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The role of nanobiosensors in identifying pathogens and environmental hazards

Ramin Mohammadi-Aloucheh[1*], Yousef Alaee Mollabashi[2], Asadollah Asadi[3], Ozlem Baris[4], Somayeh Golamzadeh[5]

[1] Young Researchers and Elites Club, Ardabil Branch, Islamic Azad University, Ardabil, Iran
[2] Department of Biology, Ardabil Branch, Islamic Azad University, Ardabil, Iran
[3]Department of Biology, Faculty of Science, University of Mohaghegh Ardabili, P.O. Box 179, Ardabil, Iran

[4]Department of Nanoscience and Nanoengineering, Institute of Natural and Applied Science, Atatürk University, 25240 Erzurum, Turkey

[5]Department of Biology, Faculty of Science, Urmia PNU University, Urmia, Iran.

*Correspondence author: ramin.p1363@gmail.com

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Abstract: The bringing human populations to cities and increasing urban living and creation of quick human progress in agriculture and industry have caused a lot of pollution. One of the main concerns that exist today is the identification and elimination of environmental pollution. The environmental pollution through heavy metals has become one of the biggest issues facing human societies today. There are several methods to identify such contaminations, but the use of nanobiosensors is the best method. Biosensors are divided to different types according to how the signals are transmitted, such as optical, magnetic, etc. In addition, nanobiosensors identify biologically pathogens such as bacteria, viruses and the like with high accuracy and sensitivity. In addition to identifying heavy metals and environmental contaminants, nanobiosensors have replaced time-consuming and expensive methods. The yeast biosensors are a good example of these biosensors. Considering all the results and activities carried out, designing and researching on the construction of new nanosensors, monitoring and caring for more human activities can have desirable results.

Keywords: NanoBiosensor, Identification, Pathogens, Environment

1. Introduction:

Nowadays, bringing human populations to cities and increasing urban living and creation of quick human progress in agriculture and industry have caused a lot of pollution. The production of heavy metals as a result of human activities and are the entry of these metals into the environment has caused many environmental pollution, and this has led to many concerns among societies (Asaduzzaman et al. 2017). Novel technologies and subsequent pollutions are serious threats to the environment and public health. Furthermore, the heavy metal pollution has pervaded many parts of the world, especially in developing countries (Wu et al. 2018). The different anthropogenic activities can broadcast heavy metals. The traffic in large cities is congested, causing the consumption of more fuel and allowing more waste gas to escape from the exhaust.Fuel combustion in factories also releases substantial amounts of heavy metals. The heavy metals thus released could accumulate in media such as water, soil, and the atmosphere (Men et al. 2018). The heavy metals in soil, have become a serious risk for human health and

the loss of balance of ecosystems because even in lower doses, they are capable of being dangerous for human health and to environment (Zhou et al. 2016), (Bae et al. 2018), and (Zhang et al. 2018). Heavy metals pollution has become one of the most important and major concerns in environmental issues in industrial areas. The three important metals, Cu, Pb, and Zn are environmental pollution factors which are released to water. (Abu-Ali et al. 2017). In recent years, marine pollution has been increased by heavy metals. Furthermore, the toxicity of heavy metals increases when ion is dissolved in water (Chaturvedi et al. 2018). These heavy metals which harmful for human health and environment, have attracted interests of many countries (Cui et al. 2018). The identification and elimination of heavy metal contamination is important due to such effects (Rasheed et al. 2018), and (Yu et al. 2017). The typical methods of identifying heavy metals and environmental pollution have got many disadvantages, such as high cost and being time consuming, but sensors are capable of performing such identifications (Zhou et al. 2016). The sensors are tools for detecting and transforming physical changes created in a sample. It is intended to convert messages and signals to be processed, the most important part of the sensor is called the converter, and the use of sensors has its own requirements and is different from other methods. Sensors detect physical changes in the sample through the transducer and by creating electrical signals (Kurbanoglu and Ozkan. 2017). In addition, by the rapid advancement of nanotechnology, the sensors have been developed specially in sensitivity and some kinds of sensors, called "nanosensors", have being used a lot. In these sensors, nanomaterials are used to identify the desired compounds such as nanotubes, nanowires, etc (Zhou et al. 2016). The high level of nanosensors ability to detect materials has attracted the attention of many specialists in the field of medical, health and environmental issues (Kurbanoglu and Ozkan. 2017). In addition to nanosensors, there are other types of sensors known as biosensors. Biosensors are also a biological and electronical component used to study biological structures which are used to study biological structures and organisms (Burlage and Tillmann. 2017), and (Yu et al. 2017). The biosensors are also a device composed of electrical and biological components to study biological structure (Burlage and Tillmann. 2017) and (Fooladsaz et al. 2012). They have many convincing features for others to use them. For example, providing quick results and rapid adaptation to the conditions for identifying pathogens is one of these features. In addition, the sensors must have features such as easy to used and small size (Templier et al. 2016) and Rasheed et al. 2018). On the other hand, the use of biosensors to detect bacteria of *Escherichia coli O157: H7* concentration range 7.23X10 (7) -1.6X10 (1) CFU / mL.) and the detection time of 15 minutes is recorded by Xu and colleagues (Xu et al. 2017). Furthermore, in the another study by Yoo *et al*, on the electrochemical biosensors, *Bacillus subtilis* bacteria was identified in 10 minutes in 10 CFU / mL 10 (10) -10 (2) concentration range (Yoo et al. 2017). In Alamer's research, they used a new nanobiosensor method to detect strains of *Salmonella*, in concentration range of 10-10(8) CFU/mL (Alamer et al. 2017). Moreover, Fluorescence Resonance Energy Transfer (FRET) based nanobiosensor were used to identify human papillomavirus (HPV18) with the least possible amount, 0.2 nm (Shamsipur et al. 2017). For detection of *influenza virus* (H1N1) using nanobiosensors, were needed only 5 minutes. While some methods like RT-PCR needed several hours. The limit of detection of this virus in water was 0.03pg/mL and in human serum 0.4pg/mL (Takemura et al. 2017). Furthermore, Mohsin et al by used the biosensors to detect methionine amino acids in bacterial and yeast cells which took 30-25 minutes and the result of this identification was the detection of 100 % (Mohsin and Ahmad 2014). Moreover, biosensors can also be used to identify heavy metals and poisonous ions. In Malcolm's research, cadmium was detected in 20-40 minutes in the range of 3µg /mL (Bereza-Malcolm et al. 2017). In another study to detect the toxic ion of silver, the range of detecting particles by nanosensor fluorescence and GQDs was 250 nm (Zhao et al. 2017). Using the *Vibrio* strain species, a kind of biosensors showed the maximum and minimum sensitivity to zinc metals and it was $14.54 mgL^{-1}$, $0.97 mgL^{-1}$, and equivalent to EC50 cadmium, respectively. Values (Mohseni et al. 2018). In Yu's research in 2016, six elements were tested and detected using biosensors including, Cd^{2+}, Zn^{2+}, Hg^{2+}, Cu^{2+}, Cr^{3+}, and Pb^{2+} which their resistance rete was 12.56%, 13.99%, 8.81%, 9.29%, and 1.95%

respectively (Yu et al. 2017). The aim of this study is a review on biosensors and nanobiosensors and their role in identification pathogenic factors and environmental hazards from heavy metals.

2. Biosensor structure:

Normally a biosensor is composed of the biological unit (tissue, microorganisms, DNA, organs, cell receptors, enzymes, antibodies, nucleic acids, proteins, glucose, etc.), A converter (which has the task of converting changes in the sample to a measurable signal by the bio-sensor (such as optical, piezoelectric, electrochemical, etc.) and the biosensor display and signal processors to illustrate the results of analyzing (Ansari et al. 2016).

3. Different type of biosensors:

Biosensors are categorized based on how the signals are transmitted from samples to different groups such as electrochemical, optical, thermal, physiometric, immunochemical, magnetic, enzyme and DNA base (Hassan et al. 2016). A group of biosensors is made of physical-chemical transducers, such as electrochemical (Yakovleva et al. 2012). The various types of biosensors are being produced such as mass, light or heat, such as sensitivity, selectivity, speed and efficacy and at the same time low prices are produced. The biosensors have various applications in areas such as the environment, agriculture, and the identification of biomolecules (Qi et al. 2018). Osteoporosis based sensors are detected using membranes, chloroplasts and mitochondria. Immunosensors act on the basis of antigen and antibodies, so that specific antibodies bind to pathogens and toxins or in the host immune system with reactive compound compounds and thus helps detect by immunosensors (Mehrotra 2016). In comparison with other structures such as chromatography and spectrometry, optical biosensors have structures which make them easy to carry out the desired activities (Khansili et al. 2018). High sensitivity and selectivity, low cost equipment, low cost, and low identification time are some reasons why it is good to use those (Qi et al. 2018). The electrochemical-enzymatic biosensors have an important role in our everyday life. Such biosensors have the potential to be used in the analysis and identification of diseases or in biochemical research, but over time, they lose their properties and functions from and they are also high cost. So non-enzymatic biosensors can be a good alternative. The electrochemical biosensors basically are divided into three based which including the ampherometric, Potentiometric, and Imphedimetric (Lawal et al. 2018). Analysis concentration measurement has been one of the physioelectric task. Physioelectrical biosensors are suitable converters for rapid identification for simple viruses, bacteria, proteins, nucleic acids and small molecules, like drugs and hormones (Skládal 2016).

3.1. Nanobiosensors:

Nanotechnology is to study on the fabrication and manipulation of materials, systems and tools in the size of 1-100 nm. The use of nanotechnology and nanoscience in biosensors has led to the production and introduction of mechanisms of new signal converter that greatly increases the sensitivity of their identification (Syed 2014). With the increasing advances in nano science and the ability to produce very small electrodes is possible the production of new types of nanobiosensors. Smaller particle size not only doesn't reduce their quality, but also increases their efficiency (Mokhtarzadeh et al. 2017). In the structure of biosensors, nano sized synthesized wires from metals (Ni, Cu, Ag and Pt), metal oxides (Fe_2O_3, SnO_2, ZnO) and semiconductor gallium silicon (Ca, GaN) spot quantum based CdSeTe or CdTe, CdSe ,carbon nanotubes and metal nanoparticles (based on Ag, Cu, Pd, Co, Au, and Pt) magnetic nanoparticles, nanoscale materials, which all of these have effects on analyzing and detecting sensors and biosensors (Dolatabadi et al. 2011), (Justino et al. 2017), and (Qi et al. 2018). Sensors that are made using nanoscience using nanoscale materials have different applications today. For example, enzyme-based nanosensors are one of the most useful analytical methods used to identify toxins present in biological samples. With the advancement of simple sensors such as hydrophobic sensors

through gold nanoscale, three strains of *E. coli* can be identified (Sun et al. 2018). By adding biomaterials and converters that work with nanomaterials, we can identify new, high-quality biosensors that can be used to identify biomolecules and diagnose diseases. These biosensors can detect environmental contamination at high speeds and high levels of pollution (Mokhtarzadeh et al. 2017). Integration of nanomaterials with biosensors through identification of materials improves the electron transfer between electrodes, otherwise they cannot enhance the quality of the identification of these biosensors. The electrochemical nanobiosensors have been considered for some reason, such as low prices, high sensitivity and low identification thresholds (Aghili et al. 2017). Such sensors are used in laboratory measurements due to easy access and easy measurement (Bagheri. et al. 2017). Terrorist attacks that take place using biological agents are important because of the identification speed and then treat is very important (Garcia- Aljaro et al. 2010).

3.2. Quantum dots:

In recent years, with the advancement of nano science, various nanomaterials such as fluorescents are used to design chemical biosensors which uses fluorescent nanoparticles in the design and development of optical sensor systems. One of the most widely used fluorescent nanomaterials in biosensors is quantum dots. This action has increased the sensitivity of detection in biosensors containing spot quanta. The spot quantum attracts more attention and GQDs is highly used in quantum dot-graphene low, property of fluorescent high, the chemistry and the ability to capture super pointed out. Quantum Point Graphene is used for various purposes in the design of nanosensors, but one of the methods used to improve and enhance the quality of the selection of graphene dot quanta is MIP (Mehrzad-Samarin et al. 2017).

3.3. Application of Graphene in Biosensors:

Over the past few years, some graphene-based biosensors have been built in some fields like medicine, environment and researches on food industrial. There are various factors which effect Graphene-rich biosensors for example, the mechanism of the transducers and the apparent characteristics of the sensors. Graphene biosensors are used in the field of medicine (Justino et al. 2017).

4. Environmental pollution caused by heavy metals:

The heavy metals have always been one of the risk factors for human and animal health which should be paid attention to. Some heavy metals like Cu^{2+}, Zn^{2+}, Hg^{2+}, and Cd^{2+} which enter the body by water and industrial activities, effect water and rivers and seas on the development of aquatic organisms which could endanger the lives of these creatures in the long run. Accordingly, the use of identification methods that are more based on the use of marine animals and animals, such as fish, shrimp and cappuccino, has been considered. But these methods had disadvantages such as cost and time, which caused us not to count on them (Cui et al. 2018). Many studies have shown that human activities have been one of the main factors in increasing pollution by heavy metal. The reason for this is the massive release of heavy metals through corrosion of metals, mining activity and energy production, population growth, fossil fuels, plating, melting, fertilizers, etc., which can pollute the environment. Such activities are from the main sources of the production and release of Heavy metals, especially cadmium, copper, etc (Jacob et al. 2018) and (Martin et al. 2018). Essentially when heavy metals are used, they affect the health of humans. For example, excessive consumption of lead, which is an unnecessary element, can cause severe and severe damage to human health and affect members and can hurt body and vital systems such as the nerve and immunity system, and ... (Wu et al. 2018). The pollution of metals can be entered into the environment through natural and human ways and created in soil and in the climate. For example, soil humus can absorb heavy metals by getting these metals from the water, in addition to the root of crops and other plants, they can absorb these elements from water and transfer them to other plants, and in the effects of animal

nutrition on other plants can be transmitted to animals from the sources of airborne, blue and even contamination in the global ecosystem (Jacob et al. 2018). The high volume of production and the use of xenobiotic compounds can be mentioned. Halogenated hydrocarbons are one of the compounds produced during industrial processes that cause pollution in the environment. Ionic contaminations of metals such as magnesium and highly toxic lead and they have become very widespread in recent years (Bidmanova et al. 2016). By dissolving these two metals in water and becoming a soluble form, these metals become extremely stable and thus human health and aquatic organisms are considered as hazardous. Due to these explanations, and with the emphasis on the toxicity of such metals in recent years, identification methods have made many improvements. The heavy elements detection and pollution-dependent methods include chemical methods, enzyme based, gold nanoparticles, point quantum, but most of these methods make it possible to detect only one of the metals (Tan et al. 2012). Today, the impurities from heavy metals and the ions of such metals have negative effects on the human and environmental health, and these dangers have attracted a lot of attention. Identifying these metals are very important for medical reasons and environmental contaminants, among which are the heaviest metals that have the highest levels of contamination and cause Cu^{2+} disease in metals, copper such as Alzheimer's, Manke, Wilson, etc. One of the traditional methods for the identification of heavy metals is in various spectrophotometric methods (Tian et al. 2017). Another heavy metal that releases a large amount of it, for example, in the thousands of tons in peripheral waters, causes pollution and illness, silver, the source of these contaminations is industrial water, etc. Silver has various uses in industries such as electronics, photography, mirrors and nanoscale. Different fluorescence sensors have been designed using nanomaterials. For the first time, the graphene silver quanta was used to detect silver ions in fluorescent nanosensors (Zhao and he 2017).

5. Environmental contaminants caused by biological agents:

The environmental pollution caused by biological agents such as bacteria, parasites and viruses has been important in accurate calculation of contamination. The toxocariasis is a zoonosis infection which is caused by parasites and can be transmitted from animals to humans and *Toxocara canis* and *Toxocara cati* as well. These biological agents which are dogs and cats intestinal parasites, choose different people as parasitic host. The main source of human infection with this parasite is the spread of toxa-contaminated eggs in nature and contamination in these areas, namely, which include high levels in Europe, for example 16.5 % in Spain, 4.5- 5% Czech Republic (Otero et al. 2018).

6. Application of Biosensors to Identify Pathogenic Factors:

The microbial biosensors are a tool for the identification and analysis of microorganisms that are found in the fields of various medical, environmental and food items, experiments and practice (Lei et al. 2006). Biological factors include bacteria, viruses and toxins that are used to identify pathogens like viruses. There are several methods, including cell implantation, sequencing of genes, etc. But each of these methods has disadvantages such as timing, sometimes high costs and hard work, but biosensors have the ability to detect despite their low concentration accurately (Mokhtarzadeh et al. 2017). Bacteria pathogens today are considered as a threat to the entire world. They have changed an effective factor due to being the reason of illness and treatment costs in the field of health and economics. Identifying and eliminating pathogenic bacteria is important. Common detection methods include biochemical and immunological reactions, bio-molecular techniques such as polymerase chain reaction or cell implantation. For example, one of the problems is that in some cases, it is necessary to determine the type of pathogen to remove the sample from the laboratory. But with the use of nanobiosensors and biosensors, these problems can be eliminated to some extent. Gold nanoparticles are one of the most widely used methods for detecting bacteria, viruses, and toxins that vary in size from 2- 100 nm. Conventional and commonly used methods for identifying bacteria is implantation which it is often expensive and time taking. So there should be alternative methods that have features like speed, reliability, and comfort. It is

easy and sensitive to use enzyme DNA nanosensors (DIPNs) (Yu et al 2017) and (Rowland et al. 2016). Rapid detection of microbial agents in water, food, samples is necessary in two ways: General health and security (Syed 2014). There are several methods to identify food contamination and food security: Gas Chromatography, Gas Chromatography, Mass Spectrometer, Liquid Chromatography, Mass Spectrometer, and Elisa. But each of these methods has its pros flaws and cons. The use of nanobiosensors makes it easier to detect food contaminants (Lv et al. 2018). In the medical fields, the used of the biosensors has grown rapidly. The biosensors are being used in identifying food pathogens, such as *E.coli* in vegetables which these identified by pH changes made using the ammonia (Mehrotra 2016) and (Shamsazar, et al. 2016). Graphene biosynthesis are used to identify pathogens, dopamine, uric acid, thrombin, H_2O_2, food contamination like erythromycin and *Staphylococcus aureus* (Justino et al. 2017). New amicrobic biosensors use respiration and metabolic activities of microorganisms to detect and inhibit their activity. Among bacterial agents identified by biosensors we can mention some gram-negative bacteria like *Pseudomonas* and *Enterobacter* (Bereza-Malcolm. et al. 2017).

7. The use of biosensors in identifying heavy metals and environmental pollution:

The heavy metals are one of the factors that are always considered to be hazardous to human and animal health (Cui et al. 2018). For this reason, various methods, including spectroscopic detection techniques are used, which have high detection rates and high sensitivity. But these methods are appropriate and time taking, and aren't good for in situ analyses. Among them microbial-based biosensors have attracted a lot of attention. In addition, this model has high flexibility in sensors compared to cell biosensors (Bae et al. 2018). Biosensors can play an important role in detecting heavy metals that are hazardous for human and environment like cadmium and arsenic (Bereza-Malcolm et al. 2017). Such biosensors are preferred to other detection methods due to their various benefits. Yew biosensors have been undergoing ascents and have been exposed to a variety of environmental pollutants. The focus is on such pollution by identifying the mechanisms of action and target molecules. They are classified into two groups: biosensors to identify contaminants from specific biological substances or toxins and biosensors with high specificity for single compounds (such as Cu). The contaminating elements can be identified by specific and non-specific biosensors. Non-specific biosensors have the ability to identify metals such as Cd^{2+}, Pb^{2+}, Fe^{2+}, As^{3+} (Jarque et al. 2016). There are other biosensors that are based on the use of nanomaterials:

١. The aptamer-based biosensors are known as aphtha sensors .

2. Aptamer biosorbents are known as adsorbents.

Using nanomaterials can greatly increase the irresistibility of uptime. In addition, nanomaterials play an important role in the direction and density of the controller groups of aptamers, so that the Pb^{2+} increases the ability to identify the optimum. Until now, various methods have been developed to identify heavy metals such as those produced and used, such as As^{3+}, Cd^{2+}, and Hg^{2+} as well as aptamers (Farzin et al. 2017). One of the strongest and best analytical tools in this field is the (DNA) is a chemical nanomaterial that is widely used in the identification of heavy metals, such as high sensitivity, selectivity, easy transportation, and the ability to operate machines and identify them in places (on-site), In addition to detecting molecules that exist in nanostructures, sensitize and increase the site's ability to identify age Luminous-chemical sensors are another sensor made in this field that has many uses and potential. Such sensors are classified in the category of chemical sensors that are used to identify and analyze the desired elements and convert them. These changes to possible signals (Ullah et al. 2018). The microarray biosensors can be another quick detection method for heavy metal (Herranz et al. 2017). Antineoplastic drugs used in the treatment of cancer, and usually without digestion and the digestion in the human body is released into the environment and, therefore, they are considered to be environmental damage (Lima et al. 2018). There are several methods for detecting these drugs, but biosensors and electrochemical sensors, due to their

high sensitivity and Low cost and high speed, even in Lima, HR Slow ability to detect these drugs the release of heavy metals in the environment has many effects on microorganisms, and microorganisms are also very sensitive. It is difficult to identify the types of pollution in the environment and to assess their concentration, so it is impossible to do this through a sensor. But the use of bacterial sensors that fits the type of infection can solve this problem. Utilizing electrical properties of cells through gold electrodes has shown positive results and has caused cell-based sensors to be used to identify the various contaminations (Abu-Ali et al. 2017). By increasing the pollution from heavy metals and their damage, one of is human products to prevent and detect graphene nanosensors. Sub-branch divisions of this model are based on the type of graphene, such as graphene oxide, spot-quantum graphene, and graphene-centric optical nano-sensors. The use of nanomaterials such as graphene is due to the high power of such materials in the simple design of the sensors and their high sensitivity to the identification of certain metallic ions. For for example, two-dimensional graphene and graphene are widely used in (Zhang et al. 2018).

8. Discussion and Conclusion:

Humans are one of the largest groups on the planet and can therefore have many effects on the environment. From human dwelling on the planet, humans and the environment were in contact with each other, but changing the lifestyle of humans is such that humans are considered to be environmental degradation, that is to say, humans and the environment are in contradiction (Schultz 2002). Studies of human behaviors have been carried out by more human contaminants. The results of these studies shows that in order to reduce environmental pollution, children's beliefs and perspectives should be given more attention and training provided. The same study was conducted on adults, which shows that with the increase in information and awareness of people can increase the interest in having a clean and healthy environment (Evans et al. 2007). Natural and industrial pollution water resources have become one of the major concerns today. This kind of pollution affects wildlife and human health. This importance and the high risk of water pollution have caused human societies to devise new methods and systems for identifying chemical and biological contaminations that can identify the least amount of contamination in the shortest possible time. The entry of heavy metals by various ways into the soil contributes to various developments (Herranz et al. 2017). The heavy metals can carry toxic and hazardous substances to the soil. Soil contamination due to the presence of heavy metals causes a loss of natural ecosystem balance, microbial population, and normal soil activity. Air pollution caused by heavy metals has spread in many parts of the world like many countries is from some metals like Cu, Zn and have a density of $5<g\ cm^3$, (Jankiewicz and Adamczyk 2010). Such pollution does not only reduce the air quality and respiratory but also by entering the body it affects the organs of the body, such as the kidneys, and bones, and can be dangerous to anyone who lives near contamination (Wu et al. 2018). According to research findings some of the benefits of working with nanosensors and biosensors, including speed, precision, high sensitivity, and comfort, have been noted. The nanosensors and biosensors have excitatory thresholds. In addition to low biological parameters, low PCR has less risks and contaminations than other methods, such as those introduced by international assemblies, are the dangers of heavy metals such as cadmium, arsenic and silver, etc should not be neglected. The heavy metals can cause long-lasting illness or affect the environment by contaminating the environment. Nano science is a relatively new science that requires more activity to get more accurate information. This applies to sensors that require further research on the use of these sensors in environmental pollution and to obtain accurate detection of heavy metals by such sensors. By designing research, or even designing and building nanosensors and biosensors in line with these issues, more detailed information can be found on this subject. In this case, the issues of time and speed are important, so in studies, these two factors must be prioritized. In addition to doing scientific research even in laboratory conditions and using nanosensors to identify them, good results can be obtained. More care and attention is needed from the industries and human activities that produce and release heavy metals to the environment and the human environment.

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