The term “biosensor” refers to powerful and innovative analytical device involving biological sensing element with wide range of applications, such as drug discovery, diagnosis, biomedicine, food safety and processing, environmental monitoring, defense, and security.

With the emphasis on the research tools that demonstrate how the performance of biosensors evolved from the classical electrochemical to optical/visual, polymers, silica, glass, and nanomaterials to improve the detection limit, sensitivity, and selectivity.

ELECTROCHEMICAL BIOSENSORS

Classical discovery of glucometer using glucose oxidase-based biosensors (Clark and Lyons, 1962) is first in the line of discovery of electrochemical biosensors. Glucose biosensors are widely popular among hospitals or diagnostic clinics as these are essential for diabetic patients for periodic monitoring of blood glucose. However, glucose biosensors are often having drawbacks due to

OPTICAL/VI SUAL BIOSENSORS

Hydrogels (polyacrylamide) are hydrophilic cross-linked polymers (Khimji et al., 2013) and can be made into different forms for immobilization ranging from thin films to nanoparticles. Hydrogels are considered as a simple substrate for DNA immobilization with other advantages, such as entrapment, controlled release, analyte enhancement, and DNA protection. These features are unique to hydrogels compared to other materials which offer biomolecular immobilization (Khimji et al., 2013). Furthermore, good optical transparency of hydrogels provides convenient strategy for visual detection. Detailed methods for immobilizing DNA biosensors (Khimji et al., 2013) in monolithic polyacrylamide gels and gel microparticles are often considered as technical advancement in the field of biosensor technology.

SILICA, QUARTZ/CRYSTAL AND GLASS BIOSENSORS

Recent methods in the development of biosensors resulted in the use of silica, quartz or crystal and glass materials due to their unique properties.

Furthermore, silicon nanomaterials have no toxicity which is an important prerequisite of biomedical and biological applications. Silicon nanomaterials (Peng et al., 2014; Shen et al., 2014) offer wide range of applications ranging from bioimaging, biosensing and cancer therapy. Furthermore, fluorescent silicon nanomaterials have long-term applications in bioimaging.

NANOMATERIALS-BASED BIOSENSORS

Wide range of nanomaterials ranging from gold, silver, silicon, and copper nanoparticles, carbon-based materials, such as graphite, grapheme, and carbon nanotubes, are used for developing biosensor immobilization

TABLE 1 | List of biosensors with principle, applications, and bibliography.

Sl. No.	Type	Principle	Applications
1.	Glucose oxidase electrode based biosensor	Electrochemistry using glucose oxidation	Analysis of glucose in biological sample
2.	HbA1c biosensor	Electrochemistry using ferroceneboronic acid	Robust analytical method for measuring glycated hemoglobin
3.	Uric acid biosensor	Electrochemistry	For detection of clinical abnormalities or diseases
4.	Acetylcholinesterase inhibition-based biosensors	Electrochemistry	Understanding pesticidal impact
5.	Piezoelectric biosensors	Electrochemistry	Detecting organophosphate and carbamate
6.	Microfabricated biosensor	Optical/visual biosensor using cytochrome P450 enzyme	For drug development
7.	Hydrogel (polyacrylamide)-based biosensor	Optical/visual biosensor	Biomolecular immobilization
8.	Silicon biosensor	Optical/visual/fluorescence	Bioimaging, biosensing and cancer therapy
9.	Quartz–crystal biosensor	Electromagnetic	For developing ultrahigh-sensitive detection of proteins in liquids
10.	Nanomaterials-based biosensors	Electrochemical or optical/visual/fluorescence	For multifaceted applications including biomedicine, for example diagnostic tools
11.	Genetically encoded or fluorescence-tagged biosensor	Fluorescence	For understanding biological process including various molecular systems inside the cell
12.	Microbial fuel cell-based biosensors	Optical	To monitor biochemical oxygen demand and toxicity in the environment and heavy metal and pesticidal toxicity

TABLE 2 | Use of biosensors in disease diagnosis.

Sl. No.	Biosensor(s)	Disease diagnosis or medical applications
1.	Glucose oxidase electrode based biosensor and HbA1c biosensor	Diabetes
2.	Uric acid biosensor	Cardiovascular and general disease diagnosis
3.	Microfabricated biosensor	Optical corrections
4.	Hydrogel (polyacrylamide)-based biosensor	Regenerative medicine
5.	Silicon biosensor	Cancer biomarker development and applications
6.	Nanomaterials-based biosensors	For therapeutic applications