BT620 BIOSENSORS Midsem Exam 23.09.2022

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 during the exam time. Each of the questions carries 3 marks. Total marks 30.

1. (A) Draw the general configuration of biosensors indicating clearly each of the parts with proper label. *Marks: 1 (figure) + 1 (labels)*

(B) Name the criterion for sample source that supports commercial success of biosensors in the field of clinical analysis. *Mark: 1*

2. (A) If the oxidation potential of a redox enzyme is +0.2V, identify the compound potential from the following list that suits best as mediator for transferring electrons from the redox centre of the enzyme to the electrode: (a) +0.1V; (b), +0.2V; (c), +0.3V; (d), 0.0V; (e), -0.1; (f), -0.2V; (g), -0.3V. *Mark: 1*

(B) State two important factors that control the penetration of an electron transport mediator (ETM) close to the enzyme active center inside the protein matrix in 2nd generation amperometric biosensors. *Marks: 2*

3. If the enthalpy change of an enzymatic reaction associated with the conversion of 2000 g of a target analyte substrate to 1 mol of the product is -100 kj/mol, the heat capacity of the system is 1 kj/K.Kg, Seebeck coefficient is 0.01 V/K, then estimate the output potential difference (ΔV) of a thermopile, with one pair of the thermocouple. *Marks: 1 (answer) + 1 (reference equation)+ 1 (steps with units).*

4. (A) Draw the Kretschmann configuration commonly used in SPR sensors and indicates its parts with proper labels. *Mark: 1 (figure)+0.5 (labels)*

(B) Calculate the refractive index change caused by the binding of COVID-19 on its specific antibody at the SPR sensor surface if the characteristic refractive index increment value is 0.3 cm^3g^{-1} and the change in concentrations of the virus particles on the sensitive layer is $0.1g/cm^3$. *Mark: 0.5 (answer)+1 (base equation + units)*

5. Different operational modes could be created by cutting the piezoelectric material. Name the modes, indicate the relations between the applied force and accumulated charge in materials of each mode, and draw their corresponding diagrams. *Marks: 1 + 1+1*

6. What are BAW and SAW piezoelectric sensors? Identify a major difference between them. *Marks: 1 (BAW)+ 1(SAW)+ 1(the difference; only the first answer will be considered if multiple answers are given).*

7. The following redox reaction occurs at the reactive center of an enzyme:

Substrate (2H) + FAD-oxidase → product + $FADH_2$-oxidase

Based on this first reaction step, show the corresponding electrochemical reactions takes place in each of the three generations of amperometric biosensors. *Marks: 1 + 1+ 1*

8. (A) When we can call a redox enzyme a molecular transducer? *Mark: 1*

(B) Calculate the surface coverage of an electroactice enzyme immobilized over a graphite electrode from the following information: Farraday constant 9.65 x 10^4 C/mol, number of electrones involved in the reaction 01, the charge obtained by integrating the CV peak current area 9.65×10^5C and the surface area of the electrode 1 cm^2.

Marks: 1 (formula) + 1 (answer with correct unit)

9. (A) State four immobilization strategies of biorecognition proteins over electrode surfaces. *Marks: 2*

(B) What is the application of Laviron equation in the characterization of 3rd generation enzyme electrodes? *Mark: 01*

10. Draw with proper labels the thermopile transducer-based flow injection calorimetric biosensor used to detect organophosphate pesticides. *Marks: 1.5 (diagram)+1 (clarity of the diagram) + 0.5 (proper labels of the parts).*

END