The Strange world of Bionanomachines

Very remarkably, many of nanomachines will always perform their functions automatically, after they are isolated and purified, provided the environment is not too hard. They must not be sequestered inside the cells in the pure state. Each of them constitutes a self-sufficient molecular machine. Natural digestive enzymes such as pepsin and lysozyme are so hard that they can be added to the laundry detergent to help dissociate partial stains. Amylases are used on an industrial scale to convert pulverulent starch into corn syrup. The entire field of genetic engineering and biotechnology is made possible by a collection of DNA and manipulative nanomachines, now commercially available. Generally the natural bionanomachines are remarkably robust. This chapter explores the bionanomachines made by living cells. They are different from machines in our world.

Bionanomachines are also chosen by their very specific tasks in a given environment, and are also subject to unfamiliar forces exerted by this environment. It is imperative to keep these notions of difference in mind before embarking on the biotechnology study.

A strange world

Natural biomolecules have often unbelievable shapes, unlike designs arranged in bread grids and tractors. They perform their functions in a strange environment, where the thermal movements, the nervous movements constantly influenced by pushing and attracting forces on their constituents. They are linked by a complex set of links and external forces. The bionanomachines are almost immune to the laws of gravity and inertia which dominate our machines.

Gravity and inertia are negligible at the nano scale

Physical properties such as friction, tensile strength, adhesion, and resistance to disintegration are comparable in magnitude to the forces exerted by inertia and gravity. This balance changes, however, when we move to larger or smaller objects. As we move to larger objects, the graduation laws shift the balance. Mass increases with the cube of size of an object, and properties such as force and friction increase linearly with the square of the waist.

The graduation laws also go in the opposite direction, the grains of micrometer-sized sands, or the cells, act on each other differently from macroscopic objects. In fact, if we consider a bacterial cell that swims in a volume of water by its ciliature, it moves slowly, and stops at a given moment as does the submarine in the ocean. However, if one considers the inertial forces relative to the viscosity of the surrounding water, the cell would stop less than the diameter of an atom!

Gravity is neglected at the nano scale, so molecules dissociated in water or propagated in the air are in continuous motion, the forces of intermolecular attraction are more important than the force of gravity. Flies take advantage of these forces and can crawl up a wall, even the water droplets may remain adhered to the ceiling as a result of these forces.

Nanomachines can show the granularity of atoms

Objects on the nanoscale scale are constructed by discrete combinations of atoms, which act on each other by specific atom-atom interactions. They must consist of a fixed number of atoms (rotary engine at the nanometer scale). Similar engines already existing, such as adenosine triphosphate synthetase, the bacterial flagellar engine.

Due to atomic granularity, typical continuous representations are not used in technology because of physical properties; Such as viscosity and friction, are not defined for discrete atomic groups. Instead, various atomic substitutive properties are used, quantum mechanics in fact provides a deep understanding of atomic properties, but fortunately most of the properties of atoms can be understood qualitatively by using simple rules: 1. The links 2. Steric repulsion between unconnected atoms, electrostatic interactions, hydrogen bonds that allow the understanding of most aspects, structures, and molecular interactions.

Generally, biomolecules are considered as articulated chains of atoms that interact precisely with one another.

Heat flux is a significant force at the nano scale

Molecular nanotechnology seeks to create the environment of the “machine phase” with different organized nanomachines, in order to form objects on the micro or macroscopic scale. On the other hand, natural ionanomachinery takes a different approach because it requires the introduction of nanomachinery inside the cell. The various parts act upon each other by induced movements and diffusion.

Biomachines work in a chaotic environment, they are continually bombarded by molecules of water. They will disperse but always held in place. Biomachines can establish specific interactions with other biomachines, adapting together to the state of rest, and separating in the event of operation. If two closely matched molecules have a good complementarity of chemical groups, they will interact for long periods, but if the interactions are weak, they will establish temporary interactions before moving on to the next.

The careful design of the bionanomachines and the rigorous regulation of the forces of their interactions give them the character of being able to form stable molecular beams that can remain years or build biological Detectors capable of detecting molecular traces. Bionanomachines require water as an environment. The shape and function of bionanomolecules are dominated by two things: the chemistry of their component atoms and the irregular properties of the surrounding water molecules. The energy of these interactions is different from what is meant in the macroscopic world, the water molecules interact strongly with each other by hydrogen bonds. They do not separate and do not interact with other molecules unless they have something to offer. Bionanomolecules, which have an important value in terms of electron richness, nitrogen (N) and Oxygen (O), interact favorably with water molecules, and therefore have good solubility in water. The hydrophobicity of biomolecules strongly influences their function and shape. The geometry of the molecular chain alone, creates a large number of conformations, one would thus rarely find simple structures. Once placed in water, the biomolecules rapidly respond to the environment, folding into a conformation, so that the hydrophobic regions are stacked inwards, the surface being decorated by the H 2 O-hydrophilic molecules . For proteins: the chain is most often forced into a compact globule, for DNA the pairs of bases are sequestered without alteration inside, leaving the phosphates heavily loaded on the surface, for lipids, hydrophobic groups (In the cell membranes) are directed inside the lamellae as well as the hydrophilic groups are directed outwards. If carefully constructed, one would obtain a unique structure with an appropriate conformation in order to perform its task properly.