PG Even Semester Examination, May 2025

CHEMISTRY

(4th Semester)

Course No.: CHM-652

(Chemistry of Advanced Materials)

Full Marks: 70

Pass Marks: 28

Time: 3 hours

The figures in the right margin indicate full marks for the question.
Answer any five questions selecting one from each unit.

UNIT-I

1. (a) How nanoscience differs from nanotechnology? Write the importance of nanoscale materials. Compare bulk gold (bulk Au) with nano gold (nano Au). 2+3+2=7

   (b) Draw and explain the DOS for (i) bulk metal and nanocrystals (ii) bulk semiconductor and Nanocrystals respectively. 2

   (c) Illustrate synthesis of nanoparticles using (i) physical vapor deposition and (ii) co-precipitation technique. 2×2.5=5

2. (a) Discuss the factors which govern the melting points of nanomaterials. Explain the term 'grain boundary effect'. 4+3=7

(b) Give an account of magnetic property of nanomaterials. Briefly state the use of magnetic nanoparticles insensing. 4+3=7

UNIT-II

3. (a) What are caspases, and what role do they play in apoptosis? Additionally, define p21 and describe its mechanism of action in cancer treatment. 2+2=4

(b) Describe the experiment to assess the level of oxidative stress caused by singlet oxygen species generated (SOG) by three different photosensitizers. 3

(c) Explain how a second-generation photosensitizer can be chemically modified to develop a third-generation photosensitizer. Illustrate the chemical transformation using a synthetic route involving any tetrapyrrolic macrocycle, to produce a final product that has the capability (i) to function underhypoxic tumor conditions and (ii) maintain immunocompatibility with normal cells. Exclude photothermal therapy (PTT) from your response. 3

(d) What are the advantages of forming diamagnetic metal-complexes of free-base tetra-pyrrolic macrocycles? Provide three advantages each for Zn(II) and Sn(IV) in developing metalloporphyrins as photosensitizers. 1+3=4

4. (a) Enumerate fourteen essential properties that define a clinically potent photosensitizer for photodynamic therapy. 7

(c) What is partition co-efficient of a drug? What is the importance of partition co-efficient in drug activity? How efficacy of aesthetic agents depends on their partition co efficient 1+2+1=4

(d) What is ADMET? On what factors Distribution of a drug in the body depends on? 1+1=2

10. (a) What is a Therapeutic Index of a drug? Why drugs with higher Therapeutic Index are preferred? 2+1=3

(b) What is Pro-drug? How pro-drugs are classified? What are the ideal properties of a Pro-drug? Why ester functional group is widely used as linking group between the drug and the pro-moiety? With an example, explain how the route of administration of a drug can be modified by converting it to a pro-drug. 2+3+2+1+3=11

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(b) Explain the mechanism through which singlet oxygen leads to irreversible cellular damage. Also, state the approximate lifetime and effective diffusion radius of singlet oxygen in biological systems. 2+1+1=4

(c) Describe the chemical strategies used to enhance the aqueous solubility of second-generation porphyrin-based photosensitizers. Give examples of two types of hydrophilic porphyrins and specify which of them preferentially localize in the mitochondria of cancer cells. 1+1+1=3

UNIT-III

5. (a) What are liquid crystals? Give one example. 2

(b) Discuss the melting process of thermotropic calamitic liquid crystals. 4

(c) Discuss pictorially self-assembly process of the thermotropic rod shaped liquid crystals. 5

(d) How liquid crystal display works? 3

6. (a) Discuss the effect of molecular structure on the thermotropic mesophase? 4

(b) What is order parameter of liquid crystal? Discuss the order parameter of the nematic phase. 2+3=5

(c) Write short notes on Cholesteric phase. 3

(d) Discuss one application of the liquid crystal found in nature. 2

UNIT-IV

7. (a) Briefly discuss the sensing of Na+ ion by using an electrochemical sensor. 4

(b) How Texaphyrin metal complexes, Gd-Tex and Lu-Tex are acts as anticancer agents? Explain 4

(c) Write an account on carbon nanotube actuator and tweezers. 3

(d) Write a short note on Molecular AND switch. 3

8. (a) Briefly discuss the optical sensing of citrate anion using a tridentate guanidinium based receptor and carboxy fluorescein. 3

(b) By taking a suitable example, explain the EDRAW (Erase Direct Read After Write) process. 4

(c) Write a short note on MRI contrast agents. 3

(d) How $[(bpy)_2Ru(azobipyridine)Os(bpy)_2]^{4+}$ act as a molecular photonic switch? Explain. 4

UNIT-V

9. (a) What is Pharmacophore? What is importance of pharmacophore in studying the Structure-activity relationship in drug design. 2+2=4

(b) How drug-target interactions are optimized? Discuss the binding role of alcoholic $-NH_2$ in optimization of drug-target interaction? 2+2=4