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Review Article

Nanotechnology Role Development for COVID-19 Pandemic Management

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The global outbreak of coronavirus disease has sent an ominous message to the field of innovative and advanced technology research and development (COVID-19). To accomplish this, convectional technology and recent discoveries can be combined, or new research directions can be opened up using nanotechnology. Nanotechnology can be used to prevent, diagnose, and treat SARS-CoV-2 infection. As the pandemic spreads, a thorough examination of nanomaterials' role in pandemic response is highly desirable. According to this comprehensive review article, nanotechnology can be used to prevent, diagnose, and treat COVID-19. This research will be extremely useful during the COVID-19 outbreak in terms of developing rules for designing nanostructure materials to combat the outbreak.

1. Introduction

Coronavirus has become a global epidemic and a major public health concern in a relatively short period of time. People's health, safety, and economic well-being have been negatively impacted by the epidemic. COVID-19 side effects ranged from minor to acute and included everything from acute lung sickness to cardiogenic shock and even death. As of January 2022, 350 million cases have been confirmed and the total deaths more than 5 million peoples. Those who are elderly or who have diseases that are dormant are more likely to suffer from life-threatening consequences [1–3]. From then on, significant efforts were committed to promoting prevention, diagnostic, and therapeutic approaches to combat the COVID-19 war. In this way, additionally, the creation of signalling and antibodies to target disease is being pursued in conjunction with prevention or the passage of the square infection has become a necessity in the fight against COVID-19. Regardless of the possibility, rapid transmission of genetic variants and development have greatly increased the global burden [4–6].

Nanotechnology completes as an important asset with a potential for measuring pollution by playing a key role in anticipating, diagnosing, and refining COVID-19 prophylaxis processes. Nanotechnology and sanitizer protective procedures are among these techniques, tools with rapid, heart-clear, and transparent diagnostic tools and rehabilitation specialists or antibodies to transmit antibodies to the human body. As a rule, nano-matadium, for example, metal nanoparticles remain shorter in size one micrometre, bringing a higher surface-to-volume ratio [7, 8]. Nanomaterials also have better melting and more efficient activation of effective drug transfer, as well as changes in quality like a positive correlation between target analysis and atomic retention in the nerves. Therefore, nanomaterials are highly focused on potentially playing a crucial function in managing the existing epidemic and prevent potential outbreaks [9].

According to this review research article concentrated on the latest developments of the nanotechnology COVID-19 based on three key categories: prevention, diagnosis, and treatment that provide comprehensive research on their ease of use and function. Finally, the critical complexity and future topics of COVID-19 nanotechnology applications are temporarily explored. During the COVID-19 epidemic, this research will be of great help in providing rules for creating nanostructure materials to deal with the episode. Current review article discussed how different nanomaterials can be used to combat the COVID-19 pandemic.

2. Role of Nanotechnology in COVID-19 Diagnostic

Atomic tests are much more obvious than CT filters to get precise conclusions because of their visible pieces of evidence. Serology testing is another way to deal with SARS-CoV-2 [10]. In particular, detection of specific antibodies alongside the corona virus spike proteins is preferable [11]. Diagnosis contributes significantly to the construction of the barrier of COVID-19, which limits its distribution by understanding ID and disconnection. While a number of diagnostic methods have been introduced, promoting critical and rapid testing of COVID-19 symptoms remains a challenge [12, 13].

Chest modernized tomography filters and atomic tests were used to evaluate and diagnose COVID-19 [14]. The serological research center explores and rapid testing projects have reached out to corona virus. Although in vitro experiments are basic and successful, they have shown problems within diagnosis of corona virus owing to the regulation of infectious diseases based on mutations [10].

Various nanomaterials are currently used in the area of infection detection. Both nucleic corrosive and protein diagnostic techniques are less sensitive to knowledge, for example, genomic and proteomic formation of a microbe or protein quality adjustment in the host when contaminated. Proteomics and genomics of SARS-CoV-2 have been detected as of March 2020; however, the response to SARS-CoV-2 assays is still being developed for this disease [15, 16].

One of the most extensively utilized nanomaterials for fast diagnostics is gold nanoparticle. Similarly, a specific measurement of colorimetric hybridization was employed to differentiate SARS-CoV-based dsDNA based on ssRNA. For example, nanoparticles of gold have been used to classify waste DNA for specific disorders, such as cancer. Specifically, in the AuNP environment, single-stranded RNA or DNA can interact with citrate particles and salt expansion can resolve particles and modify the tone [17–19]. These structures interact with the immune response, which brings about absorption and changes of dignity, enabling the effective diagnosis of COVID-19. In another study, a successful protein-binding process was performed on the outer layer of Au using Au-restricting polypeptides. The Au-restricting polypeptide complex protein and AuNP nanopattern protein did not move to the refined raw luminous antigen, corona virus antigen E, and specific antigen pattern [20].

AuNPs combined with specific antibodies as reagents for another COVID-19 test, pestilence looseness of the bowels infection (PEDV), in the immunochromatographic area in pig manure testing. In addition, AuNPs that work with green proteins show changes in shade and absorption due to interaction with compatible antibodies, which can be used in COVID-19 [21]. One of these strategies, color recognition based on disulfide protection, was developed thiDNA-threshed testing can be used to identify specific regions of the MERS-CoV genome, to form a long-component component, which keeps the AuNP-coated citrate particles in salt-mixed clusters [22]. It can allow for the presence of infection with limited plasmon reverberation (LSPR) mutations and changes in AuNPs shading [23]. Immobility is usually achieved quickly with thiol-gold interactions, quality sensory response is accompanied by biotinylated target correction at a range of 2.5 and 50 pmol/L, and an acquisition of 2.5 pmol/L [24].

Also, a quality sensor was used to construct the AuNP-based electrolytic hybrid process, which incorporates thiolated-DNA stable motion into the gold-carbon nanoparticles cathode for synthesize biologically active biotinylated target DNA (btDNA). In order to establish consistency, the thiol-gold interaction was used, and the sensory response was observed by placing 2.5 to 50 pmol/L at one location, with 2.5 pmol/L monitoring intervals [24]. To construct plasmonic auNPs with star-shaped keys to detect other diseases, such as CoVAcknowledgment, QDs were previously employed to create chiral gold nanohybrids. Each CAuNP and QD-electronically combined two clear antibodies and a nanolayered sandwich converges when a specific infection is recognized, occurring in a strong QD environment paired with a huge plasmonic transformation. A single pg/mL of bioassay awareness was formerly thought to be sufficient [25]. To analyze Covid concentration, carbon cathodes manufactured from AuNP clusters were used in an electrochemical chip [26]. Covid protein was bound to the AuNP-anode, and both Covid proteins and free radicals require limited areas within the immune system. There was a decent direct reaction between sensory responses and Covid groups varying between 0.001 and 100 ng/mL (Figure 1). The experiment was performed to reach a very low altitude such as 1.0 pg/mL. The procedure was one step, soft, and precise. It has been used successfully to test spiked nose models [26].

In another study, the strategy became accustomed to detecting infection with COVID-19 without the use of modern tools. Color identification was created using thiol-adjusted antisense oligonucleotides covering AuNPs that are explicitly designed for N attributes. The thiol-adjusted ASO-cap AuNPs were especially collected in the eyes of the corona virus target RNA system and demonstrated the modification of its surface plasmon flexibility. The effect can be seen in 10 minutes to recognition of 0.18 ng/μL [27]. In addition, one meeting promoted a consistent broadcast rate of quick IgM an antidote for SARS-CoV-2 using a circular immunochromatographic method [28]. For the most part, the SARS-CoV-2 nucleoprotein was coated with a rational layer to capture the target, and hate on human IgM was established in the AuNP, filling in as the author of the identifying

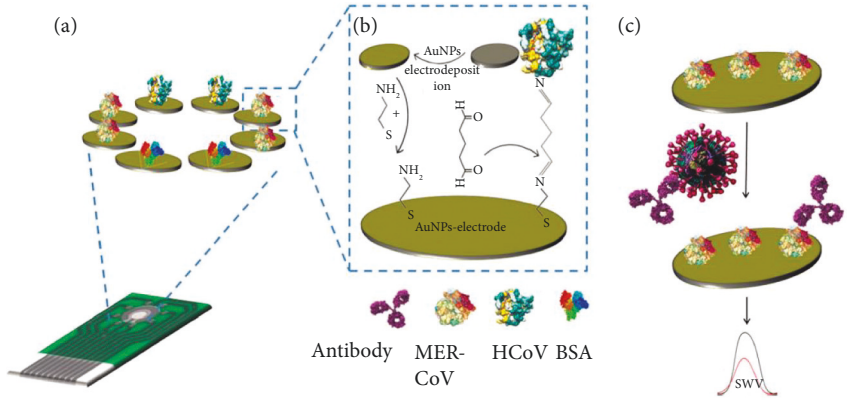

Figure 1: COV immunosensor array chip (a). The immunosensor fabrication steps (b). the detection process of the competitive immunosensor for the virus (c) [25].

column. The AuNP-LF study has shown amazing selections in IgM detection without being prevented by other diseases. Within 15 minutes, each test requires 10–20 L of serum, and the results can be realized. Zhao et al. have announced a poly union with carboxyl circuits coated with attractive nanoparticles pcMNPs next to key RNA extraction techniques. Basically, test time and combined the two stages of lysis and limitation into one and pcMNPs-RNA structures can be combined into the RT-PCR response result. This test identifies two different viral sites RNA, and access to 10 copies of the COVID-19 pseudo-virus molecule has been developed [29]. One study revealed the location of COVID-19 respiratory biomarkers using an AuNP-based sensor. A sensor that integrates various auNP connected environmentally. Larger as it is later, the location of COVID-19 using painless methods is proposed [30, 31].

Accurate recognition requires productive extraction and separation of nucleic acids in experiments that allow for targeted purification. Magnetic nanoparticles are commonly used to decompose nucleic decomposition before detection. For example, superparamagnetic nanoparticles are based on key experiments in the target system SARS-CoVs used in a single study. By using magnetism, active superparamagnetic nanoparticles can produce targeted cDNA in models [32, 33]. In another study, Somvanshi et al. announced the formation of surface-level MNPs and a viral RNA release protocol to evaluate the feasibility of COVID-19. How much DNA was extracted by PCR was tested using silica-covered fluorescence nanoparticles composed of clusters. There are luminous signals related directly to the target cDNA collection in silica-covered fluorescent nanoparticles [32, 34]. Zinc-based nanoparticles were produced by burning and treated with silica and carboxyl-changed polyvinyl liquor on their surface regions. One such study demonstrates the capacity for viral RNA extraction from a range of different strains. Reducing the action steps provides incredible power for the diagnosis of COVID-19 atomic level. In addition, another study introduced a single nucleic corrosive extraction that explicitly combines viral RNA using polycarboxyl-functionalized amino-gathered altered MNPs. Nucleic acids are collected using an attractive field and are later released into the MNPs by the expansion of the bath bed. MNPs with polycarboxyl functionalization were shown to have positive similarities and paramagnetic structures with quick capture targets by identifying COVID-19 pseudoviruses [33].

Quantum dots are another fluorescence imaging technique for atoms. Quantum dots, or semiconductor nanoparticles with a diameter of 1–10 nm, are frequently employed to identify corona virus infection [35]. One of QD's great qualities, which include its visual properties, has made it an amazing opportunity to fill in as fluorescent. In addition, their output frequency can be adjusted efficiently and accurately by altering their dimensions [35]. Because of its outstanding characteristics, QDs are currently the most common cognitive test for diagnosis [36]. For example, Ashiba et al. are associated with a soft biosensor in a different way that identifies infection and prevents the spread of contaminants. Surface plasmon reverberation-assisted fluoroimmunosensor formulation and QD fluorescent color were used for testing. As a result, the sensor had the option of achieving a longer transmission rate of 0.01 ng/mL compared to infectious particles. The ability to arouse QD, the level of electrical field development with SPR, and the substrate's autofluorescent on the chip have been simplified to lessen base signals [37].

Another study put a QD-based RNA chip into the heart and rapid location of the SARS-CoV N protein. Simply said, the introduction of fluorescent QDs enables analysts to create more intricate pathways for COVID-19 symptoms. A QD-based RNA aptamer, in instance, can directly attach the corona virus immobile protein to a chip, generating a visual signal. The longest acquisition time was 0.1 pg/ mL [38, 39].

Carbon stains were exposed in 2004 and consistently have photoluminescence, bio similarity, and high visibility, which combine them with a variety of applications, including biosensing and bioimaging [40–43]. The use of CNTs in diagnosing respiratory diseases including SARS-CoV-1 and SARS-CoV-2 is listed. Yeh et al. identified a type of bird flu through this gadgetwas. CNT-STEM actually improves levels of infection differentiation, and detection awareness has announced the first CNT microdevice that opens the CNT size that can develop and imagine infection through obscure models. For the most part, the deflected

sidewall on a small device is created by CNT-nitrogen-doped multiwalled CNT, where the intertubular distance between CNTs is improved to match the size of various diseases [44]. Given the simplicity and reliability of this process, it is often modified to identify SARS-CoV-2 RNA or protein. In another update, CNT, a self-contained optical test method, was introduced in COVID-19. A nanosensor that synthesizes nonfunctional SWCNTs with ACE2 was created, expressing a highly limited SARS-CoV-2 spike protein. The use of SWCNT has resulted in a twofold expansion of fluorescence signal at targeted detection [45]. Carbon-based nanomaterials have been widely used in the construction of the COVID-19 diagnostic platform. Carbon nanotubes, graphene, and carbon dabs can be classified as nonexistent, single-1D, and double-2D carbon nanomaterials [46]. These nanodiamonds were motionless in the test line, and the microwave field was used to specifically distinguish their fluorescence signal from the base signal, which completely improved the detection awareness. This measure was 105 a greater amount of softness than the horizontal test based on gold-nanoparticle standard. Externally and externally, these tests recommend that carbon-based nanomaterials can be used as an antiviral regenerative specialist in COVID-19 [23]. The immune system was directly bound to the antigens after it was delivered to the gadget, which repairs the blockage of the electrical circuit. Possible vaccine testing against SARS-CoV-2 spike S1 proteins and their receptor-restricting space were 2.8 10^{-15} and 16.9 10^{-15} M, each. In addition, a nanomaterial-based biosensor was created that could quickly differentiate COVID-19 antibodies. The biosensing stage was performed using 3D bioprinted electrodes mixed with nanoflakes that reduced graphene oxide. Explicit viral antigens have been implicated in nanoflakes to detect the target [47]. In another study, SARS-CoV-2 RapidPlex, an integrated electronics platform, introduced the fast-paced COVID-19. It detects viral antigen nucleocapsid proteins, IgM and IgG antibodies, and the incendiary biomarker, for example, the C-response protein. The stage showed deep and direct contact, for SARS-CoV-2 blood detection and saliva testing. Apart from this, nanodiamonds have received significant diagnostic considerations for COVID-19 due to its high reliability and low cytotoxicity. In one study, fluorescent nanodiamonds were used as the most sensitive COVID-19 horizontal immunoassay [48].

3. Role of Nanotechnology in COVID-19 Prevention

Since a satisfactory drug supply may not be readily available, nondrug interventions are suggested as an important alternative. The outbreak of COVID-19 has grown at an alarming rate. Predictability measures include drug production and nondrug measures [49]. Therefore, emerging areas for developing COVID-19 protection techniques exist in the field of nanotechnology [50].

When it comes to high filter coverings, an electrostatic charger and a separating surface component made of polypropylene microfibers are employed. Nano-matadium such as nanofibres and nanofiber networks are often used as part of the cover to limit the dispersal of droplets that are large enough to persuade healthcare workers that there will be no transmission between patients [51]. The coverage of various antibacterial covers has been developed through the use of channel materials, for example, nanofibres and nanofiber networks [52–55], as well as treating the channel area with antibacterial properties. They have a small empty size, low weight, improved penetration, and amazing void connections. Nanofibres provide an excellent storage environment [56]. Nanofibres triggered with synthetic compounds and nucleating specialists such as β-cyclodextrin and iodobenzoic corrosive have reduced respiratory infection and disease risks by dissecting or shutting off pollutants. The most common method used for a combination of nanofibrous materials is electrospinning [57, 58]. Using electrospinning, nanofibres are fabricated that have an electric charge, which increases their ability to capture target particles [59]. It has been shown that the nanofiber separator face piece has a moderate pass rate in the appropriate test and has a very high viral filter output compared to different market covers. Ultrasonic innovation has been used for facemask integration. This innovation empowers bonds to be made faster, creating more flexible creases and edges. It was shown that nanofiber channels incorporate careful covers that result in lower air flow restriction and improved filter performance compared to commercial covers [60, 61]. It has been found that nanofiber has better ventilation and more antibacterial exercise than N95 mask respirators and careful veins. Thus, nanomaterials, for example, nanofiber, play a key role in the viability of the masks. Nanofibre sifting facepiece respirators consist mainly of gelled submicron, polypropylene nanofibres, and hydrophilic biocide film that can block sufficient microorganisms [62].

As a result of silver nanoparticles' antibacterial characteristics, numerous gloves have been manufactured. Along with the masks, nanoparticles have been employed to validate COVID-19 clinical gloves. Silver nanoparticles were confirmed to have veridical action [63]. Considering that COVID-19 infection enters cells through the conversion of angiotensin over 2 receptors, lowering angiotensin-converting enzyme 2 (ACE2) degrees in the body may help to reduce infection [64]. It was recommended that catching infections before they got into phones using nanotechnology on gloves would be a wonderful help [27]. In addition, ACE2 proteins coated with nanoparticles have shown excellent synergist action and chemical reliability, which can be used to make gloves. Nano-matadium containing ACE2 have been proven to be efficient in terms of pollutant reduction. These gloves can protect against infections in the coating film that kills it, and the transmission of COVID-19 was reduced [65].

These nanomaterials consist of metallic nanoparticles especially TiO_2 and AgNPs as well as water-soluble nanostructures that counteract viral properties, which help ensure protection against COVID-19. Nanotechnology offers a few open doors in developing a common sense and ensuring sterilization [50].

In addition, nanomaterials transmit a flexible mixture into photothermally, electrothermal, photocatalytic, and

other light. Several antipollution properties of metallic nanoparticles have also been discovered. For example, AgNPs can be used as a potent disinfectant. Biomolecules and polyamines are rich in sulfur that make up the bacterium's inner and outer layers. Deactivation of these atoms, which may be present in SARS-CoV-2, can be achieved by using silver. Antiviral activity can be influenced by a variety of factors, including the size and number of molecules in a compound. Nanoparticles smaller than 20 nm were thought to be more significant interaction with microorganisms that cause microbe death. From now on, they can be used effectively as a COVID-19 sanitizer [66, 67]. Similarly, researchers have developed water-based nanosanitizers that have undergone a number of modifications, including contaminated water, electrolyzed water, and hydrogen peroxide in response to physical inactivity. These nanosanitizers have been tested for the ability to kill microorganisms. According to their findings, there has been a dramatic decline in the biological focus on the hydrogen peroxide system that can be used for corona virus pandemic combat. A sanitizer incorporating TiO_2 and AgNPs has been marketed by Biotech Interface Technologies, which creates antibacterial effects [68].

Many technicians have now used them to transmit vaccines to harmless cells such as dendritic cells. Nanoparticles have been extensively processed to develop antibody due to their flexible size, photothermally and attractive properties, regulated release properties, and basic functionality, allowing for selective binding to specific cell types [69, 70]. Many systems used for specialized concentrations of dendritic cells contain nanomaterials, which show great potential for low-dose vaccine growth. Until recently, various antibody applicants have been developed against COVID-19 contamination primarily focusing on viral S protein. Nano-matadium has been shown to improve antibody potency and injection mechanisms to promote a safe response [71, 72].

4. Role of Nanotechnology in COVID-19 Treatment

Antiviral drugs have been tried at the beginning of the COVID-19 trial, for example, lopinavir, chloroquine, remdesivir, ritonavir, and rakuvirim, and have shown promising results against SARS-CoV-2 [8]. The main barriers to current antiviral treatment are ineffective diagnosis, which leads to cell cytotoxicity. Nanotechnology lays down some freedom for antiretroviral therapy. The prevalence of new diseases and their variability require novel treatment. The flexibility of nanoparticles makes them readable vectors for the clear transmission of regenerative drugs and focused infection. How to use nanoparticles to fight SARS-CoV-2 can contain systems that contribute to the transmission of infection to the host cell until it is inactive. Inhibition of excess viral protein may result in death of the infection, so focusing on nanoparticles, which are specific to the proteins transmitted by infection, may reduce viral secretion [73, 74]. Natural nanoparticles have been used in the transmission of antimicrobials, such as acyclovir, zidovudine, efavirenz, and dapivirine, to enhance drug bioavailability, drug transfer, and prescribed antiviral action [8, 75].

Stained nanocomposites and metal nanoparticles are known to be effective against diseases and organisms due to their irresistible properties, as well as the ability to control the arrival of particles. For example, the arrival of controlled metals, for example, Ag, Fe, Cu, Zn, TiO_2, CdS, and MnS_2, has shown antimicrobial properties and antibacterial properties of metal united GO [76, 77]. Nanotechnology can assist in the development of COVID-19 drug delivery due to the benefits associated with nanoparticle morphology and licensing for the transfer of drugs to inaccessible areas without stimulating the unresponsive reactions of retinal endothelial cells. The surface-to-volume component enhances drug accumulation of the nanoparticles limit crossing layers by contrasting charges due to their surface charge change and the nanoparticles such as silver and their innate AuNPs viracidal movements, and current therapeutic nanoparticles for CoVs are summarized in Table 1 [78–81].

These applications rely on their ability to escape incomparable confession, rapid corruption, and some sad zeta power for long-term transmission through the body and small size forcing tissue penetration. Corrective protection and efficacy of exosome transfer to the target cell have now received more than usual consideration. A few clinical applications have been introduced as potential nanoorganic carriers in the treatment of COVID-19 [82, 83]. These exosomes are then transported to the target tissue; however, different methods can be used to create discretionary exosomes that include rotating design methods and direct design methods. In circular design, a few cells, for example, indistinguishable organisms are refined by auxiliary technicians or genetically modified to make artificial exosomes and drugs, while in rapid design, recycling technicians are packed directly into isolated exosomes from source cells. Truth be told, there are three stages in their creation from the endocytic cell pathway, the formation of endocytic vesicles through plasma invagination film, the internal growth of the previous endosomal barrier, and conversion of MVBs by plasma layer to form exosomes [84–86].

Examination of exosomes as an immunogenic mutation in the treatment of SARS Covid disease has been considered. The Covid S protein produces indirect titers to respond to antibodies that develop through the immunization program and then to the beneficial adenovirus vector antibody. These exosomes are not the only options. Transmembrane gaps in the SARS-S protein were substituted with vesicular stomatitis-infection G protein gaps in order to improve the efficiency of protein exosomes for use as a SARS Covid vaccine [87]. Similarly, to treat SARS-CoV-2 pneumonia, scientists recommend the use of exosomes as drug delivery mechanisms [88].

Exosomes have hypoimmunogenic properties, making them remarkably stable to move to an organ intended for immunization. Integrated antimicrobial systems and isolated cells with high immunity, tissue coverage, and recovery near their exosomes can reduce the risk of COVID-19. It has been shown that these extracellular vesicles respond to the exchange of genetic material between immature and mature

Table 1: Summary of the role of nanomaterials for COVID-19.

Key role for COVID-19	Nanomaterial	Purpose
Diagnostics	Magnetic nanoparticle Metal nanoparticle Carbon-based nanoparticle Quantum dot	(i) Conjugated with a probe is used to detect complementary target sequence of SARS-CoVs (ii) Modified (nucleic acid or protein bound) and integrated into COVID-19 sensors, mostly for colorimetric detection (iii) Integrated into diagnostic platform for COVID-19 detection (iv) Incorporated into sensor, acting as fluorescent label for COVID-19 detection
Prevention	Metal nanoparticle Carbon-based nanoparticle Quantum dot	(i) Induce structural changes in viral S protein, resulting in viral neutralization (ii) Inactivate virus and inhibit its entry into host cells (iii) Prevent viral RNA genome amplification
Treatment	Metal nanoparticle Carbon-based Nanoparticle Quantum dot Exosome	(i) Antiviral activity is achieved by altering the structural properties of virus S protein (ii) Inhibit the virus's ability to enter host cells by destroying it. (iii) Inhibit binding of S protein receptor of coronavirus to host cells (iv) Target, bind, and suppress cellular uptake of coronavirus

cells. COVID-19 is now being treated with this technique [82, 89].

A few speculations of nanoparticles are designed to develop an alternative to developing or eliminating a serious disease. Metal nanoparticles, for example, gold nanoparticles (AuNPs) and silver nanoparticles (AgNPs), have miraculously analyzed the nanotechnology method of treating bacterial contamination. Sarkar and participants estimated that the use of AgNPs dispersed water by mixing with bronchodilators in the lungs by inhaling a bilevel air or direct nebulizer machine may result in better viracidal activity. Finally, it is still high in the air that colloidal Ag with a molecular size between 3 and 7 nm can be very effective in treating and preventing bacterial infections at the beginning of the respiratory stage [90, 91]. AgNPs have attractive colloid type that also includes active amine particles SiO_2–Fe_3O_4 indicating a promising nanosystem to block infection. The structures have the ability to interact with proteins of infection by linking between thiol circles and Ag particles. In addition, Ag particles can induce ROS of infection activation [92].

Resistance to the SARS-CoV-2 movement has recently been observed with AgNPs ranging from 2 to 15 nm. Immunofluorescence focused on ensuring that polyvinylpyrrolidone coated 10 nm silver nanoparticles completely suppressed SARS-CoV-2; however, AgNP100 did not [93]. AuNPs also demonstrate the potential for vaccine development as they may initiate a harmless response in the form of APC encryption [94, 95]. The various breathable and inedible systems of the AgNP are accessible as useful market experts. They can be used in inorganic environments to reduce the spread of COVID-19 [96, 97].

Various components of the work have made MONPs a competent antimicrobial specialist and an important tool linked to creating ROS. The antimicrobial action of metal oxide nanoparticles (MONP) was similar to late studied [98, 99]. ROS mixes a number of biomolecules and sites of microorganisms that cause cell proliferation. Several strains of the virus have been regarded as invulnerable to new repair techniques used by metal oxide nanoparticles. Appropriately, the usefulness of MONPs has been explored as well. For example, the action of antimicrobial iron oxides nanoparticle is frequently observed [99, 100] against influenza virus that is the H1N1 [92], dengue infection, and rotavirus [101, 102]. FDA-approved IONPs are also biocompatible in the treatment of weakness [103]. The results showed that IONPs could be a definite opportunity to fight disease control or as an immunologist. Therefore, IONPs can be harmless and promising to be used immediately in the treatment of a COVID-19 patient. Other iron oxide particles such as ZnO nanoparticles are expressed in terms of cytotoxicity, biocompatibility, and accessibility. It was thought that the IONP is associated with more protein-infected proteins and the inhibition and connectivity of the infection or that may extend beyond the host cell, which stimulates balance. There are several studies on the antiviral activity of ZnO NPs [104, 105]. Another study analyzed antiviral action against H1N1 and showed that polyethylene glycol coated with ZnO NPs had higher antiviral action and lower cytotoxicity than ZnO NPs illustrated. Therefore, ZnO NPs may act as a powerful antiviral nanomaterial for COVID-19 treatment [106]. Also, active metal nanoparticles act as an antiviral specialist in preventing contact with infection and entry into host cells [107]. In particular, supraattractive iron oxide nanoparticles (SPIONPs) fill as attractive anchors to direct particles just like MRI differential specialists. Lipid-coated SPIONPs can refer antiviral specialists to a focus of interest [108]. In this way, they provide greater therapeutic potential for COVID-19. The antiviral potential of these nanoparticles can be attributed to their exposure to viral sites and the effect of local mutations, for example, glycoprotein agglutination, effectively preventing the entry of infection and phase into cells [109, 110].

As reports show, the composite composition and cost actually contribute to the antibacterial effects. The antiviral movement of promising nanoplatforms has increased the

use of GO and its substrates against bacterial contamination. For the most part, the ill-fated GO may be referring to a fixed-layer viral lipid that promotes its secretion. A few pieces of pegs and an envelope were later destroyed by GO hatching and infection. It was also found that GO protects against viral infections by activating the infection before half of the infection becomes cells [111]. This type of nanocomposite has reduced both uncontrolled and coagulated infections and has a much more significant barrier to Covid than GO. Graphene and nanocomposites of silver block Covid in a subtle way of repairing against coagulated and uncontrollable diseases.

Carbon nanocomposites can be financed by polymeric or metallic NP through additional resource circuits, for example, lactones, carboxylic acids, and hydroxyls [112]. Certified carbon plays a key role in preventing the new spread of COVID-19, which is caused by an increase in the number of diseases affecting its energy. Custom-made powdered carbon removes germ particles by trapping their nanopores through hydrophobic association and the outer layer of infection. There are certain types of viral molecules with different types of carbonaceous nanomaterials, for example, carbon quantum, nanodiamonds, enacted carbons, SWCNT or multiwall carbon nanotubes, GO, and graphene. Their applications are likely to be used in the treatment of COVID-19 depletion of viral particles in water or air using various contaminated tools [112, 113]. More recently, it has been shown that active CQDs with boronic corrosive ligands impair the potency of S-Covid protein and basically inhibit their penetration into cells. Carbon quantum specks are important decisions to communicate disease and prevent disease from entering host cells. The results of the study showed that the proliferation of these nanomaterials in cell culture media, both before and during COVID-19, reduced the rate of cell contamination [114]. In addition, the efficacy of rakuvirim or isoprinosine in the SWCNT environment has improved drug performance. CNT has a wide range of specific therapeutic implications for various theranostics that can be used as antimicrobial nanocarriers in the treatment of COVID-19. CNT-based nanosystem has the capacity to modify viral genomes and reduce viral activity [115–117].

Following the secretion and binding of the S protein, the amount of infection will be inhibited by these nanoparticles by means of a subnanoparticle modification. Quantum dots are flexible semiconductor particles that can transmit high-frequency photons that provide highly effective and robust fluorescence for POC virus testing. More recently, curcumin-based cationic CDs have been developed with potent anti-Covid techniques. Utilitarian carbon quantum spots can fill as a personal Covid correction [118, 119]. QDs play an important role in treating human CoVs contamination. For example, in one study, an antiviral dose of seven different quantum dots treatments for human CoV HCoV-229E was considered. CQDs, about 10 nm in size with significant solubility in water, are created using aqueous carbonation of carbon precursors, ethylenediamine citrus extract, and post-production changes using boronic acids. Blocking of the HCoV-229E corridor into cells is possible due to the interaction of virtual CQD circuits with HCoV-229E phase receptors. In addition, the repetitive phase of the virus was also suppressed. Functional effect of infection under fixation was revealed in quantum dots treatment [70].

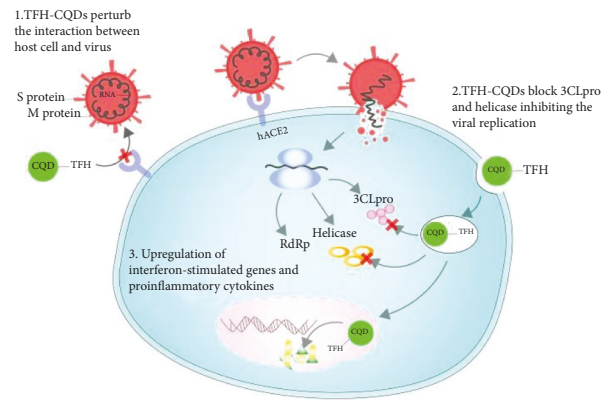

Figure 2: A schematic representation of the role of triazole functionalized heteroatom codoped carbon quantum dots against human coronaviruses.

CQDs incorporate active hydrophilic circuits that make them suitable for different biomedical applications. They replenish it as a multisite inhibitor by blocking viral passage and their RNA union and replication. In another study, triazole-based CQDs were recommended for use as an antiviral specialist in treating COVID-19 [119, 120]. Figure 2 demonstrated the role of triazole-functionalized heteroatom codoped carbon quantum dots against human coronaviruses. Their focus is important on regulating the number of diseases in the body [120, 121].

Also, the openness of the infection and the synthesis of oxygen-responsive forms that are connected to the cells simultaneously by resetting the expression to support the stimulating cytokines are reduced. It has also been reported that quantum dots associated with glycyrrhizin corrosive show strong antiviral behavior in RNA infection [122]. Moreover, semiconductor nanoparticles, including QDs, can produce radiation-resistant radicals by interacting with light. The changing response to other diseases suggests that CQDs also differ from antiretroviral systems and require further testing. It was common for CQDs or their useful analogs to show strong viracidal action rather than simply prevent the transmission of COVID-19 or human RNA infections into cells. These interactions may damage viral components such as platelets, DNA and RNA, and proteins. These interactions are commonly referred to as infections with other microbial photodynamic inhibitors and are driven by both natural photosensitizing and slow-moving nanoparticles compounds. A complete view of these two circuits is the creation promoted by the ROS light [120, 123].

Theranostics nanomaterials have emerged as a new field of medicine in the last decade, combining specific targeted therapy based on diagnostic tools for the next-generation treatment of a variety of diseases. The low toxicity of these nanoparticles, combined with their size, charge, and chemical modification capabilities, enables them to overcome the numerous barriers that obstruct their path through various administration routes.

Pregnancy-induced hypertension (PIH) was proposed by Huang et al. as a powerful heptad repeat 1 (HR1) peptide inhibitor that suppresses HR1/HR2-mediated membrane fusion between MERS coronavirus and host cells as the key pathway of MERS-induced host infections. They discovered that when this peptide inhibitor was delivered via gold nanorods, it had ten times the inhibitory activity of free PIH [124].

In another intriguing study, Loczechin A. et al. demonstrated that boronic acid ligands conjugated with carbon quantum dots interfered with the function of the coronavirus S protein, effectively stopping its entry into host cells [125]. It was reported that adding these nanoparticles to the cell culture medium before and during coronavirus infection significantly reduced the infection rate of the cells.

Coleman et al. reported that vaccination with a recombinant MERS-CoV S NP vaccine and Matrix-M1 adjuvant combination effectively and completely blocked MERS-CoV replication in mouse lungs [126]. The MERS-CoV S NP vaccine generated high titer anti-S neutralizing antibodies and protected mice from MERS-CoV infection in vivo. Jang et al. used an in vitro SELEX method to create an ES15 RNA aptamer with NTPase/Helicase enzymatic activity that inhibits SARS-CoV nonstructural protein 10 (nsP10). 37 Because helicases play such an important role in viral genome replication, transcription, and translation, inhibiting their enzymatic activities is critical in the development of promising drugs.

Another study used 1-pyrene butyric acid N-hydroxysuccinimide ester (PBASE) as an interface coupling agent to immobilize the SARS-CoV-2 spike protein antibody onto the fabricated graphene-based device [127]. The developed biosensor demonstrated an excellent limit of detection of the viral spike protein of 1 fgmL-1. The biosensor's sensitivity was tested using a control experiment, which revealed that the spike protein was required for specific binding with the viral antigen. The selectivity was confirmed when the COVID-19 FET developed did not respond to MERS-CoV spike proteins.

5. Conclusions and Future Perspectives

Lack of information and accessible resources regarding human is tics and components of COVID-19 pathophysiology as well as nano-bio-interface interactive tools that are constantly tested. Nanomaterials may be useful for detecting or working with COVID-19 infection, blocking their activity, and modulating human responses to the fight against the virus, but further testing is needed to determine their multifunctionality. In line with these lines, further studies involving the surface-to-bottom investigation of the relationship between viral particles and nanoparticles are important to obtain additional information on the usefulness, functional tools, and impact of nanoparticles on infection. These data are fundamental in determining appropriate approaches to the outcome, conclusion, and treatment of COVID-19.

In addition, ensuring the safe usage of nanomaterials is a major difficulty. Behavioral changes in nanomaterials in the bloodstream should be thoroughly evaluated and evaluated. The use of decaying nanoparticles is essential to ensure the complete release of the human body. In vivo research should lead to easier understanding of human body nanoparticle toxicity as a function of distance traveled by nanoparticles. In short, this study presents the framework of an excellent class of nanotechnology research for COVID-19 anticipation, diagnosis, and treatment. Significant features of nanomaterials, which include its strong visual and electrochemical properties, controllable sizes, biological compatibility, and cost effectiveness, play an important role in a wide range of applications. Their structures can be easily processed by switching and operating the process using different substrates, providing a great deal of logical performance. Despite their critical progress, research on COVID-19 is still in its infancy and there are still many challenges. In addition, the large area that allows the release of the best nanoparticles is critical in response to the COVID-19 epidemic. The most recommended aspects to be considered in future applications are affordability, sensitivity, fastest and solid, easy equipment, and easy delivery to end clients should be produced for immediate COVID-19 diagnosis. The inclusion of nanomaterials, for example, carbon-based nanoparticles, in the recognition gadget can produce more sensitive detection methods in monitoring a patient's long life. While enhancing local sensitivity and specialty, client businesses from planning to flag recognition should be simplified. This can be achieved by combining all the functions into one gadget. The development of a basic, flexible, and wireless gadget can be useful in the testing of COVID-19 in remote areas. Moreover, integrating mobile applications will enable you to track a patient's health status in assessing local health. Conventional therapies can be performed by transferring antiviral nanoparticles to initiate a safe response against disease. We think nanotechnology is useful in combating COVID-19, and further research is needed to provide new sensible information to help the use of nanomaterials in dealing with the COVID-19 episode and future epidemics. To put it bluntly, as the epidemic continues, the development of nanomaterial-based materials is critical to the prevention, diagnosis, and treatment of COVID-19. Through the innovative work, nanotechnology can help curb the spread of the virus and improve diagnostic implications using just a small sample of living organisms. Table 1 presents a summary of the role of nanomaterials for COVID-19 pandemic management.

Data Availability

The data that support the findings of this study are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present work.

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