BT505 - BIOSENSORS

FINAL TERM IMPORTANT QUESTIONS

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Admin: **BS Biological Sciences** (One place to all your solutions)

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1. What is biosensor on basis of galvanic electrochemical detection?

A biosensor based on galvanic electrochemical detection is an electrochemical biosensor in which the signal is produced by a spontaneous redox reaction without applying any external voltage. The biological element (such as an enzyme or antibody) reacts with the target analyte, causing electron transfer between two dissimilar electrodes. This generates an electric current, whose magnitude is proportional to the analyte concentration. These biosensors work on the principle of a galvanic cell and are commonly used in clinical and environmental analysis.

2. Write applications of biomarkers.

Applications of biomarkers include their use in disease diagnosis, where they help in early detection and confirmation of disorders such as cancer, cardiovascular diseases, and infectious diseases. They are widely applied in disease prognosis to predict disease progression and patient outcome. Biomarkers are also important in monitoring treatment response, as changes in biomarker levels indicate the effectiveness or toxicity of a therapy. In drug discovery and development, biomarkers are used to assess drug efficacy, safety, and mechanism of action. Additionally, they are applied in environmental and toxicological studies to evaluate exposure to pollutants and assess biological effects on organisms.

3. Explain oxidation of Guanine.

Oxidation of guanine refers to the chemical modification of the guanine base in DNA or RNA due to reactive oxygen species (ROS) such as hydroxyl radicals, hydrogen peroxide, or singlet oxygen. Guanine is the most easily oxidized DNA base because it has the lowest redox potential among nucleobases.

During oxidation, guanine is converted into 8-oxo-7, 8-dihydroguanine (8-oxoG), a common and stable oxidative lesion. This altered base can mispair with adenine instead of cytosine during DNA replication, leading to GC → TA transversion mutations. Accumulation of oxidized guanine causes genomic instability and is associated with aging, cancer, and neurodegenerative diseases.

Cells normally counteract guanine oxidation through DNA repair mechanisms, especially the base excision repair (BER) pathway, which removes 8-oxoG and restores DNA integrity.

4. Write medical disadvantages of lead.

Medical disadvantages of lead:

- Causes neurological damage, especially in children, leading to reduced IQ, learning disabilities, and behavioral problems
- Leads to anemia by inhibiting heme synthesis
- Causes kidney damage and impaired renal function
- Affects the gastrointestinal system, causing abdominal pain, constipation, and nausea
- Results in cardiovascular problems, including hypertension
- Interferes with reproductive health, causing infertility and developmental defects
- Weakens the immune system and overall growth and development

5. Write methods of fabrication.

Methods of fabrication:

- ***Photolithography*** – patterning micro/nano structures using light
- ***Screen printing*** – low-cost fabrication of electrodes and sensor layers
- ***Thin-film deposition*** *(sputtering, evaporation)* – coating conductive or sensing materials
- ***Microfabrication / MEMS techniques*** – fabrication of miniaturized sensor components
- ***Electrodeposition*** – controlled deposition of metals or polymers on electrodes
- ***Inkjet printing*** – precise deposition of biomaterials and conductive inks
- ***Self-assembly methods*** – spontaneous organization of biomolecules on sensor surfaces

6. Write advantages of Aptamers.

Advantages of aptamers:

- High specificity and affinity for target molecules
- Can bind a wide range of targets (ions, small molecules, proteins, cells)
- Chemically synthesized, ensuring high purity and reproducibility
- More stable than antibodies under temperature and pH variations
- Low immunogenicity and toxicity
- Easy to modify and label for sensing applications
- Cost-effective and suitable for long-term storage

7. Write steps of functioning of lab on a chip.

Steps of functioning of a lab-on-a-chip (LOC):

- ***Sample introduction:*** A very small volume of the sample is introduced into the chip through micro-inlets or reservoirs.
- ***Sample preparation:*** The sample may undergo on-chip processes such as filtration, cell lysis, mixing with reagents, or dilution.
- ***Fluid manipulation:*** Microchannels guide the controlled movement of fluids using pressure, capillary forces, electroosmosis, or centrifugal force.
- ***Reaction or separation:*** Biochemical reactions (e.g., antigen–antibody binding, enzymatic reactions) or separations (such as electrophoresis) occur in micro-chambers.
- ***Detection:*** The processed sample is analyzed using integrated detection systems like electrochemical, optical, or fluorescence sensors.
- ***Signal processing and output:*** The detected signal is converted into readable data, providing qualitative or quantitative results.

8. What is organoid?

An organoid is a three-dimensional (3D) miniaturized and simplified version of an organ grown in vitro from stem cells or organ-specific progenitor cells. It mimics the structure, function, and some cellular complexity of the actual organ, including multiple cell types and tissue organization.

Organoids are used in disease modeling, drug testing, regenerative medicine, and studying organ development, providing a more realistic model than traditional 2D cell cultures.

9. Write domain of three way DNA junction.

A three-way DNA junction is a branched DNA structure where three double-stranded DNA arms converge at a single point**.** The domains of a three-way DNA junction refer to the regions that define its structural and functional properties:

- ***Stem domains:*** The double-stranded arms extending from the junction point, providing structural stability.
- ***Branch point (core) domain:*** The central region where the three DNA strands meet and base-pair interactions create the junction.
- ***Flexible hinge regions:*** Short single-stranded or partially unpaired segments near the branch point that allow bending and conformational flexibility.

10.Explain mechanism of antibiotic resistance in Pseudomonas aeruginosa.

Mechanism of antibiotic resistance in ***Pseudomonas aeruginosa*** involves multiple strategies that allow this bacterium to survive despite antibiotic treatment:

- ***Efflux pumps:*** *P. aeruginosa* expresses membrane proteins that actively pump out antibiotics (like β-lactams, quinolones, and aminoglycosides), reducing intracellular drug concentration.
- ***Enzymatic degradation:*** The bacterium produces enzymes such as β-lactamases that hydrolyze and inactivate β-lactam antibiotics.
- ***Target modification:*** Mutations in antibiotic targets, such as DNA gyrase, topoisomerase, or ribosomal components**,** reduce drug binding and efficacy.
- ***Reduced permeability:*** Changes in outer membrane porins limit antibiotic entry into the cell.
- ***Biofilm formation:*** *P. aeruginosa* can form biofilms, a dense matrix of cells and extracellular polymeric substances, which protects bacteria from antibiotics and host immune responses.
- ***Adaptive resistance:*** Exposure to sub-inhibitory antibiotic levels can induce stress responses that transiently increase resistance.

11.Write applications of positive and negative photo resistors.

Applications of photoresists:

1. Positive photoresists:

- Used in microelectronics and semiconductor fabrication for patterning circuits.
- Fabrication of microchips and integrated circuits where exposed areas are removed.
- MEMS (Microelectromechanical Systems) devices production.
- Printed circuit board (PCB) manufacturing for precise pattern transfer.

2. Negative photoresists:

- Used in microfabrication where exposed areas remain after development.
- Microfluidic device and lab-on-a-chip fabrication.
- 3D microstructure creation and embossing techniques.
- Protective coatings and masks in photolithography processes.

12.What is BOD and how can we measure BOD in industrial water?

BOD (Biochemical Oxygen Demand) is a measure of the amount of dissolved oxygen required by microorganisms to decompose organic matter in water over a specific period (usually 5 days at 20 °C). It indicates the degree of organic pollution in water or wastewater. Higher BOD means more organic pollution.

Measurement of BOD in industrial water:

1. ***Sample collection:*** Collect water sample carefully to avoid contamination and preserve it at 4 °C.
2. ***Dilution:*** Dilute the sample with BOD-free water to ensure oxygen is not fully depleted during incubation.
3. ***Seeding:*** Add a microbial inoculum if the sample lacks sufficient microorganisms.
4. ***Initial DO measurement:*** Measure the dissolved oxygen (DO) of the sample using a DO meter or Winkler method.
5. ***Incubation:*** Seal and incubate the sample at 20 °C for 5 days in the dark to prevent photosynthesis.
6. ***Final DO measurement:*** Measure the DO after 5 days.
7. ***BOD calculation:***

$$BOD = Initial\ DO - Final\ DO\ (after\ 5\ years)$$

13.What are Nano enzymes? Compare them with protein enzymes with examples.

Comparison of nanoenzymes and protein enzymes

Nanoenzymes are nanomaterials that mimic the catalytic activity of natural enzymes, whereas protein enzymes are biological macromolecules composed of amino acids. Compared to protein enzymes, nanoenzymes are more stable under harsh conditions such as high temperature, extreme pH, or the presence of organic solvents, while protein enzymes are sensitive and can denature easily.

Protein enzymes exhibit high substrate specificity, catalyzing very precise biochemical reactions, whereas nanoenzymes generally have moderate specificity, though their activity can be tuned chemically. Nanoenzymes are cost-effective, easy to produce, and often reusable, while protein enzymes are typically expensive and limited in reusability due to denaturation. Examples of nanoenzymes include Fe_3O_4 nanoparticles with peroxidase-like activity and CeO_2 nanoparticles with oxidase activity, whereas common protein enzymes include glucose oxidase, catalase, and lipase. Overall, nanoenzymes are advantageous for applications requiring stability and durability, while protein enzymes remain essential for highly specific and biologically compatible reactions.

14.Explain composition of blood.

Composition of blood:

Blood is a specialized connective tissue composed of cellular components suspended in a liquid matrix called plasma**.** Its main components are:

1. ***Plasma (≈55% of blood volume):*** A pale yellow fluid that contains:
   - ***Water (90–92%)*** – serves as a solvent and transport medium.
   - ***Proteins*** – such as albumin (maintains osmotic pressure), globulins (immune functions), and fibrinogen (blood clotting).
   - ***Electrolytes*** – sodium, potassium, calcium, chloride, bicarbonate.
   - ***Nutrients*** – glucose, amino acids, lipids.
   - ***Waste products*** – urea, creatinine, carbon dioxide.
   - ***Hormones and gases*** – oxygen, carbon dioxide, and signaling molecules.
2. ***Cellular components (≈45% of blood volume):***
   - ***Red blood cells (RBCs / erythrocytes):*** Carry oxygen using hemoglobin.
   - ***White blood cells (WBCs / leukocytes):*** Immune defense; includes lymphocytes, neutrophils, monocytes, eosinophils, and basophils.
   - ***Platelets (thrombocytes):*** Cell fragments involved in blood clotting.

15.Write a short note on perfluorocarbons.

Perfluorocarbons (PFCs):

Perfluorocarbons are synthetic compounds composed entirely of carbon and fluorine atoms, where all hydrogen atoms in hydrocarbons are replaced by fluorine. They are chemically stable, non-toxic, and biologically inert, with a remarkable ability to dissolve large amounts of gases, especially oxygen and carbon dioxide.

Applications:

- Used as artificial blood substitutes due to high oxygen-carrying capacity.
- Serve as oxygen carriers in organ preservation and liquid ventilation.
- Applied in medical imaging as contrast agents.
- Used in industrial applications for heat transfer and electronics due to chemical stability.

16.What is Porous silica biosensor? Write its working principle.

Porous silica biosensor:

A porous silica biosensor is a type of biosensor that uses silica (SiO_2) with a porous structure as a support material for immobilizing biological recognition elements such as enzymes, antibodies, or nucleic acids. The high surface area and controlled porosity of silica allow efficient binding of biomolecules, enhanced mass transfer, and improved sensitivity in detecting target analytes.

Working principle:

1. ***Immobilization:*** The biomolecule (e.g., enzyme or antibody) is immobilized onto the surface or within the pores of silica.
2. ***Interaction with analyte:*** When the target analyte enters the pores, it specifically interacts with the immobilized biomolecule.
3. ***Signal generation:*** This interaction produces a measurable signal, which can be optical, electrochemical, or fluorescence-based.
4. ***Signal detection:*** The generated signal is proportional to the concentration of the analyte and is detected by a transducer.

17.What are environmental microbial biosensors?

Environmental microbial biosensors:

Environmental microbial biosensors are biosensors that use microorganisms as the biological recognition element to detect and monitor pollutants, toxins, or changes in environmental conditions. These microbes respond to specific chemicals or stressors by producing measurable signals, such as changes in luminescence, fluorescence, metabolic activity, or electrical output.

Key features:

- Can detect organic pollutants (like hydrocarbons), heavy metals, pesticides, and toxins.
- Microorganisms used can be naturally occurring or genetically engineered for higher sensitivity and specificity.
- Responses are usually measured electrochemically, optically, or via reporter genes.

Applications:

- Monitoring water and soil quality.
- Detecting environmental contaminants in real-time.
- Studying ecotoxicity and effects of pollutants on microbial communities.

18.Write key applications of perfluorocarbons.

Key applications of perfluorocarbons (PFCs):

- ***Artificial blood substitutes*** – carry oxygen and carbon dioxide in medical emergencies.
- ***Liquid ventilation*** – used in respiratory therapy and premature infant care.
- ***Organ preservation*** – improve oxygenation during transplantation.
- ***Medical imaging*** – act as contrast agents in ultrasound and MRI.
- ***Industrial uses*** – heat transfer fluids, electronics cooling, and chemical inert solvents.
- ***Environmental applications*** – gas delivery or storage due to high gas solubility.

19.How viruses act as bio receptor?

Viruses as bioreceptors:

Viruses can act as bioreceptors because their surfaces contain specific proteins or glycoproteins that can recognize and bind to target molecules with high specificity. When used in biosensors, viruses or virus-like particles (VLPs) are immobilized on a transducer surface. The target analyte (such as a toxin, pathogen, or biomolecule) binds to the viral receptor, producing a measurable signal (electrochemical, optical, or piezoelectric). Viruses as bioreceptors are stable, sensitive, and versatile tools in biosensor development.

20.Explain mechanical bio signals in plants.

Mechanical bio-signals in plants:

Mechanical bio-signals in plants are physical responses generated by stimuli such as touch, wind, pressure, or injury. These signals are detected by mechanoreceptors or stretch-activated ion channels, which trigger ion fluxes and changes in membrane potential, producing electrical signals. The signals propagate through plant tissues, leading to responses such as thigmotropism, leaf folding, or trap closure, as seen in *Mimosa pudica* and the Venus flytrap.

21.What is SPR?

SPR (Surface Plasmon Resonance):

Surface Plasmon Resonance is an optical technique used to detect molecular interactions in real time without labeling. It measures changes in the refractive index near a metal (usually gold) surface when a target molecule binds to a ligand immobilized on the surface. SPR is widely used in biosensing, drug discovery, and biomolecular interaction studies.

22.Define community, biome and biosphere.

- ***Community:*** A group of different species living together in the same area and interacting with each other.
- ***Biome:*** A large region with similar climate, vegetation, and organisms, e.g., desert, rainforest, or tundra.
- ***Biosphere:*** The global ecological system comprising all living organisms and their interactions with the air, water, and land.

23.What is Lateral Flow Assay?

Lateral Flow Assay (LFA):

A Lateral Flow Assay is a rapid, simple diagnostic **test** that detects the presence of a target analyte (like proteins, pathogens, or antibodies) in a sample. The sample moves laterally along a strip, where it interacts with labeled reagents and produces a visible signal, usually a colored line, indicating a positive or negative result. Common examples include pregnancy tests and COVID-19 rapid tests.

24.Explain the structure of Molecular Beacon.

Molecular Beacon:

A molecular beacon is a single-stranded oligonucleotide probe with a stem-loop (hairpin) structure. The loop contains a sequence complementary to the target nucleic acid, while the stem holds a fluorescent reporter at one end and a quencher at the other. In the absence of the target, the stem keeps the reporter and quencher close, suppressing fluorescence. When the target binds to the loop, the beacon opens, separating the reporter and quencher, producing a fluorescent signal.

25.What is paper chromatography?

Paper Chromatography:

Paper chromatography is an analytical technique used to separate, identify, and analyze components of a mixture. It works on the principle that different substances have different solubilities and affinities for the stationary phase (paper) and the mobile phase (solvent). A small sample is applied on the paper, which is then placed in a solvent. As the solvent moves up the paper by capillary action, different components travel at different rates, forming distinct spots. This method is commonly used for separating amino acids, pigments, sugars, and small organic molecules and is valued for its simplicity, low cost, and ease of visualization.

26.Define EDTA as a chelating agent.

EDTA as a chelating agent:

EDTA (Ethylenediaminetetraacetic acid) is a chelating agent that binds to metal ions through its multiple electron-donating groups, forming stable metal–EDTA complexes. This prevents metal ions from participating in chemical reactions, making EDTA useful in removing heavy metals, softening water, and stabilizing solutions in biochemical and medical applications.

27.What is bio recognition layer?

Bio-recognition layer:

The bio-recognition layer is the component of a biosensor that contains biological molecules (such as enzymes, antibodies, nucleic acids, or cells) which specifically recognize and bind to the target analyte. This specific interaction triggers a detectable signal in the transducer, allowing quantitative or qualitative measurement of the analyte.

28.Write strategies of sample collection for air borne pathogens.

Strategies for sample collection of airborne pathogens:

- ***Impaction:*** Air is drawn onto a solid or agar surface, trapping microorganisms for culture.
- ***Filtration:*** Air passes through filters that capture pathogens for analysis.
- ***Liquid impingement:*** Air bubbles through a liquid medium, collecting microorganisms for further testing.
- ***Cyclone samplers:*** Air is spun in a vortex to separate and collect particles.
- ***Settling plates:*** Expose culture plates to air, allowing microorganisms to settle naturally.

29.What is embedded or proximity optical fiber?

Embedded or Proximity Optical Fiber:

An embedded or proximity optical fiber is a type of fiber optic sensor that is integrated into or placed close to a material or surface to detect physical, chemical, or biological changes. It works by monitoring variations in light transmission, reflection, or intensity caused by changes in the surrounding environment, such as strain, pressure, temperature, or the presence of analytes. These fibers are widely used in structural health monitoring, biomedical sensing, and environmental detection.

30.What is propioreceptor?

Proprioreceptor:

A proprioreceptor is a sensory receptor located in muscles, tendons, and joints that detects body position, movement, and muscle tension. It provides the **ce**ntral nervous system with information about limb position and motion, enabling coordination, balance, and posture control. Examples include muscle spindles, Golgi tendon organs, and joint capsule receptors.

31.What are the requirements for micro fluids?

Requirements for microfluids:

- Small sample and reagent volumes for cost-effectiveness and efficiency.
- Precise fluid control within microchannels (using pressure, electrokinetic, or capillary forces).
- Biocompatible materials to prevent reactions with samples.
- Rapid mixing and reaction for fast analysis.
- Integration with detection systems (optical, electrochemical, or fluorescence).
- Portability and ease of use for point-of-care or field applications.

32.Write the characteristics of asbestos.

Characteristics of Asbestos:

- ***Fibrous structure:*** Composed of long, thin, and flexible fibers.
- ***Heat resistance:*** Can withstand high temperatures without burning.
- ***Chemical resistance:*** Resistant to most acids, alkalis, and corrosion.
- ***Insulating properties:*** Excellent thermal and electrical insulation.
- ***Durability:*** Strong and long-lasting material.
- ***Flexibility:*** Can be woven into fabrics or mixed with other materials.
- ***Toxicity:*** Harmful when inhaled**,** causing lung diseases like asbestosis, lung cancer, and mesothelioma.

33.Write working of lactate oxidase enzyme.

Working of Lactate Oxidase (LOX) enzyme:

Lactate oxidase is an enzyme that catalyzes the oxidation of L-lactate to pyruvate. During this reaction, molecular oxygen (O_2) acts as the electron acceptor, and hydrogen peroxide (H_2O_2) is produced as a byproduct. The overall reaction is:

$$\text{L-lactate} + O_2 \rightarrow \text{Pyruvate} + H_2O_2$$

In biosensors, the generated hydrogen peroxide is detected electrochemically or optically, and its concentration is proportional to the lactate level, allowing quantitative measurement of lactate in biological samples like blood or sweat.

34.What is the structure of beta- Cyclodextrin?

Structure of β-Cyclodextrin:

β-Cyclodextrin is a cyclic oligosaccharide composed of seven glucose units linked by **α**-1,4-glycosidic bonds, forming a torus (doughnut)-shaped structure. It has a hydrophobic inner cavity and a hydrophilic outer surface, allowing it to encapsulate hydrophobic molecules for drug delivery, solubilization, and stabilization purposes.

35.What is olfactory system?

Olfactory System:

The olfactory system is the sensory system responsible for the sense of smell. It consists of olfactory receptors in the nasal cavity that detect odor molecules, the olfactory bulb which processes the signals, and the olfactory cortex in the brain where odors are identified and perceived. This system allows organisms to detect, recognize, and respond to chemical stimuli in the environment.

36.Write the types of electric signal.

Types of Electric Signals:

- ***Action potential:*** Rapid, transient change in membrane potential used for nerve and muscle signaling**.**
- ***Graded potential:*** Small, variable changes in membrane potential proportional to stimulus strength.
- ***Oscillatory signals:*** Repetitive, rhythmic electrical changes, often seen in pacemaker cells.
- ***Electrochemical signals:*** Generated by ion fluxes across membranes, producing measurable currents.
- ***Bioelectric signals:*** Overall electrical activity in tissues, such as ECG (heart), EEG (brain), and EMG (muscles)**.**

37.How monoclonal antibodies are produced?

Production of Monoclonal Antibodies (mAbs):

1. ***Immunization:*** Inject an animal (usually a mouse) with the target antigen to stimulate antibody-producing B cells**.**
2. ***Cell fusion:*** Isolate B cells from the spleen and fuse them with immortal myeloma cells to create hybridoma cells.
3. ***Selection:*** Grow fused cells in HAT medium, which allows only hybridomas to survive.
4. ***Screening:*** Identify hybridomas producing the desired antibody using assays like ELISA.
5. ***Cloning and expansion:*** Clone selected hybridomas to produce large quantities of identical monoclonal antibodies**.**
6. ***Harvesting and purification:*** Collect antibodies from cell culture supernatant and purify for use in diagnostics, therapy, or research.

38.Name three electrodes in biosensors.

Three electrodes in biosensors:

- ***Working electrode:*** Where the biochemical reaction occurs and signal is generated.
- ***Reference electrode:*** Provides a stable potential for accurate measurement.
- ***Counter (auxiliary) electrode:*** Completes the electrical circuit by allowing current to flow.

39.Explain traditional analytical methods for detection of environmental pollutions and the reason behind the failure of these methods.

Traditional analytical methods used for the detection of environmental pollution include chromatography (such as gas chromatography and liquid chromatography), spectroscopic techniques (UV–visible spectroscopy, atomic absorption spectroscopy, ICP-MS), and wet chemical methods like titration and colorimetric assays. These techniques are highly accurate and sensitive and are commonly used to detect heavy metals, pesticides, organic pollutants, and industrial chemicals in air, water, and soil samples.

However, these methods often fail for routine and large-scale monitoring because they are time-consuming, expensive, and require complex sample preparation and well-equipped laboratories with skilled personnel. They are generally not suitable for on-site or real-time monitoring, and transporting samples to laboratories can lead to contamination or degradation. Due to these limitations, traditional methods are being replaced or supplemented by biosensors and portable analytical devices for rapid and continuous environmental monitoring.

40.Write principle of optical biosensor.

The principle of an optical biosensor is based on the detection of changes in the optical properties of light resulting from the interaction between a biological recognition element and a target analyte. When the analyte binds to the bioreceptor, it causes measurable changes in parameters such as absorbance, fluorescence, luminescence, refractive index, or light intensity. These changes are converted by an optical transducer into a detectable signal, which is proportional to the concentration of the analyte.

41.What is the use of fluorophore in SPR immunosensor?

In an SPR immunosensor, a fluorophore is used to enhance sensitivity and signal detection. When the antigen–antibody binding occurs on the metal surface, the fluorophore emits fluorescence that is amplified by surface plasmons (SPR-enhanced fluorescence). This allows better detection of low-concentration analytes, improves signal-to-noise ratio, and enables more accurate immunoassays.

42.Write components of immobilization enzymes.

The components involved in enzyme immobilization include the enzyme, which acts as the biocatalyst, and a support or matrix such as polymers, gels, membranes, silica, or nanoparticles that provide a solid surface for attachment. A binding method or linker (for example adsorption, covalent bonding, entrapment, or cross-linking agents like glutaraldehyde) is used to attach the enzyme to the support. In some systems, a stabilizing agent or spacer is also included to maintain enzyme activity and improve durability.

43.What is multiplexed lateral flow?

Multiplexed lateral flow is an advanced form of lateral flow assay that allows the simultaneous detection of multiple analytes in a single test. It uses multiple test lines or differently labeled detection probes on the same strip, so several targets can be identified at the same time. This approach saves time and sample volume and is widely used in clinical diagnostics, food safety, and environmental monitoring.

44.What is ELISA? How it is performed?

ELISA (Enzyme-Linked Immunosorbent Assay)

ELISA (Enzyme-Linked Immunosorbent Assay) is an immunological technique used to detect and quantify antigens or antibodies in a sample using specific antigen–antibody interactions and an enzyme-mediated color reaction.

Performance of ELISA:

First, the antigen or antibody is immobilized on a microplate well. The sample is added so that the target molecule binds to the immobilized component. After washing to remove unbound substances, an enzyme-linked antibody is added, which binds specifically to the target. A suitable substrate is then added, and the enzyme converts it into a colored product. The intensity of the color is measured using a spectrophotometer and is proportional to the concentration of the target analyte.

45.What components are used in paper lab on chip device?

A paper-based lab-on-a-chip (μPAD) device is composed of several simple and low-cost components. The main component is the paper substrate (such as cellulose or filter paper), which acts as the microfluidic platform and enables fluid flow by capillary action. Hydrophobic barriers (made using wax printing, ink, or polymers) define the microchannels and reaction zones. Biorecognition elements such as enzymes, antibodies, or nucleic acids are immobilized in specific detection areas. The device also includes reagents stored on the paper, a detection zone for visual or electrochemical readout, and sometimes electrodes or optical readout elements for signal measurement.

46.How PNA is used in DNA based biosensor?

Peptide Nucleic Acid (PNA) is used in DNA-based biosensors as a synthetic probe for the specific detection of complementary DNA sequences. In a biosensor, PNA probes are immobilized on the sensor surface. When a target DNA strand is present, it hybridizes strongly and specifically with the PNA probe. Because PNA has a neutral backbone, it shows higher binding affinity and better mismatch discrimination than DNA. The hybridization event causes a measurable optical or electrochemical signal, which is proportional to the concentration of the target DNA.

47.What is refractive index? Why it is important?

Refractive index

Refractive index Refractive index is a measure of how much the speed of light changes when it passes from one medium to another**.** It is defined as the ratio of the speed of light in vacuum to its speed in the given medium.

It is important because it determines how light bends, slows down, and propagates in a material. Changes in refractive index are used to identify substances, measure concentration, and detect molecular interactions**,** especially in optical techniques such as SPR, optical biosensors, and refractometry.

48.Differentiate between electric nose and electric tongue.

An electronic nose is a device that detects volatile compounds or odors, mimicking the human olfactory system, whereas an electronic tongue detects liquid-phase compounds and mimics the human gustatory system. The electronic nose typically uses gas sensors like metal oxide sensors to analyze aroma patterns, while the electronic tongue relies on electrochemical sensors to evaluate taste attributes such as sweet, sour, bitter, salty, and umami. Both devices employ sensor arrays and pattern recognition to identify, classify, and monitor samples, but they differ in the type of analytes they detect and their applications—electronic noses are used in food quality, environmental monitoring, and medical diagnostics, whereas electronic tongues are applied in beverage testing, water quality assessment, and pharmaceutical analysis**.**

49.Write three junctions of DNA switch.

Three junctions of a DNA switch:

1. ***Two-way junction (Holliday junction):*** A crossover point between two DNA duplexes that allows branch migration.
2. ***Three-way junction:*** A branch point where three DNA double-stranded arms meet, often used in molecular switches and nanostructures.
3. ***Four-way junction:*** A crossover of four DNA strands, forming a stable structure for complex DNA nanomachines and switching mechanisms.

50.What is photoresist?

A photoresist is a light-sensitive chemical material used to form temporary protective patterns on a surface—most commonly in photolithography for microelectronics, semiconductor fabrication, and micro-/nano-technology.

When a photoresist-coated surface is exposed to ultraviolet (UV) light through a patterned mask, the exposed regions undergo a chemical change. This change allows selective removal of either the exposed or unexposed areas during development, transferring the desired pattern onto the underlying substrate.

51.Write advantages of microPADs.

Advantages of microPADs (microfluidic paper-based analytical devices):

1. ***Low cost*** – *fabricated* from inexpensive materials like paper, making them affordable for large-scale and resource-limited use.
2. ***Simple operation*** – do not require external pumps or complex instruments; fluids move by capillary action.
3. ***Portability*** – lightweight and compact, suitable for field and point-of-care testing.
4. ***Rapid analysis*** – provide quick results due to short diffusion paths and small sample volumes.
5. ***Minimal sample and reagent consumption*** – require only microliter quantities.
6. ***Disposable and biodegradable*** – reduce contamination risk and environmental impact.
7. ***User-friendly*** – can be operated by untrained personnel.
8. ***Multiplexing capability*** – allow simultaneous detection of multiple analytes on a single device.
9. ***Compatibility with colorimetric and electrochemical detection*** – enable easy visual or instrumental readout.