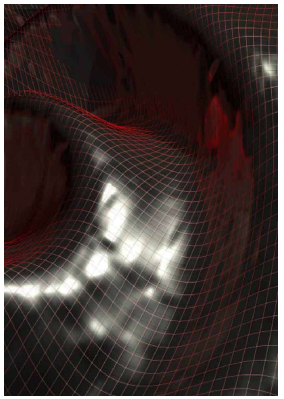


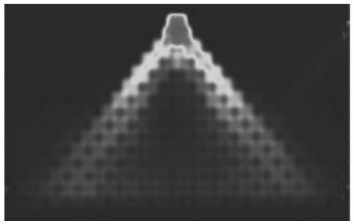
These bio-devices are hybrid systems that incorporate hierarchically features at large- and small- scales. Large scales are millimetres, and some tens of mm, or more, is the characteristic size of a scaffold.

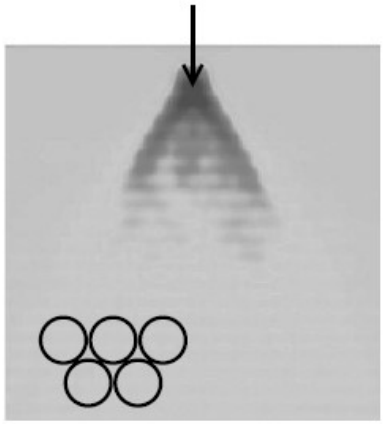
Applications in biology,
biomedical nanotechnology,
and medicine

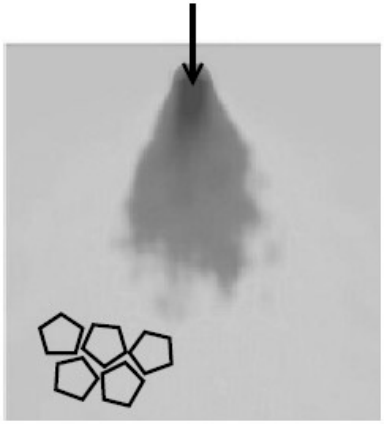


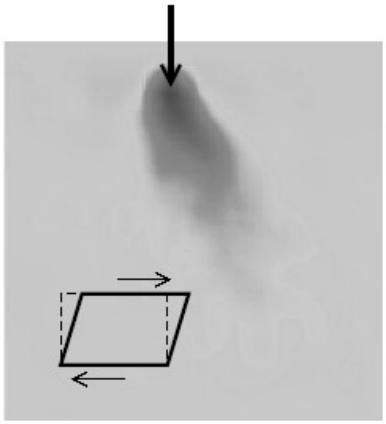


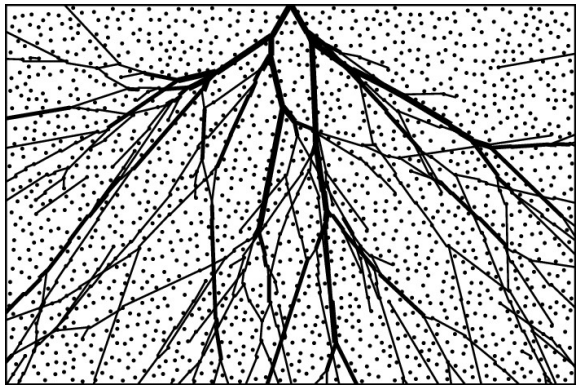








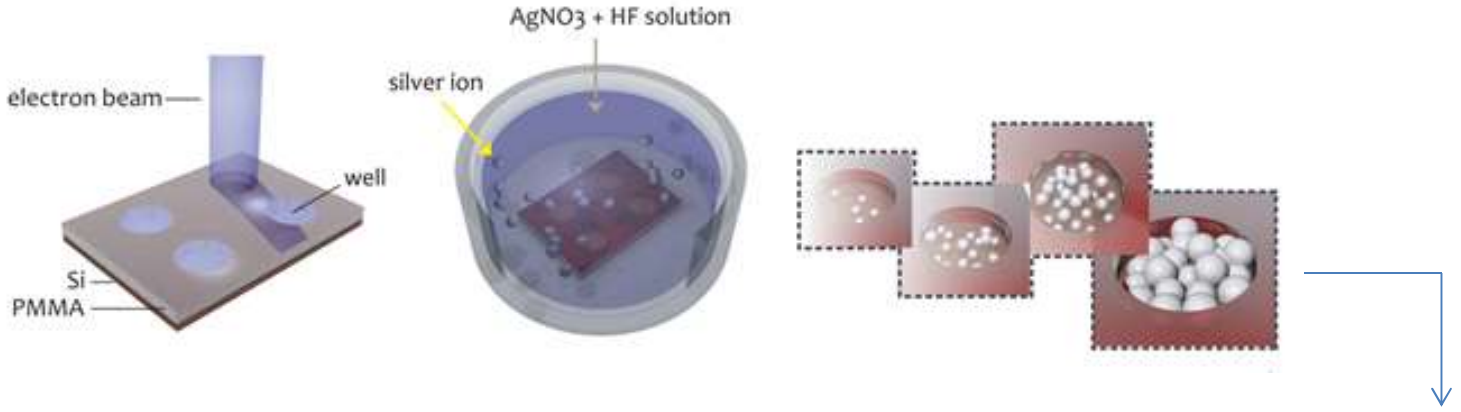


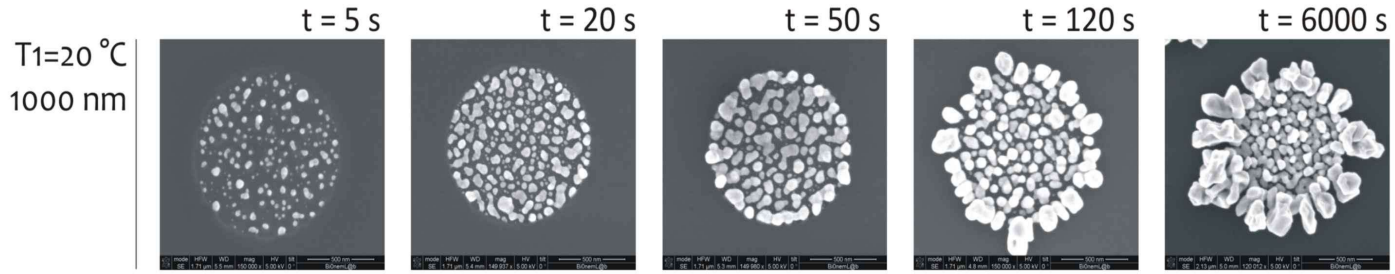


Applications in biology, biomedical nanotechnology, and medicine

The new revolution in **materials science** is being driven by our ability to **manipulate matter** at *the* **molecular level** to create structures with novel functions and properties.

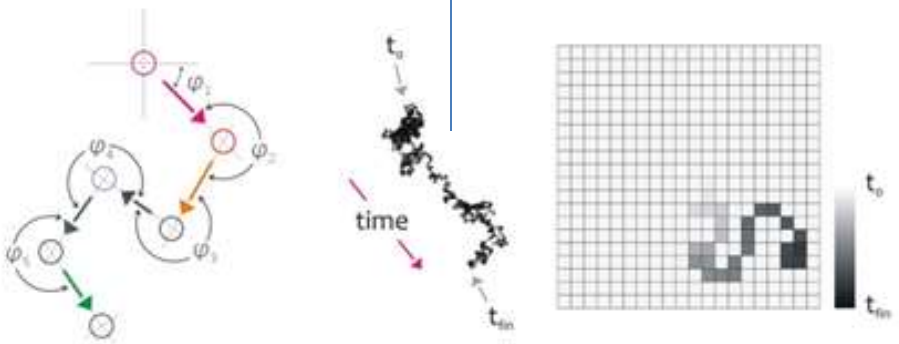
We explored new strategies to obtain **plasmonic metal nano-structures** through the combination of a top down method, that is electron beam lithography, and a bottom up technique, that is the chemical electroless deposition.



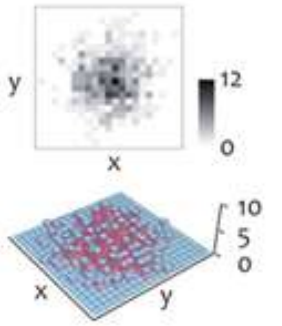


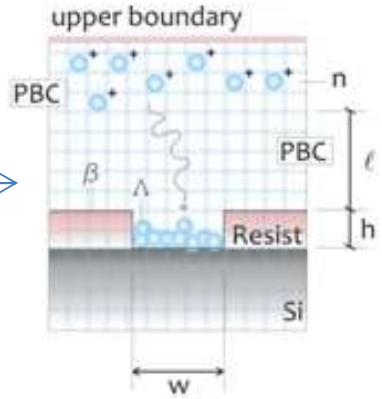
Applications in biology, biomedical nanotechnology, and medicine

Random walk

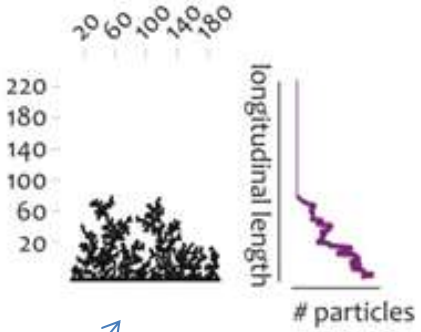


Gaussian distribution of a random walk

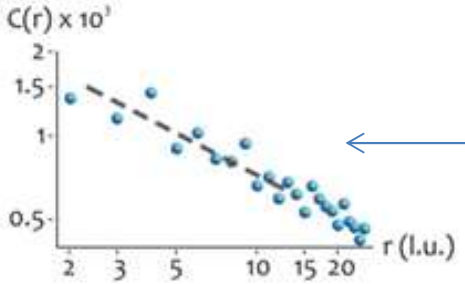




Aggregation scheme



Aggregate



PS of a numerical aggregate

outline

- Il metodo sperimentale. Le 4 forze della natura. Interazione forte, interazione debole, forza gravitazionale, forza elettromagnetica. Massa di un corpo. Quantità di materia. Densità. Gravitazione universale. Massa gravitazionale. Dipendenza della forza dalla massa e dal quadrato dell'inverso della distanza di due corpi. Concetto di forza nella teoria Newtoniana. Massa inerziale. Quantità di moto. Forza come variazione della quantità di moto. Pressione. Lavoro. Evoluzione del pensiero scientifico e contributo alla teoria della meccanica nei secoli.
- Richiami di matematica. Derivata. Derivata parziale e derivata totale. Significato fisico della derivata totale. Gradiente. Divergenza. Rotore. Energia potenziale. Campo. Forza come gradiente dell'energia potenziale. Potenziale di Lennard-Jones. Campo irrotazionale. Lagrangiana. Equazioni di Eulero-Lagrange. Matrici. Vettori, matrici e tensori. Convenzione degli indici ripetuti e notazione di Einstein. Tensore di Kronecker.
- Geometria delle masse. Area. Centro di massa. Momento di inerzia. Teorema degli assi paralleli. Esercizi.
- Moto. Gradi di libertà di un corpo rigido. Angoli di Eulero. Equazioni del moto e dinamica del corpo rigido. Equilibrio del corpo rigido. Statica.

outline

- Vincoli esterni. Determinazione delle reazioni vincolari necessarie all'equilibrio di un corpo. Reazioni interne. Sforzi assiali o normali. Sforzi di taglio. Momenti.
- Azioni interne. Tensioni. Equazione di equilibrio. Spostamenti e deformazioni. Equazioni di compatibilità. Legame costitutivo. Legame costitutivo elastico-lineare.
- Modelli reologici dipendenti dal tempo. Materiali visco-elastici.
- Il problema di De Saint Venant.
- Estensioni del problema di De Saint Venant e teoremi energetici. Energia di deformazione.
- Elementi di biomeccanica statistica. Coefficiente di diffusione molecolare. Coefficiente di diffusione longitudinale in fluidi biologici. Modello di Taylor. Entropia.
- Elementi di biomeccanica statistica. Interazioni superficiali. Interazioni di Van der Waals, interazioni steriche e covalenti. Potenziale chimico di interazione. Densità di energia superficiale all'interfaccia fra due corpi.

textboos

- Jacob N. **Israelachvili**, Intermolecular and Surface Forces, Academic Press.
- Y.C. **Fung**, Biomechanics: Mechanical Properties of Living Tissues, Springer.
- Y.C. **Fung**, Biomechanics: Motion, Flow, Stress and Growth, Springer.
- R. **Glaser**, Biophysics, Springer.
- E. **Viola**, Scienza delle Costruzioni: Teoria della Trave, Pitagora Editrice Bologna.
- J. **Barber**, Elasticity, Springer.
- L. **Corradi Dell'Acqua**, Meccanica delle Strutture, McGraw-Hill.
- W. M. **Saltzman**, Drug Delivery: Engineering Principles for Drug Therapy, Oxford University Press.