Chapter-19

Nanotechnology and its Applications in Neurological Sciences

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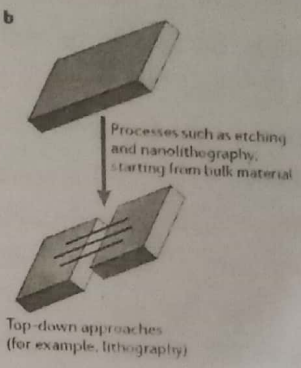
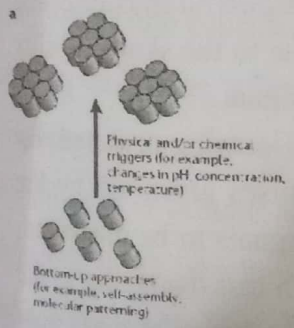
Introduction

Nanotechnology is an innovative new technology on the frontline of modern scientific research. Focusing on the manipulation of matter on a scale of 10^{-9}, it allows us to create functional structures through the bottom-up approach; where these systems are built from single atoms or molecules assembled chemically. Or the —top-down approach may be used where these nanostructures are created from splitting down larger systems to its base elements. Nanotechnology is taken where the entity's smallest functional structure of at least one of its dimension on the Nano-scale (normally ranging from 1 ~ 100 billionth of a meter).

When utilizing the top-down approach (example shown by Figure), one of the challenges faced is the fact that entities on a nano scale have very different physical and chemical properties to those on a macro or even micro scale. For such small objects, gravity becomes significantly less important; however forces such as van der Waals and surface tension have much greater impact on the structures. Once a larger object is split down to its simplest elements, the electronic assets of solids are altered; these quantum materials have completely different physical behavior to their larger alternatives; it is these phenomenons which create much of the enthrallment for the development of Nanomaterials. As the scale of an article is reduced, its surface area to volume ratio increases; this changes its chemical interactions with other structures, therefore making even inert materials such as gold efficient catalysts for chemical reactions. Down at this scale some insulators become conductors due to the quantum size effect and some substances can also be turned





The bottom-up approach employs a very different technique of manipulating single molecules to create a bigger and more useful system (example shown by Figure). Current research has enabled scientists to influence small molecules to form specific shapes but in the near future, small Nanoscale machines may be built which have structures similar to machines on the macro scale and have specific functions. On this scale, molecules have the tendency to organize themselves into small structures. By modifying the organization of these molecules, scientists may be able to persuade them to join in a particular order forming a useful composition; one way of performing this is through the employment of the Watson-crick base pairing rules.

Since the idea of nanotechnology was first envisioned in 1959 by the Nobel Prize physicist Richard Feynman, his speech, There's Plenty of Room at the Bottom, suggests the use of one set of specific instruments to manoeuvre another smaller set of instruments and so on, until the smallest set is able to direct subjects on the nanoscale (i.e. molecules and even single atoms). Although at the time this hypothesis was commonly seen as theoretically plausible, the first breakthrough in fulfilling this vision came after the first studies of cluster science and the development of the first scanning tunnelling microscope.