

## Department of Biosciences and Bioengineering, IIT Guwahati

**Instructions:**

Answer all the questions. Answers must be specific and concise. Ambiguous and verbose answers will carry no marks, even if the answer is identified somewhere in the write-up. Questions are self-explanatory; hence, no queries are responded to during the exam. Each of the questions carries 3 marks. Total marks 30.

1. Draw the general configuration of the ISFET device, indicating its parts with proper labels.
2. (a) Mention the three main stages of the CRISPR-Cas immune response. (b) State the role of the tracrRNA in the CRISPR-Cas system. (c) What is the 'Collateral activity' of the Cas enzyme widely used for detecting nucleic acid through CRISPR/Cas systems?
3. (a) Why is the radiation from quantum dots "blue-shifted" compared to the bulk semiconducting materials?  
(b) State two major advantages of quantum dots over traditional organic fluorophores.  
(c) Relate the metabolic energy gain for the bacterial catalysts with anodic potential and linked attainable potential status of the microbial biofuel cell.
4. Show schematically the SELEX process with proper labels for selecting an aptamer against a target.
5. (a) Define Reynold number (must write the equation) and relate its values to the flow characteristics of fluids.  
(b) State the significance of Peclet number in operating microfluidic devices.  
(c) Depict through a schematic diagram the assay protocol for monitoring arsenic in environmental samples using the bacterial transcriptional switch.
6. Show schematically the photolithography for creating microfluidic channels on a chromatographic paper. All steps must be shown clearly with proper labels.
7. State three mechanisms proposed for exchanging electrons between bacterial cells and electrodes to generate power in microbial fuel cell devices.
8. Describe briefly:  
(a) Molecular Beacons  
(b) Molecular imprinting technique and  
(c) Critical steps sequentially involved in performing a typical dual-coloured DNA microarray analysis.
9. Describe schematically the Lateral Flow Immunoassay for detecting SARS-CoV-2.
10. (a) What is the Site-binding model in ISFET? (b) State one of the advantages and disadvantages of PNA over DNA. (c) Between two metal nanoclusters (sizes reaching the Fermi wavelength of the electron) with  $n$  (whole number) and  $n+1$  number of metal atoms, which one produces higher emission energy? The answer should be based on the Spherical Jellium model for the metal nanoclusters.

\*\*\*\*\*END\*\*\*\*\*

$$r = \frac{2r}{\lambda} - 1 \quad r < 0.5$$
$$3 = 2(1-r)$$