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Review Article

Biomedical Relevance of Biological Smart Materials Approach for Synthesis of Selenium Nanoparticles by Agrobacterium

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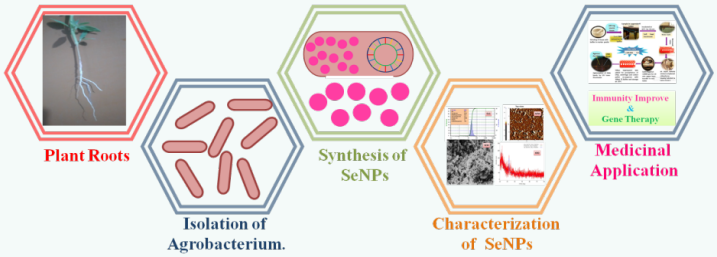
Abstract

Nanotechnologies are making more efforts to develop new materials to use in different ways to be beneficial to human life. Their unique properties are constantly being improved to enhance more effective and perfect activity as per the requirement. Researchers are continuously producing highly useful materials with the help of different types of microorganisms and green technology for the synthesis of nanoparticles as per the requirement. Primarily Agrobacterium species are the most useful microorganisms for the synthesis of selenium nanoparticles in the diameter range of nanoscale. These are capable and more effective in making nanomaterials from selenium to use in medicinal and other applications. These are opening a new dimension in the field of medical science which is beneficial for multipurpose use directly or indirectly.



The schematic diagrams of the abstract

Keywords: Nanotechnology; Agrobacterium; Selenium nanoparticles; Medicinal use

Introduction

In recent times globally, research on selenium nanoparticles (SeNPs) synthesized using various techniques has emerged as novel antimicrobial agents for their unique chemical and physical properties [1-5]. In recent times, most cases have paid attention to microbial transmittable diseases, which have posed noteworthy challenges to comprehensive health globally, in particular, alongside the appearance of resistant fungi and the unpleasant special effects allied with the expanded use of effective antifungal treatment [6-8]. This makes it imperative for the development of secure and effective alternatives to conventional antifungal drugs. Thus, instead of antifungal studies on SeNPs, it could be very useful for dimension open a new technology in the subjects of science known as biomedical, biotechnology, chemistry, electronics, and medicine [9-11].

Consistent with examples from the literature, nanotechnologies have achieved the target by means of biologically synthesized nanoparticles surrounded by a size up to less than a thousand nanometers (diameter of nanoscale). Such resources can develop an assortment of applications in the multidisciplinary areas of science. Which find the physical property of nanomaterials expected as on its dimension of shape and sizes in the nanoscale, and consequently, these nanoparticles can be used in the design of invention and assembly of nanomaterials and required device with expected creativities. Currently, significant developments have been made in the capability to produce specific shapes and sizes of controlled nanoparticles, for example, nanorods and nanowires, especially using chemical and biological synthetic methods. The production of SeNPs can be achieved through various biological means. In this way, the species of Agrobacterium is applied to synthesize SeNPs through an easy biologically active process to reduce sodium selenite mixed with selective culture media. This process is more able

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to produce SeNPs in sizes nanometers; Nanoparticles synthesized in the bacterial cell can be easily separated from the bacterial cell destabilizing by the vapor penetration and then by high-speed centrifugation [12-14]. Nanoparticle synthesis using microorganisms has been suggested as one of the possible alternatives to chemical and physical approaches [15].

Two modern approaches to nanotechnology with biological science were found as nano-technological tools and apparatus applied to biological objects that are modified into a range of nano-scale called Bionanotechnology (BNT). When biological species-derived biological organelles or bio-molecules are measured with the aid of analytical instruments in a range of nano-scale called Nanobiotechnology (NBT), (Figure 1) [16].

BNT

BNT is a field of science that involves the modification and manipulation of biological objects at the nano-scale. This field combines the principles of biology, chemistry, physics, and engineering to create new materials, devices, and systems with unique properties and functionalities. There are many biological objects that can be modified and used in BNT:

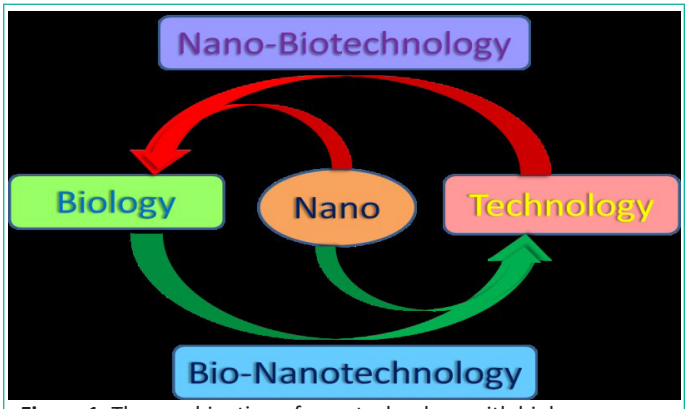

Figure 1: The combination of nanotechnology with biology.

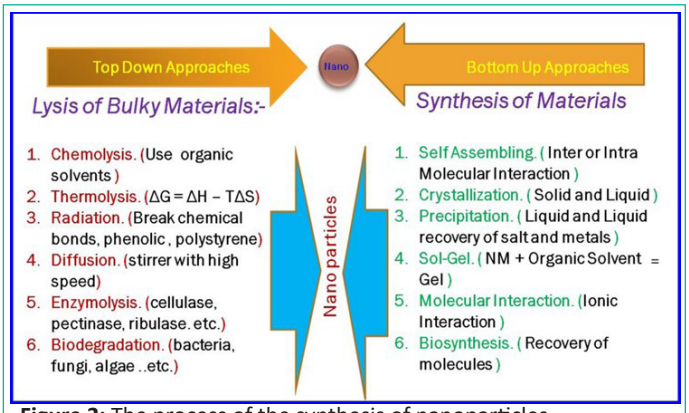

Figure 2: The process of the synthesis of nanoparticles.

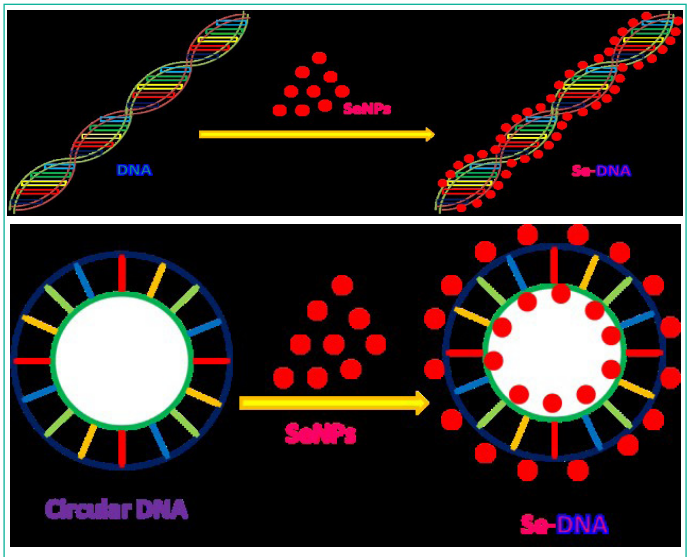

Figure 3: DNA intercalation with SeNPs (A) Liner DNA (B) Circular DNA.

***Proteins*:** Proteins are versatile biological molecules that can be engineered and modified to perform specific functions at the nano-scale. BNT can be used as building blocks to construct nanostructures and molecular machines for various applications.

***DNA*:** DNA molecules can be modified and manipulated to create nanostructures with precise shapes and patterns. DNA nanotechnology allows the creation of nano-sized devices, such as sensors, drug delivery systems, and molecular computing systems.

***Viruses*:** Viruses can be genetically modified and engineered to serve as nano-sized delivery vehicles for drugs, genes, or imaging agents. BNT can be designed to specifically target certain cells or tissues, making them useful in targeted therapies and diagnostics.

***Liposomes*:** Liposomes are small vesicles made of lipids that can encapsulate and deliver drugs or other molecules. BNT can be modified to increase stability, improve targeting capabilities, and control release kinetics, making them valuable in drug delivery applications.

***Cells*:** Living cells can be modified and engineered to perform specific functions at the nano-scale. For example, immune cells can be modified to target and destroy cancer cells, or stem cells can be engineered to differentiate into specific cell types for regenerative medicine purposes. These are some examples of biological objects that can be modified and used in BNT. The field is constantly advancing, and researchers are constantly exploring new ways to harness the unique properties of biological materials at the nano-scale for a wide range of applications.

NBT

NBT is a field of science that focuses on the study and manipulation of biological organelles and biomolecules at the nano-scale using analytical instruments. This field combines nanotechnology and biology to develop new tools and techniques for understanding and exploiting biological systems at the molecular level. Many biological organs and biomolecules can be measured and analyzed using analytical instruments in NBT:

***Proteins*:** Analytical techniques such as Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), and fluorescence microscopy can be used to study the structure, dynamics, and interactions of proteins at the nano-scale. NBT provides valuable insights into protein folding, function, and protein-protein interactions.

***DNA and RNA*:** DNA and RNA molecules can be analyzed using techniques such as nanopore sequencing, which involves threading single-stranded DNA or RNA through a nanopore to read the sequence of bases. Other techniques such as polymerase chain reaction (PCR) and gel electrophoresis can also be used to analyze and manipulate DNA and RNA molecules at the nano-scale.

***Lipids*:** Lipids are important components of cell membranes and can be analyzed using techniques such as lipid bilayer formation, lipid vesicle encapsulation, and lipid monolayer studies. NBT helps to understand the behavior and properties of lipids at the nano-scale, which is important for designing drug delivery systems and understanding cellular processes.

***Organelles*:** Organelles such as mitochondria, endoplasmic

reticulum, and Golgi apparatus can be studied at the nano-scale using techniques such as fluorescence microscopy, confocal microscopy, and electron microscopy. NBT provides insight into the structure, function, and dynamics of organelles within cells.

Nanoparticles: Nanoparticles, both natural and synthetic, play an important role in NBT. Analytical tools such as Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), and Dynamic Light Scattering (DLS) can be used to characterize the size, shape, and surface properties of nanoparticles. NBT helps in understanding the interactions between nanoparticles and biological systems. NBT allows researchers to examine and manipulate biological organelles and biomolecules at the nano-scale, leading to advances in fields such as medicine, diagnostics, and environmental sciences. It provides a deeper understanding of biological systems and opens up new possibilities for developing innovative solutions to various challenges.

Approaches of Synthesis Biological SeNPs

There are mainly two approaches followed for synthesized nanoparticles known as bottom-up and top-down process Figure 2.

***Bottom-up process*:** For the synthesis of materials from monomer units began to convert nanoparticles into nano-scale sizes. Including processes known as self-assembly, crystallization, precipitation, sol-gel, molecular interactions, vapor deposit and biosynthesis, etc [17,18]. The bottom-up approach refers to the creation or assembly of nanoscale structures or systems, starting from individual molecules or building blocks and gradually building up to larger and more complex structures. This approach is inspired by natural biological processes, where complex structures and systems are formed through the self-assembly of individual molecules or components. The bottom-up process in nanobiology involves several key steps:

Table 1: Medicinal applications of Selenium supplements.

Sr. No.	Diseases	Expectation of Se Application	References
1.	Asthma	The Se contained supplements taken for fourteen weeks it is protected against asthma placebo.	[51,52]
2.	Blood Disorders	The Se supplementation may provide benefits in infected persons with G-6-P (Glucose-6-phosphate) lack, hemolytic of chronic, platelet function and coagulation, etc.	[53]
3.	Bronchitis	The Se plays a role in immune function, preventing patients with various infections. Se promotes recovery from pneumonia and bronchitis caused by RSV.	[54]
4.	Cancer	The people living in areas with Se element found in foods and soil have the lowest cancer rates. Because 200 mcg/day of Se may help protect against colorectal cancer, and skin damage (cancer). The literature showed proof that prompted researchers to investigate how Se could be cared for adjacent to skin cancer. Although higher than daily selenium supplements can enhance the chance of carcinoma and nonmelanoma cancers.	[43, 55]
5.	Cystic fibrosis	The Se supplementation may protect patients from cystic fibrosis.	[56]
6.	Dandruff	Se-containing shampoos can remove dandruff.	[57,58]
7.	Dialysis	The Se supplementation in dialysis may maintain plasma levels.	[59]
8.	Eye Disorders	The Se may be more effective in inflammation of the eye.	[60]
9.	Fatigue	The Se may be evidence of benefit for Fatigue.	[61]
10.	HIV	The Se is used as an anti-HIV drug because a Se contains enhancement known as Selenomax very slowly increases in viral load and has maximum counts to CD4 cells.	[63]
11.	Heart Disease	The Se used to treat heart disease that might make atherosclerosis worse. Atherosclerosis, or hardening of the arteries, occurs when plaque builds up in the arteries, which can lead to heart attack and stroke. The Se combined with antioxidants including vitamin E and beta-carotene may help lower LDL ("bad") cholesterol levels.	[64,65]
12.	High Blood Pressure	In serum, Se levels can be controlled to increase blood pressure and are known to be anti-hypertensive.	[66]
13.	Immune Function	The Se contains minerals that may facilitate the construct of WBC (white blood cells), which provide the capability to fight against diseases and infections such as bacterial skin infection so as to often accompany lymphedema and Mycoplasma pneumoniae.	[67,68]
14.	Infection prevention	The Se may be beneficial in preventing infections from micro-organisms such as bacterial skin infections associated with lymphedema, sepsis, Mycoplasma pneumoniae, etc.	[68,69]
15.	Liver Diseases	The Se supplementation may control an assortment of affected liver functions as well as cause cirrhosis, hepatitis, and liver cancer.	[70]
16.	Anti-aging	The Se supplementation is an antioxidant that may increase longevity and control aging.	[71]
17.	Pancreatitis	The Se has inconclusive evidence regarding its use in pancreatitis.	[72]
18.	Radiation side effects	The Se has importance significant in use as an adjunct therapy to treat the side effects of radiation.	[73]
19.	Rheumatoid arthritis	The Se is used for the treatment and diagnostic purposes in Rheumatoid Arthritis patients.	[74,75]
20.	Seizures	The serum levels of selenium are interrelated to disease Seizures found in patients with Epilepsy or Brain hallucinations and affect the frequency of seizures.	[76,77]
21.	Sunburn prevention	The photoprotective properties present in selenium supplements are antioxidants, which prevent light-induced erythema (redness of the skin).	[78]
22.	Thyroid conditions	The disease thyroid is a high-level problem showing in infected patients amid related diseases, the Se has been shown in the direction of getting better goiter with Anti-Inflammatory action found in CAT (Chronic Autoimmune Thyroiditis).	[79,80]
23.	Yeast infections	The Se presence forms SeS in shampoo treatment of tinea capitis and tinea versicolor infection.	[81]

***Design and synthesis of building blocks*:** The first step is to design and synthesize the molecular building blocks that will be used to construct the desired nanostructure. These building blocks can be organic molecules, inorganic nanoparticles, or biomolecules such as DNA or proteins.

***Self-assembly*:** Once the building blocks are synthesized, they are allowed to self-assemble into larger structures through non-covalent interactions such as hydrogen bonding, electrostatic interactions, or hydrophobic interactions. These interactions drive the spontaneous assembly of building blocks into ordered structures.

***Characterization and manipulation*:** The assembled structures are characterized using various analytical techniques such as electron microscopy, spectroscopy, or atomic force microscopy to confirm their size, shape, and properties. Additionally, the structures can be manipulated or modified by incorporating external stimuli such as temperature, pH, or light.

***Functionalization*:** Nanostructures can be further functionalized by adding functional molecules, such as dyes, drugs, or targeting ligands, to the surface or within the structure to provide them with specific functions or properties. This step allows the customization of nanostructures for specific applications.

***Applications*:** The final step of the bottom-up process is the application of the fabricated nanostructures in various fields such as medicine, electronics, energy, or environmental sciences. These nanostructures can be used for drug delivery systems, sensors, catalysts, or tissue engineering, among other applications. Bottom-up approaches in nanobiology provide precise control over the design and assembly of nanostructures, allowing the creation of complex and functional systems at the nanoscale. This approach holds great promise for developing innovative solutions in a variety of fields by using the principles of self-assembly and molecular recognition found in biological systems.

Top-down process: In this process nanoparticles from the bulk material are converted into nanoscale sizes and shapes for synthesis of nanoparticles. Including processes known as chemolysis, thermolysis, irradiation, diffusion, enzymolysis, biodegradation, etc. [17,18]. The top-down approach refers to the creation or manipulation of nanoscale structures or systems by starting with large-scale materials or structures and gradually reducing their size or dimensions. This approach involves controlled removal or modification of bulk materials to achieve nanoscale features. Here are the major steps involved in the top-down process in nanobiology:

***Substrate selection*:** A suitable substrate or material is chosen as the starting point for the manufacturing process. This substrate can be a solid material such as silicone, glass, or polymer.

***Lithography*:** Lithography techniques, such as photolithography or electron beam lithography, are used to pattern a substrate with desired features on the nanoscale. These techniques involve the use of masks or focused beams of light or electrons to selectively expose or remove material from the substrate.

***Etching*:** Etching processes, such as wet etching or dry etching, are employed to selectively remove material from a substrate based on a pattern defined by lithography. This step allows the creation of nanoscale features by removing material from the larger substrate.

***Deposition and growth*:** Additional layers or materials can be deposited or grown on the patterned substrate to further refine the nanoscale structure. Techniques such as Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), or Molecular Beam Epitaxy (MBE) can be used to deposit or grow thin films or nanostructures.

***Characterization and modification*:** The fabricated nanostructures are characterized using various analytical techniques such as electron microscopy or atomic force microscopy to confirm their size, shape, and properties. Further modification or functionalization can be performed by adding or incorporating specific molecules or functional groups onto the nanostructure.

***Applications*:** The final step involves using the fabricated nanostructures for specific applications in fields such as medicine, electronics, or energy. These nanostructures can be used as sensors, actuators, or components in nanoelectronics, or biomedical applications for drug delivery, imaging, or tissue engineering. Top-down approaches in nanobiology allow precise fabrication and manipulation of nanoscale structures starting from large-scale materials. This approach provides control over the size, shape, and properties of nanostructures and enables nanoscale features to be integrated into larger systems for various applications.

About Agrobacterium

The known species of Agrobacterium are considered Gram (-ve) bacteria to apply it for horizontal gene transfer to induce tumors in the plants. The species *A. tumefaciens* has the greatest capability in the direction of transferring the DNA between the plants and itself, therefore this activity causes they to have a very more effective role as the tools for assisting to develop fields of genetic engineering. The resource soil-borne bacterial species of Agrobacterium that causes crown gall in most dicotyledonous and some monocotyledonous plants [19]. It not only infects fruit trees such as peaches and pears but is also a major threat to the nursery industry, as infected plants often cannot be sold. The sequencing of genetic information from many bacterial species including Agrobacterium has allowed learning of the history of the evolution of these microorganisms and finding information regarding the total genes and active system concerned with related pathogenesis, control of biological activity, and symbiosis. A significant verdict is the possibility that the chromosomes are developing from plasmids DNA in various bacteria. One more finding is various chromosomal structures obtained in this group to capable of supporting both pathogenic and symbiotic lifestyles. Finding the accessibility of gene sequencing of species of Agrobacterium will prolong to enhance, consequential in considerable insight into the role and evolutionary biggest of this group of plants correlated with microbes [20].

Application in Biotechnology

The aptitude of the species of Agrobacterium to transfer genes to plants and some fungi is applied in the field of biotechnology, mainly in genetic engineering to improve plants [21]. Due to some modified DNA known as Ti/Ri plasmids also can be applied. The bacterial tools plasmids are disarmed through removing the gene of tumors inducing. Some essential pieces of Ti-DNA are its two small sequences with at least twenty-five base pairs limit repeat and in which one is an essential part for the transformation of genes into the plant [22]. A scientist from the University of Ghent, Belgium, discovered the mechanisms of gene transfer from Agrobacterium to plants. The M D Chilton was confirmed the first time the virulence genes were removed without any affecting the ability of Agrobacterium to be inserted into the plant genome. All kinds of plants cannot be infected

by Agrobacterium, but many other techniques may be applied for gene transformation in plants such as using gene guns [23].

Genetic Engineering

Use of Agrobacterium species in biological process, the major role of Agrobacterium used in gene transfer in plants is known. In vitro modification or manipulation of bacterial plasmid DNA with essential DNA is introduced into the bacterial cell and bacterial cell with the help of recombinant DNA technology which is able to transfer the DNA to the plant cell and find the products as needed [24,25].

Intercalation with DNA

SeNPs can be intercalated with the phosphate backbone side chains of DNA molecules through phosphodiester bonds and ionic interaction electro negativity presents oxygen to provide space for establishing bonds with the nanoparticles and are known as P-SeNP complexes [26-28].

Liner DNA: The liner DNA double helix molecule is a straight line of DNA. It can provide space for binding SeNPs attached to one or two backbone phosphate molecules of DNA as a liner Figure 3(A) [26,28,29]. The interaction between linear DNA and SeNPs is an area of interest in nanobiology and nanotechnology. SeNPs are nanoscale particles made of selenium atoms and have unique properties that make them suitable for various applications including biomedical and environmental fields. When linear DNA interacts with SeNPs, several events can occur:

***Adsorption*:** Linear DNA molecules can absorb on the surface of SeNPs. This adsorption may be due to electrostatic interactions between the negatively charged phosphate backbone of DNA and the positively charged surface of the nanoparticle. Adsorption of DNA on SeNPs can affect the stability and structure of the DNA molecule.

***DNA Protection*:** SeNPs are reported to protect DNA from degradation by Reactive Oxygen Species (ROS) and other damaging agents. The antioxidant properties of SeNPs can eliminate ROS, reducing oxidative damage to DNA. This protective effect could be beneficial in various applications, such as drug delivery or DNA-based therapy.

***DNA binding and condensation*:** SeNPs can bind to DNA and induce DNA condensation. The binding of SeNPs to DNA can lead to condensation and compaction of DNA molecules, which can affect their accessibility and functionality. This property has potential applications in gene delivery and gene therapy.

***DNA damage or modification*:** In some cases, SeNPs can induce DNA damage or modification. Interactions between SeNPs and DNA can generate reactive oxygen species, which can cause oxidative damage to DNA bases or induce DNA strand breaks. However, the extent of DNA damage or modification depends on various factors including nanoparticle size, concentration, and experimental conditions. The interactions between linear DNA and SeNPs are important for the development of DNA-based materials and applications involving SeNPs. Further research is needed to clarify the mechanism and optimize the conditions for the interaction between linear DNA and SeNPs, taking into account factors such as nanoparticle size, surface chemistry, and DNA sequence.

Circular DNA: Plasmid or circular form of double helix DNA molecules can interact on the inner side with the backbone of sizable DNA within one or more SeNPs to trap, break, and deactivate the replication mechanism of DNA and single molecules of SeNPs attached to single phosphate molecules of the DNA and also nanoparticles can do interaction at outside DNA which each phosphate molecule Figure 3(B) [27-29]. Circular DNA interaction with SeNPs refers to the interaction between circular DNA molecules and nanoparticles made of selenium. SeNPs are nano-sized particles made from selenium, a chemical element with unique properties and potential applications in various fields, including biotechnology and medicine. As the name suggests, circular DNA molecules are DNA molecules that form a circular shape rather than the typical linear structure found in most DNA molecules. Circular DNA can be found in a variety of organisms, including bacteria and viruses, and can also be artificially synthesized for research purposes. When circular DNA interacts with SeNPs, several processes can occur. For example, SeNPs can bind to the surface of circular DNA molecules, forming complexes or conjugates. This interaction can be used for various applications, such as DNA delivery systems or DNA-based nanomaterials.

The interaction between circular DNA and SeNPs can also affect the stability and structure of the DNA molecule. SeNPs have been shown to protect DNA from degradation by enzymes or other external factors, thereby increasing its stability and potentially extending its lifespan. Additionally, SeNPs have been reported to have antimicrobial properties. When circular DNA interacts with SeNPs, it can potentially enhance antimicrobial activity, making it a promising approach to combat microbial infections. The interaction between circular DNA and SeNPs holds significant potential for various applications in biotechnology, medicine, and nanotechnology. More research is needed to fully understand the mechanisms and optimize the interactions for specific purposes.

Nucleic Acid-Based Vaccines

In the case of recombinant antigen vaccine, the gene encoding any immunogenic protein can be cleared and expressed in the bacterial cell using recombinant DNA technology [30]. The recombinant vector vaccine gene, which encodes an antigen isolated from a pathogen, can be inserted into non-virulent bacteria. Such recombinant microorganisms serve as vector replicators within the host and express the gene product of the pathogen-encoded antigenic protein. Expression of genes within the host generates foreign proteins to which the host immune system responds. Therefore in a DNA vaccine, an immune response is carried out against the proteins encoded by the vaccine DNA Figure 4 [31-33]. SeNPs have shown promise in the

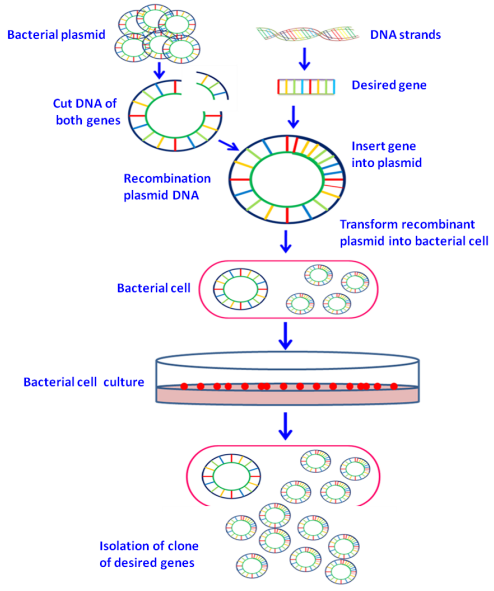

Figure 4: Recombinant DNA technology used to clone the desired gene to generate a vaccine.

development of nucleic acid-based vaccines. Nucleic acid-based vaccines, such as DNA vaccines or RNA vaccines, are a type of vaccine that uses genetic material (DNA or RNA) to encode specific antigens. These vaccines have attracted attention due to their ability to generate strong immune responses and rapid development against emerging infectious diseases.

SeNPs can be used in nucleic acid-based vaccines in several ways:

***Delivery of nucleic acids*:** SeNPs can act as a carrier or delivery system for nucleic acids. They can protect nucleic acids from degradation, increase their stability, and facilitate their efficient delivery into target cells. This may improve the absorption and expression of the encoded antigen, leading to a more effective immune response.

***Adjuvant activity*:** SeNPs have inherent immunomodulatory properties. They can stimulate the innate immune system, promoting the activation of immune cells and the production of cytokines. This adjuvant activity may enhance the immune response generated by the nucleic acid-based vaccine, resulting in enhanced antibody production and cellular immune response.

***Antioxidant and anti-inflammatory effects*:** SeNPs have antioxidant properties, which may help reduce oxidative stress and inflammation induced by nucleic acid-based vaccines. This may prevent tissue damage and improve the overall safety and tolerability of the vaccine.

***Improved immunogenicity*:** SeNPs can improve the immunogenicity of nucleic acid-based vaccines. Studies have shown that combining SeNPs with DNA or RNA vaccines can significantly enhance the immune response, leading to increased antibody production, T-cell activation, and improved protection against pathogens. The use of SeNPs in nucleic acid-based vaccines holds great potential to enhance their efficacy and safety. Further research is ongoing to optimize the formulation, dosage, and delivery strategies of SeNPs in these vaccines to maximize their immunogenicity and therapeutic potential.

Production of Antibodies

The role of SeNPs in the production of antibodies,[34] Normally the human body induces five types of antibodies known. It plays a role in improving immunity and protecting human beings from various types of diseases caused by antigens Figure 5 [35]. SeNPs may play a role in the production of antibodies in several ways:

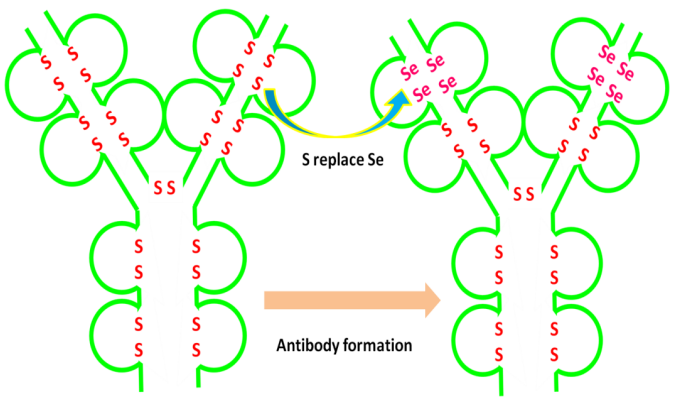

Figure 5: In antibody contained S replaced by Se.

***Immunostimulatory effects*:** SeNPs have been found to have immunostimulatory properties, meaning they can activate and enhance immune responses. They can stimulate immune cells, such as B cells, which are responsible for the production of antibodies. This stimulation can lead to increased antibody production, resulting in a stronger immune response.

***Antioxidant activity*:** SeNPs have antioxidant properties, which may help protect immune cells, including B cells, from oxidative damage. Oxidative stress can impair the function of immune cells and interfere with antibody production. By reducing oxidative stress, SeNPs may support the proper functioning of B cells and promote antibody synthesis.

***Adjuvant activity*:** SeNPs can act as adjuvants, substances that enhance the immune response to antigens. When mixed with antigens, such as those used in vaccines, SeNPs can boost the production of antibodies. They can stimulate the immune system, promote activation of B cells, and facilitate the generation of specific antibodies against target antigens.

***Enhanced immune cell interactions*:** SeNPs can improve communication and interactions between immune cells involved in antibody production. They can regulate the expression of cell surface molecules and signaling pathways, thereby facilitating antigen recognition and response by B cells. This increased interaction may lead to increased antibody production. It is important to note that the exact mechanism by which SeNPs promote antibody production is still being studied, and further research is needed to fully understand their role. However, the immunostimulatory, antioxidant, and adjuvant properties of SeNPs make them promising candidates for enhancing antibody production and improving immune responses.

Selenocysteine: It contains selenium instead of the sulfur of its structural analog cysteine. Since selenocysteine is incorporated into polypeptides during translation, it is called twenty-one amino acids.[36] Although it is a triple codon UGA is specified by a nonsense codon. Selenocysteine has its tRNA containing the anticodon UCA. It is a biologically derived amino acid synthesis and is found in Agrobacterium. It is a part of cysteine-containing a thiol group or sulfhydryl group which is the unique amino acid to which selenium is found similar to sulfur in known cysteine and known as selenocysteine and is responsible for the synthesis of the selenium-containing protein known as selenocysteine Figure 6(A) [37,38].

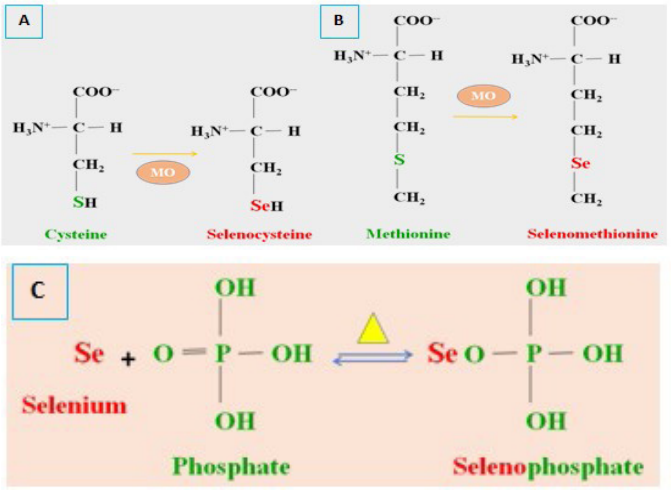

Figure 6: Formation of Biomolecules with Selenium (A) Cysteine to Selenocysteine, (B) Methionine to Selenomethionine, (C) Phosphate to Selenophoshpate.

Selenomethionine: This is called twenty-two amino acids. It has a synthesis mechanism similar to selenocysteine derived from methionine amino acid from some plants and microbes, this microbial also derived organic amino acid in which the selenium substance is attached to the place of sulfur in the methionine molecules of amino acid and is called selenomethionine amino acid Figure 6(B) [39,40].

Selenophosphate: ATP or ADP consists of an adenosine moiety, with three or two phosphoryl groups known as -PO_3^{2-} linked sequentially referring to a phosphodiester bond, [41,42] followed by two phosphoanhydride bonds, known as a called high energy bonding. Phosphate molecules are available in the DNA backbone in which selenium substances are attached to an oxygen atom via a phosphodiester bond and modify their properties known as selenophosphates Figure 6(C) [29].

Use of Selenium

The element, selenium, is a form pseudo elements present in the periodic table group 16 and has chemical properties similar to S and was first observed in 1300 by the chemist Arnold of Villanova. Selenium is present in different colors like red, gray, and black. In 1817 the famous Swedish chemist JJ Berzelius focused his attention on the red deposits left after the burning of sulfur in an H_2SO_4 factory. Berzelius told Marcel about the discovery of a new element, which was proposed as selenium (Se) from the Greek word 'selen' meaning 'moon goddess'. Among its essentials for microbial and mammalian life was the Se discovery of the first suggestions of precise biological functions. It was found in a group of enzymes as the selenocysteine amino acid in proteins. The codon of the selenocysteine genetic material is encoded by TGA [43,44].

Properties of Selenium

The element, selenium is able at 117pm of atomic radius, at 220.5°C of melting point, at 685°C of boiling point, and also has three oxidation states of +6, +4, and -2. The Se element is a non-metallic element member belonging to the sulfur group. The Se has properties such as photovoltaic action which directly light energy into electrical energy and photoconductivity action which shows the electrical divergence decreases and the illumination capacity increases. The Se occurs in many forms, other than its frequently organized structure known as crystalline or amorphous. The amorphous structure of the Se occurs either as dark glass or red powder forms. Crystalline monoclinic Se is dark red; the most stable form of Se is a crystalline hexagonal one that is grey in color with a metallic bunch. It is quite harmless but may be taken as an essential trace element for good food. However, the Se-based compound such as H_2Se and other forms of the Se are highly toxic, as are the As (Arsenic) in their physiological reactions. The Se occurs in sufficient amounts from soil to cause severe effects on animals' health while taking plants grown as foods in Se-contained soil[45].

Sources of Se

Se generally, is obtained from the mineral staff site. It can be isolated from Cu_2Se ores. In addition, Se can be improved by burning the sludge along with soda or H_2SO_4.

$$Cu_2Se + Na_2CO_3 + 2O_2 \rightarrow 2CuO + Na_2SeO_3 + CO_2$$

On acidification of Na_2SeO_3 with H_2SO_4, Se is precipitated out from solution in the form of H_2SeO_3. Finally, Se is liberated from H_2SeO_3 by SO_2 [46,47].

Isotopes of Se

The Se has approx twenty-nine isotopes together with Se-65, Se-67 to Se-94, and it has six stable isotopes known as 0.89% of Se-74, 9,37% of Se-76, 7.63% of Se-77, 23.77% of Se-78, 49.61% of Se-80, and 8.73% of Se-82 with variable oxidation states: 6, 4, -2, etc [48].

Chemical Properties

Se exists in hot and cold temperatures and is involved in carrying out different chemical reactions. Se is usually available in amorphous red powder, which melts rapidly with other α, β and γ forms of Se produced from black Se. In the structure of Se rings found distance between the Se-Se at 233.5 pm and their structure angle at 105.7° from the Se-Se-Se. The Se has a grey color isotope having hexagonal chains of helical polymers, somewhere the distance between the Se-Se is 237.3 pm and has an angle at 130.1° from the Se-Se-Se [49]. Se has nine stable isotopes such as Se-72, Se-74, Se-75, Se-76, Se-77, Se-78, Se-79, Se-80 and Se-82 [50]. Se compounds commonly exist in four oxidation states −2, +2, +4, and +6 [51].

Se is near to the S in the periodic table and it forms acids. Salts of H_2SeO_3 compound are known as selenites and these embrace Ag_2SeO_3 and Na_2SeO_3 salts. The reaction of H_2S with aqueous H_2SeO_3 produced SeS_2 [52].

$$H_2SeO_3 + 2H_2S \rightarrow SeS_2 + 3H_2O$$

Se exists as a stable halide chloride like Se_2Cl_2 because Se is more electro-positive as compared to S.

Physical Properties

Se have a hemispherical moon symbol against a pitted "cratered" surface. Se can occur in two forms silvery metal and red powder, and is used in photoelectric cells, photocopiers, solar cells, photovoltaic, photoconductive and semiconductors, etc. In addition, it finds various applications in glass, stainless steel, pigments, rubber, metal alloys, textile, and petroleum industries as well as medical therapeutic mediators and photographic suspensions [53].

Medicinal Application

The element Se is available in soil as a form of a mineral and also available in water and some foods. Although very small amounts of Se are needed in the lady lent (kitchen goods), it plays an important role in metabolism. It has antioxidant properties, which protect cells from damage caused by light [54]. There is some evidence that Se supplements may reduce the chance of prostate cancer [55]. Se has also been studied for the treatment of dozens of diseases such as asthma, arthritis, dandruff, and infertility [56]. For prostate cancer prevention, 200 µg Se/day is recommended while the upper limit for selenium is 400 µg Se/day in adults. Se content in food is largely dependent on location and soil conditions, which vary widely; daily consumption is between 55-70µg/day [57,58]. As a good source of Se from nuts, fish, beef, poultry, and grains can be considered. The major sources of Se in drinking water are discharges from petroleum and metal refineries, erosion of natural deposits, and discharges from mines.

Biological Significance

Se is a vital trace element but is additionally toxic. It is carcinogenic and teratogenic. The hydrogen selenide and Se compounds are very toxic.[59] The Se is an essential mineral and is available in small amounts in the body like vitamins E. Antioxidants can neutralize free radicals and facilitate avert some little of the damage it is cause. Se performs a major role in maintaining the function of the thyroid and the proper functioning of our immune system. Those who consumed 200 micrograms/day of selenium intake over seven years had found an important privileged risk of diabetes type-2 developing. The applications

of selenium supplements as clinically beneficial agents are presented in detail [60,61].

Hypothesis

Some of the latest scientific papers reported that SeNPs would enclose exceptional antifungal properties that could be valuable in favor of diagnosis here in skin diseases caused by dermatophytes, [15] The SeNPs slow down the growth rate of fungi and expect fungicidal action against fungi. Incidentally, the molecular characteristic of SeNPs can be optimized through intercalations with DNA along the site of H_2PO_4, and thus the single molecules of SeNPs can interact as well as four or six nucleotides of RNA or DNA molecules. Another molecular aspect of SeNPs as an antifungal agent, it may influence the conversion of cysteine and methionine amino acids interested in Selenocysteine or Selenomethionine generated by the supplements of the Se.

Conclusions

The various research kinds of literature show that selenium element has a high level of applications in medical fields. Nano-based synthesis of SeNPs could lead to more effective and rapidly enabling results in medicinal applications. These nanoparticles may be synthesized by Agrobacterium which are more effective to use as medicine. The SeNPs may be synthesized using Agrobacterium species microbial synthesis in various nanoparticle sizes as per programmed metabolism to study the aforesaid molecular aspect of SeNPs.

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