# Question Paper

Exam Date & Time: 12-Dec-2023 (02:30 PM - 05:30 PM)

## MANIPAL ACADEMY OF HIGHER EDUCATION

**Nanomedicine [BME 4306]**

**Marks: 50** **Duration: 180 mins.**

**Descriptive**

**Answer all the questions.** Section Duration: 180 mins

Answer all the questions

1A) Olga Matos *et al* developed a point of care lateral flow immunoassay (LFIA) to detect Pneumocystis jirovecii pneumonia from blood samples of patients using gold nanoparticles conjugated to recombinant synthetic antigens (RSA) of P. jirovecii's. Figure 1 illustrates the working of the LFIA assay. Currently the colour of the test and control lines are red. Suppose if Olga Matos team required the test and control line to appear blue rather than red, then propose a method by which the researcher can obtain violet colored gold nanoparticles. Explain the rationale behind your proposed solution with illustrations. (3)

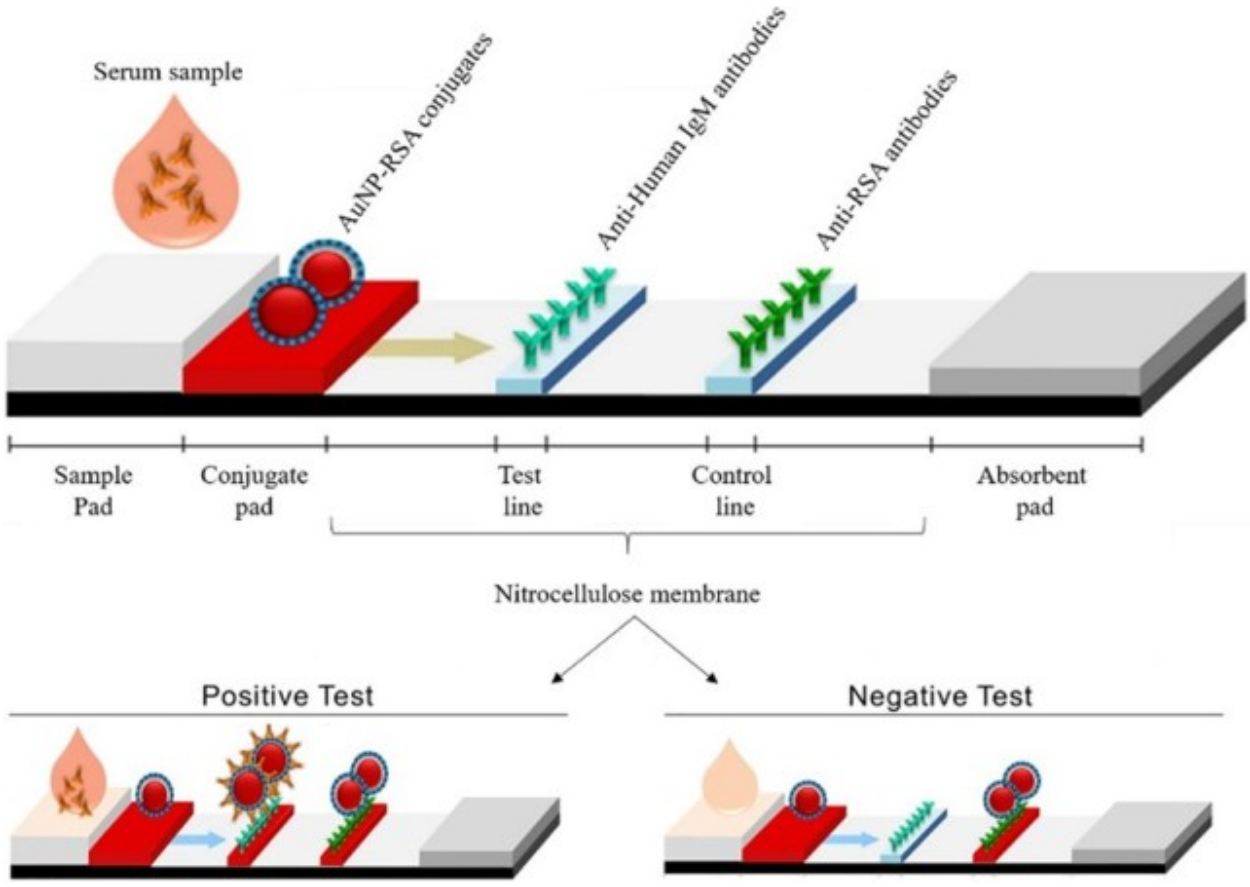


**Figure 1**: Schematic of Lateral flow assay (LFIA).

1B) Discuss various methods to stabilize nanoparticles and explain the process of stabilization with suitable illustrations. (3)

1C) Nanoparticles encounter various biological barriers to reach the target site. Elaborate in detail with suitable illustrations the various levels of biological barriers encountered by an anticancer nanoparticle intended to be delivered to the nucleus of targeted cells. (4)

2A) Two patient A & B were given 500 mg of a drug. Patient A was given the drug by oral route while Patient B received the same dosage by intravenous route. After two hours the cerebrospinal fluid (CSF) from two (2)

patients were taken and drug concentration in CSF was determined. Predict in which patient's CSF would there be a higher concentration of the drug. Explain the rationale behind your answer.

2B) Tarun wants to deliver an anticancer drug to treat Glioblastoma, a brain tumor using a nano carrier. Recommend potential strategies that Tarun can employ to deliver the drug across the blood brain barrier to the tumor site. (3)

2C) A list of redox responsive linkers is given in Figure 2. Using the information provided design a redox responsive nanocarrier to deliver the drug doxorubicin to a pancreatic tumor site. Illustrate and explain the mechanism of action, route of delivery and mechanism by which the drug reaches the intended site from your designed nanocarrier. Predict the drug release profile of your nanocarrier in the presence and absence of Glutathione (GSH). (5)

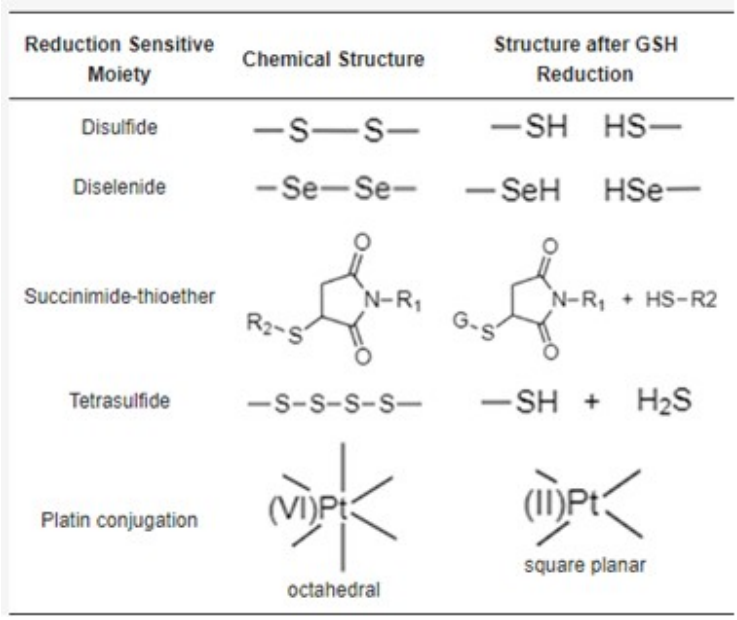


**Figure 2:** List of redox responsive linkers

3A) NaYF4:Yb3+,Er3+ nanoparticles are a type of upconverting nanoparticles, while Rose Bengal (RB) is a photosensitizer molecule. Using NaYF4:Yb3+,Er3+ nanoparticles and RB dye, design a nanocarrier system for photodynamic therapy (PDT) based treatment of prostate cancer. Illustrate and explain the mechanism of action of PDT based therapeutic for prostate cancer. (4)

3B) Magnetic nanoparticles are used for photothermal therapy (PTT). Discuss the various process by which Magnetic nanoparticles generate heat and hyperthermia under alternating magnetic fields (AMF) to kill cancer cells. (4)

3C) NIR laser of wavelength 800 -900 nm is generally used for optical imaging modality. Examine the reason why NIR laser are used for optical imaging rather than green light laser. (2)

4A) Figure 3 shows the contrast agents used for different imaging modalities. Using the information provided design a Multimodal nanocarrier for both diagnosis and treatment of deep-seated gall bladder cancer. Illustrate and explain the role of each competent of your multimodal nanocarrier system and how each modality aids in diagnosis and treatment of cancer. (4)

| Modality | Component |
|---|---|
| Optical imaging | Organic dye<br>Dye-doped silica<br>Quantum dots<br>Lanthanide atom |

| | |
|---|---|
| | Carbon nanotube |
| MRI[a] | Paramagnetic ion ($Gd^{3+}$, $Mn^{2+}$) |
| | Nanoparticles of paramagnetic ion ($Gd_2O_3$, MnO) |
| | Superparamagnetic nanoparticle ($Fe_3O_4$, $MnFe_2O_4$, FeCo) |
| OCT[a] | Gold nanostructure (nanoparticle, nanorod, nanoshell, nanocage) |
| PET[a], SPECT[a] | Radioisotope ($^{18}F$, $^{124}I$, $^{64}Cu$, $^{99m}Tc$, $^{11}In$) |
| CT[a] | Iodine |
| | Gadolinium |
| | Gold nanoparticle |
| | Bismuth sulfide nanoplate |
| Ultrasound | Microbubble |
| | Perfluorocarbon nanoparticle |

**Figure 3** shows imaging modality and contrast agents

4B) Design a field effect transistor (FET) based biosensor for detection of prostate cancer using prostate specific antigen (PSA) and PSA antibodies. Illustrate and elaborate the working mechanism of the designed sensor. Explain how you will validate such a biosensor. (4)

4C) Classify biosensor based on the bioreceptor and signal transducer mechanism. (2)

5A) In a study done on rats it was determined that the rats showed signs of toxicity on long term exposure to carbon nanotubes. Identify the possible nanotoxicological principles involved in CNT toxicity. (3)

5B) Elaborate on the exposure, fate, transport, and transformation of nanomaterial in the environment. (4)

5C) Discuss the challenges in regulation of nanomedicine. (3)

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