BT308 Bioengineering Midsem Exam 27.02.2024

Instructions: *Answer all the questions. Answers must be specific and concise. More than required number of answer for the question will lead to zero marks. Questions are self-explanatory; hence, no queries are responded to during the exam. Each of the questions carries 3 marks. Total marks 30.*

1. (a) Draw the general configuration of the ISFET device, indicating its parts with proper labels.
(b) Which of the following is not a terminal of a FET device: (i) Gate, (ii) Drain, (iii) Source, (iv) Membrane element, (v) Body.

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) Which of the following Cas protein does not have collateral activity: Cas9, Cas12a and Cas13a.

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) Larger quantum dots exhibits shorter / longer lifetime because they have more closely/widely spaced energy levels in which the electron-hole pair can be trapped. Identify the correct underlined words.

4. (a) State four basic steps involved in SELEX process (Only one word is allowed to write against each of these steps; zero mark will be awarded for the non-compliance). (b) State two key advantages of aptamers over antibody for their commercial biosensing applications.

5. (a) Show schematically the photolithography for creating microfluidic channels on a chromatographic paper (All steps must be shown clearly with proper labels). (b) State the type of transport phenomenon occurs in chromatographic paper and assess its Peclét number with respect to 1.

6. (a) Define Non-Newtonian fluid based on a relation among coefficient of viscosity, shear stress and shear rate. (b) Name the fluid from the following list that is suitable to create a turbulent-like flows in microfluidic channels: water, oil, glycerin, blood, gas (c) State the major difference between Lab-on-a-chip and Micro Total Analysis Systems.

7. State three mechanisms known for exchanging electrons between bacterial cells and electrodes to generate power in microbial fuel cell devices.

8. (a) If the oxidation potential of a redox enzyme is +0.2V, identify the voltage from the following list that suits best for a mediator in a 2nd generation amperometric biosensors to transfer electrons from the redox centre of the enzyme to the eletrode: +0.1V; +0.2V; +0.3V; 0.0V; -0.1; -0.2V; -0.3V. (b) State the functions of auxiliary and reference electrodes in an electrochemical setup.

9. (a) Biofuel cell is a thermodynamically……..system. Fill the gap with a right word.
(b)Identify the correct statement: (i) Higher the anode potential, lower would be the metabolic energy gain for the bacteria in the microbial fuel cell. (ii) Upon scaling down the size of a biofuel cell, its ohmic resistance decreases. (iii) High power density is a major challenge to the practical utility of biofuel cells. (iv) The polarization curve used to characterize biofuel cells is a plot of current density versus time of its operation.
(c) Write 2 critical factors that attribute biofuelcell as green energy technology.

10. (a) Calculate the strength of acetylcholinesterase inhibition by dichlorovos organophosphate pesticide if 0.4V and 0.3V are voltage signals without and with Dichlorvos, respectively detected in flow-injection calorimetric biosensors.
(b) Name the reactant used to produce gel from metal alkoxide sols in sol-gel technology.
(c) Which physicochemical factor in solid is closely related to the formation of piezoelectric effect? Show the equation involved in the bulk piezoelectric material with units.

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