

Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech (BT)/SEM-3/MBT-303A/2010-11

2010-11

NANOTECHNOLOGY

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

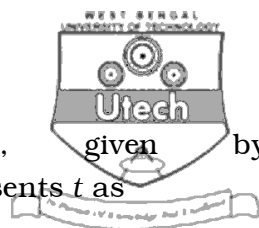
- i) How can nanoparticles be used to treat cancer ?
 - a) Nanotubes can create pores in the cancer cells, thus leaking out the cellular components and killing the cell.
 - b) Some nanoparticles can bind to specific enzymes in cancer cell metabolism to block reactions.
 - c) Nanoparticles can recruit immune system components directly to the cancer cells.
 - d) Nanoparticles can be designed to absorb radiant energy in the IR spectrum, which produces heat that destroys only the cancer cells because living tissue does not absorb IR energy.



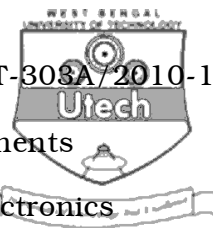
- ii) Which cellular component is considered to be a nano- (assembler) ?
- a) Chromatin b) Ribosomes
c) DNA d) mRNA.
- iii) What is a potential use of nanoparticles in the field of biotechnology ?
- a) Delivery of pharmaceuticals or genetic material
b) Tumour destruction
c) Fluorescent labelling
d) All of these.
- iv) What is nanotechnology ?
- a) The individual manipulation of molecules and atoms to create materials with novel or improve properties
b) The creation of new terms to describe very small, almost unimaginable, particles in physics
c) The term is used to describe the size of cellular components
d) The transition of molecular biology into the physical sciences.
- v) Which of the following is structure that can be created by nanoengineering of DNA ?
- a) Cubical structure
b) Nanoscale scaffolds and nanowires
c) Frameworks for mechanical device
d) All of these.



- vi) What purpose could nanotubes serve in biotechnology ?
- a) As a metallic conductor or semiconductor
 - b) For the creation of components of electronic equipment
 - c) For attachment of biomolecules, including enzymes, hormone receptors and antibodies
 - d) For the detection of a specific molecules in a sample, such as blood.
- vii) Unique properties of nanoparticles develop due to
- a) increase of surface exposed atom/molecule
 - b) increase of particle mobility
 - c) changes of interacting force
 - d) all of these.
- viii) The strength of a nanomaterial develops due to
- a) uniform packing of the particles
 - b) inherent strength of the nanoparticles
 - c) tight binding between the particles
 - d) all of these.
- ix) Comparison of the size of a bacterial cell with reference to a nanoparticle of maximal size yields a ratio of
- a) 10:15
 - b) 1:5
 - c) 100:200
 - d) 300:400.



- x) The Hertz-Knudsen equation, given by $dN/dt = A\alpha (2\pi mkT)^{-1/2} (p^* - p)$, represents t as
- a) the rate of evaporation of a liquid
 - b) an isobaric expression
 - c) a temperature jump expression
 - d) a volume change expression.
- xi) A zigzag CNT is formed for
- a) $\theta = 0$ and chirality ($a, 0$)
 - b) $\theta = \pi/6$ and chirality (a, a)
 - c) $0 < \theta < \pi/6$ nd chirality (a, b)
 - d) $0 < \theta < \pi/2$ and chirality (a, a).
- xii) Which of the following measurement techniques has led to maximal development of molecular electronics ?
- a) Fluorescence microscopy
 - b) Near-IR spectroscopy
 - c) Scanning tunneling microscopy
 - d) UV-spectrophotometry.
- xiii) Quantum dots are nanoparticles with
- a) luminescent tags
 - b) chromophore attachments
 - c) conducting properties
 - d) all of these.



- xiv) Soft molecule electronics uses as components
- logic gates and switches of microelectronics
 - organic and organometallic molecules
 - single crystals
 - field effect transistors.
- xv) Electrical conductivity in nanoparticles is measured by
- $\sigma = Ne^2 \tau / m$
 - $\sigma = Ne^2 \tau^2 / m$
 - $\sigma = Ne \tau^3 / m$
 - $\sigma = Ne^2 \tau^3 / m$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

- Describe antibacterial nanocarpets with a diagram.
- Write the names of different branches of science which helped to develop nanotechnology.
 - Describe size dependent properties of nanomaterials.
- First who coined the term 'Nanotechnology' ?
 - Describe the different applications of Nanotechnology.
 - Describe the difference between nanotechnology and Nanoscience.

$$2\frac{1}{2} + 2\frac{1}{2}$$

$$1 + 2 + 2$$



5. a) Explain briefly how cell signalling can occur by the use of nanotubes.
- b) How are gap junction proteins involved in the nanotube mediated process ?
- c) How are tunneling nanotubes implicated in HIV-I transmission ?
- 1 + 2 + 2
6. Define SWCNT and MWCNT in terms of geometrical considerations. How can you convert SWCNTs to MWCNTs ?
- 3 + 2
7. How can a dry powder nanoparticle's (e.g. TiO_2) size be determined by XRD ? What is the operative equation ? Define the terms in it.
8. How have nanoparticles (at least two types) been used for experimental delivery of vaccines ?

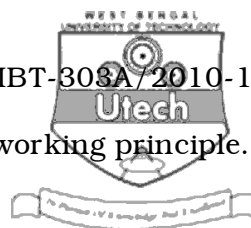
GROUP – C

(Long Answer Type Questions)

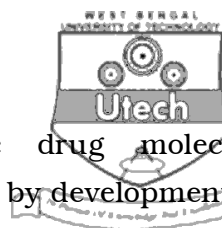
Answer any *three* of the following. $3 \times 15 = 45$

9. a) What is a nanorobot ?
- b) What are its basic features and how do they work ?
- c) How are nanorobots utilized in medicine ?
- d) Describe the different diagnostic and therapeutic applications of nanotechnology in medicine.

1 + 4 + 2 + 8



10. a) What is a sensor ? Explain briefly its working principle.
- b) Why do we need nanosensors ?
- c) Describe the recognition process and applications of a nanosensor using a diagram only.
- d) Describe the operational mechanism of the following with a diagram :
- i) H_2S nanosensor
 - ii) SiNW based pH nanosensor
 - iii) SiNW based nanosensor in detection of protein and DNA.
- 2 + 2 + 3 + 8
11. Discuss the use of protein nanoparticles in biotechnology. Briefly describe the use of different proteins for this purpose. What are the different methods available for the synthesis of protein nanoparticles.
- 15
12. a) Draw the diagram of a electron beam lithography setup.
- b) Of what material is a soft lithographic mold made of ?
- c) Name 5 different ways of replicating patterns in soft lithography. Highlight the two methods of soft lithography that have the most biological/biomedical significance. Use diagrams as appropriate to highlight your answer.
- 4 + 3 + 8



13. a) What are two ideal therapeutic drug molecule characteristics that have been altered by development of nanotube based drug delivery schemes ? 4
- b) What are the common methods of functionalization of pristine carbon nanotubes ? Why is it necessary to functionalize carbon nanotubes prior to use in drug delivery applicaitons ? 4 + 2
- c) Detail two methods of synthesizing MWCNTs. Based on available reliable information in the literature, what are two most appropriate techniques to characterize CNTs ? 5
14. What are the three technical reasons why regulatory approval of nanomedicines have been delayed ? What are the structurally and size-wize differences between a medicinal liposome and a nanoparticle used for site of action drug delivery ? How has cellular uptake of peptides been mediated by nanoparticles ? 4 + 6 + 5
15. a) Define and illustrate Moore's law. How has development of a 13.5 nm EUV light source helped in ensuring that Moore's law is not violated ? In what areas of medical technology has this been of primary utility ? 4 + 3 + 2
- b) How have nanotechnology principles been utilized to improve ideal drug characteristics of
- i) suicide inhibitors
- ii) Triggered response drugs. 6
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