Example of Examination questions for Introduction to Biosensors Technology (TFYA62)

- The examination consists of 15 questions for a total of 45 points.
- In order to approve this part of the final examination a minimum of 20 points is required.

- Permitted aids:
  - English-Swedish Dictionary

- Write your solution on one side of the sheets only

- Write you AID-number on each sheet you hand in. On the envelope mark each question for which you hand in solution.

  Good Luck
Questions:

1. Describe the main components of biosensors and explain their function. (3p)

   Biorecognition element
   Transducer
   Electronics

2. Describe how 3D functionalization is achieved in a Biacore chip and list its advantages (three, 3). (3p)

   Use of Hydrogel (Dextran matrix)

   ADVANTAGES
   - Allows the use of all the evanescent field generated by plasmonic
   - Allow immobilisation of larger number of ligands (presence of functional groups)
   - Reduce unspecific adsorption
   - Better environment for the biomolecules to be in

3. Define accuracy and precision and what also does it mean for a sensor to be precise but to have low accuracy. (2p)

   Accuracy: is the ability of a sensor to report the exact value of the investigated parameter.
   Precision: The ability to have high reproducibility upon repetition of measurements of the same sample.
   Sensor that has good reproducibility of its response (low standard deviation) but the response if far from the real concentration of the analyte.

4. Describe the physical, chemical and biochemical factors that regulate the hybridisation process (3p)

   Temperature.
   Salt concentration
   Composition of the DNA sequences
   Length of the DNA sequences
   Concentration of the sequences

5. List two (2) advantages and one (1) disadvantage of the use of microsystem in the handling of samples. (2p)
FOR EXAMPLE

Costly
Technically challenging in producing them with adequate functionalities
Difficulties in mixing different reagents

Low sample volume
Higher control of liquids with low mixing (no loss of sample or reagents); capillary forces……..
Faster
no need of technical person

6. Nano-mechanical Biosensors (Cantilever biosensors); what are they? How these have been used for biosensor development? How can the biorecognition event be transduced? (4p)

These are microfabricated finger like transducers (a draw will be nice) that can band/oscillate (depending on the material) as a result of a physical/electrical stimulation. The bending/oscillation of these devices are proportional to their mass. Cantilever based biosensors have been used for hybridisation assay, for the screening the effect of drugs on the growth of bacteria, for affinity (antibodies) based assay by immobilising on the surface of the cantilever DNA probes, drugs or antibodies. Transduction can be optical or piezoelectrical.
In optical the reflection of a laser beam is used to evaluate the bending of the cantilever.
In the case of piezoelectrical changes in the oscillation frequency of cantilever (made with piezoelectric material) are used to detect changes in the mass onto them.

7. Monoclonal and polyclonal antibodies; how are these produced? Which one is their main difference when it comes to the recognition of the antigen? (3p)

Monoclonal:
From a single B-Cell, all the same, recognise a specific epitope
Polyclonal
From an animal (several B.Cells), mixture of different antibodies, recognise several epitopes of the antigen

8. Which one is the function of label in a biosensor? Give two examples of possible labels. (4p)

Label is used to help transduction (make it readable or amplify) of biorecognition event

SOME Examples:
Fluorophors (QDs, fluorescence molecules) in optical measurement
Enzymes in ELISA or electrochemical affinity sensors
Nano-particles in lateral flow device

9. List two (2) advantages in the use of nano-material in biosensing? Give an example of how these are currently used in biosensor technology. (3p)
High surface area (higher number of biorecognition element can be immobilised)
High reactive area (catalytic properties, good electron transfer ability)
Can help to modulate the surface properties of the biosensor
Have specific physical properties (colour of nano-particles; interaction with light)

Nano-particles in lateral flow assay
Quantum dots as label in fluorescence assay

10. Suggest a possible format (What would you immobilise as biorecognition element? What will you use to transduce the recognition event?) of Enzyme Linked ImmunoSorbent Assay (ELISA) to detect an antibody in a clinical sample. (4p)

Sandwich assay:
Immobilise the antigen
Use a second antibody (recognising the Fc part of the target antibody) with enzyme label for generating colour.

11. What is an enzyme? What is the function of an enzyme when used as a biorecognition element? (3p)

Protein and catalyst
Catalyse analyte conversion faster and efficiently
Correlate the analyte to a measurable event (loss in a substrate or generation of a product)

12. What are the two (2) main problems associated with the use of the Oxygen electrode (Clark electrode) as transducer in the glucose electrochemical biosensor. (3p)

This is dependent from starting concentration of oxygen in the starting solution
Use high potential: sensitive to interference from other molecules
Electrochemical reaction consume oxygen (this can produce false positive)

13. What information can be achieved from a cDNA array? (3p).

Present/Absent of specific gene
expression of genes
biological significance of genes

14. What is the use of the control line in a lateral flow device (for example the pregnancy test?). (2p).

To show that test worked correctly.

15. What are the main advantages (list 2) and disadvantages (list 2) of the sensor functionalization via adsorption process (3p)

Fast and easy to perform
Low stability of the surface and low control of the composition and orientation of molecules onto the surface.