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Study overview: Nanotechnology in Covid-19 “vaccines”

Ray Kurzweil

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Robert Freitas & Ray Kurzweil

Nanomedicine, Drug Delivery, and Medical Diagnostics
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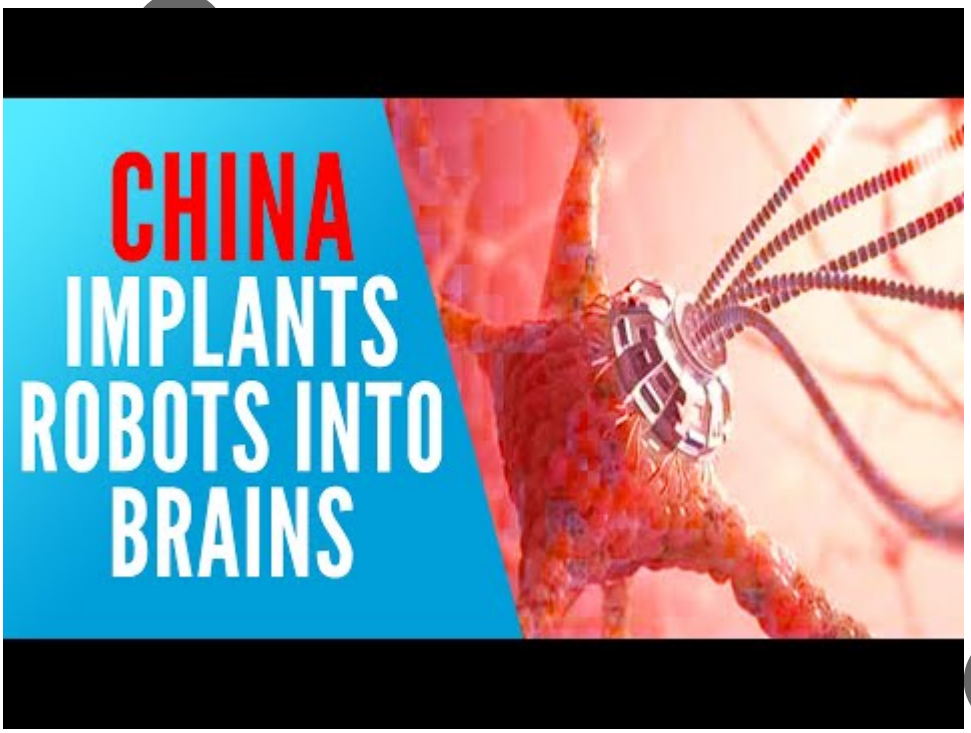

The future of nanotechnology

Interview with the father of nanotechnology Eric Drexler
Ray Kurzweil
Longevity and DNA nanotechnology
Robert Freitas & Ray Kurzweil
Nanomedicine, Drug Delivery, and Medical Diagnostics
China uses neuro-nanobots

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Further References

Ruiz-Hitzky, E., Darder, M., Wicklein, B., Ruiz-Garcia, C., Martín-Sampedro, R., del Real, G., & Aranda, P.. (2020). Nanotechnology Responses to COVID-19. Advanced Healthcare Materials

Plain numerical DOI: 10.1002/adhm.202000979
DOI URL
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“Researchers, engineers, and medical doctors are made aware of the severity of the covid-19 infection and act quickly against the coronavirus sars-cov-2 using a large variety of tools. in this review, a panoply of nanoscience and nanotechnology approaches show how these disciplines can help the medical, technical, and scientific communities to fight the pandemic, highlighting the development of nanomaterials for detection, sanitation, therapies, and vaccines. sars-cov-2, which can be regarded as a functional core–shell nanoparticle (np), can interact with diverse materials in its vicinity and remains attached for variable times while preserving its bioactivity. these studies are critical for the appropriate use of controlled disinfection systems. other nanotechnological approaches are also decisive for the development of improved novel testing and diagnosis kits of coronavirus that are urgently required. therapeutics are based on nanotechnology strategies as well and focus on antiviral drug design and on new nanoarchitectured vaccines. a brief overview on patented work is presented that emphasizes nanotechnology applied to coronaviruses. finally, some comments are made on patents of the initial technological responses to covid-19 that have already been put in practice.”

Yang, D.. (2021). Application of nanotechnology in the COVID-19 pandemic. International Journal of Nanomedicine

Plain numerical DOI: 10.2147/IJN.S296383
DOI URL
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“COVID-19, caused by sars-cov-2 infection, has been prevalent worldwide for almost a year. in early 2000, there was an outbreak of sars-cov, and in early 2010, a similar dissemination of infection by

mers-cov occurred. however, no clear explanation for the spread of sars-cov-2 and a massive increase in the number of infections has yet been proposed. the best solution to overcome this pandemic is the development of suitable and effective vaccines and therapeutics. fortunately, for sars-cov-2, the genome sequence and protein structure have been published in a short period, making research and develop- ment for prevention and treatment relatively easy. in addition, intranasal drug delivery has proven to be an effective method of administration for treating viral lung diseases. in recent years, nanotechnology-based drug delivery systems have been applied to intranasal drug delivery to overcome various limitations that occur during mucosal administration, and advances have been made to the stage where effective drug delivery is possible. this review describes the accumulated knowledge of the previous sars-cov and mers-cov infections and aims to help understand the newly emerged sars-cov-2 infection. furthermore, it elucidates the achievements in developing covid-19 vaccines and therapeutics to date through existing approaches. finally, the applicable nanotechnology approach is described in detail, and vaccines and therapeutic drugs developed based on nanomedicine, which are currently undergoing clinical trials, have presented the potential to become innovative alternatives for overcoming covid-19."
Tharayil, A., Rajakumari, R., Chirayil, C. J., Thomas, S., & Kalarikkal, N.. (2021). A short review on nanotechnology interventions against COVID-19. Emergent Materials

Plain numerical DOI: 10.1007/s42247-021-00163-z
DOI URL
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"The covid-19 has affected all major aspects of the society in a global perspective. the role of nanotechnology is much sought after in fighting this pandemic. advanced materials based on nanotechnology are the basis of several technologies starting from masks and personal protection equipment to specific diagnostic tools that could diminish the impact of covid-19. development of nanotechnology-based products is therefore an absolute necessity for fight against covid-19. we examine the fundamental concepts related to virology, histopathologic findings and how nanotechnology can help in fighting the disease. in this review we discuss the state of the art and ongoing nanotechnology-based strategies like antiviral coatings, 3d printing and therapeutics to fight against this deadly disease. the importance of using nanoparticles in point of care tests and biosensors is also highlighted."
Rasmi, Y., Saloua, K. S., Nemati, M., & Choi, J. R.. (2021). Recent progress in nanotechnology for covid-19 prevention, diagnostics and treatment. Nanomaterials

Plain numerical DOI: 10.3390/nano11071788
DOI URL
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"The covid-19 pandemic is currently an unprecedented public health threat. the rapid spread of infections has led to calls for alternative approaches to combat the virus. nanotechnology is taking root against sars-cov-2 through prevention, diagnostics and treatment of infections. in light of the escalating demand for managing the pandemic, a comprehensive review that highlights the role of nanomaterials

in the response to the pandemic is highly desirable. this review article comprehensively discusses the use of nanotechnology for covid-19 based on three main categories: prevention, diagnostics and treatment. we first highlight the use of various nanomaterials including metal nanoparticles, carbon-based nanoparticles and magnetic nanoparticles for covid-19. we critically review the benefits of nanomaterials along with their applications in personal protective equipment, vaccine development, diagnostic device fabrication and therapeutic approaches. the remaining key challenges and future directions of nanomaterials for covid-19 are briefly discussed. this review is very informative and helpful in providing guidance for developing nanomaterial-based products to fight against covid-19."
Chauhan, G., Madou, M. J., Kalra, S., Chopra, V., Ghosh, D., & Martinez-Chapa, S. O.. (2020). Nanotechnology for COVID-19: Therapeutics and Vaccine Research. ACS Nano

Plain numerical DOI: 10.1021/acsnano.0c04006
DOI URL
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"The current global health threat by the novel coronavirus disease 2019 (covid-19) requires an urgent deployment of advanced therapeutic options available. the role of nanotechnology is highly relevant to counter this 'virus' nano enemy. nano intervention is discussed in terms of designing effective nanocarriers to counter the conventional limitations of antiviral and biological therapeutics. this strategy directs the safe and effective delivery of available therapeutic options using engineered nanocarriers, blocking the initial interactions of viral spike glycoprotein with host cell surface receptors, and disruption of virion construction. controlling and eliminating the spread and reoccurrence of this pandemic demands a safe and effective vaccine strategy. nanocarriers have potential to design risk-free and effective immunization strategies for severe acute respiratory syndrome coronavirus 2 vaccine candidates such as protein constructs and nucleic acids. we discuss recent as well as ongoing nanotechnology-based therapeutic and prophylactic strategies to fight against this pandemic, outlining the key areas for nanoscientists to step in."
Tang, Z., Zhang, X., Shu, Y., Guo, M., Zhang, H., & Tao, W.. (2021). Insights from nanotechnology in COVID-19 treatment. Nano Today

Plain numerical DOI: 10.1016/j.nantod.2020.101019
DOI URL
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"In just a few months, sars-cov-2 and the disease it causes, covid-19, created a worldwide pandemic. virologists, biologists, pharmacists, materials scientists, and clinicians are collaborating to develop efficient treatment strategies. overall, in addition to the use of clinical equipment to assist patient rehabilitation, antiviral drugs and vaccines are the areas of greatest focus. given the physical size of sars-cov-2 and the vaccine delivery platforms currently in clinical trials, the relevance of nanotechnology is clear, and previous antiviral research using nanomaterials also supports this connection. herein we briefly summarize current representative strategies regarding nanomaterials in antiviral research. we focus specifically on sars-cov-2 and the detailed role that nanotechnology can play in addressing this pandemic, including i) using fda-approved nanomaterials for drug/vaccine

delivery, including further exploration of the inhalation pathway; ii) introducing promising nanomaterials currently in clinical trials for drug/vaccine delivery; iii) designing novel biocompatible nanomaterials to combat the virus via interfering in its life cycle; and iv) promoting the utilization of nanomaterials in pneumonia treatment."
Singh, Y. D., Ningthoujam, R., Panda, M. K., Jena, B., Babu, P. J., & Mishra, A. K.. (2021). Insight from nanomaterials and nanotechnology towards COVID-19. Sensors International

Plain numerical DOI: 10.1016/j.sintl.2021.100099
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"The pandemic coronavirus disease 2019 (covid-19) becomes one of the most dreadful disease in the history of mankind in the entire world. the covid-19 outbreak started from wuhan city of china and then rapidly transmitted throughout the world causing mass destruction and seldom. this sporadical disease has taken many lives due to sudden outbreak and no particular vaccines were available at the early wave. all the vaccines developed are mostly targeted to spike protein of the virus which involves the encapsulation of mrna and nanoparticles. nanotechnology intervention in fighting against the covid-19 is one way to tackle the disease from different angles including nano coating mask, nano diagnostic kits, nano sanitizer, and nano medicine. this article highlights the intervention of nanotechnology and its possible treatment against the covid-19. it is high time to come together all the units of material science and biological science to fight against the dreadful covid-19. as an alternative strategy, a multidisciplinary research effort, consisting of classical epidemiology and clinical methodologies, drugs and nanotechnology, engineering science and biological apprehension, can be adopted for developing improved drugs exhibiting antiviral activities. the employment of nanotechnology and its allied fields can be explored to detect, treat, and prevent the covid-19 disease."
Paliwal, P., Sargolzaei, S., Bhardwaj, S. K., Bhardwaj, V., Dixit, C., & Kaushik, A.. (2020). Grand Challenges in Bio-Nanotechnology to Manage the COVID-19 Pandemic. Frontiers in Nanotechnology

Plain numerical DOI: 10.3389/fnano.2020.571284
DOI URL
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"The outbreak of the covid-19, a human beta coronavirus severe acute respiratory syndrome (sars-cov-2) virus infection, has severely affected the world. the pandemic is not yet in full control due to a lack of rapid diagnostics and therapeutics. this viral infection continues to result in a steadily increasing loss of life, and it has also emerged as a significant global socio-economic burden. as result, it has united many countries for the purposes of exploring molecular biology, biomedical science, and the nanotechnology to manage covid-19 successfully. as of today, the current priority is to investigate novel therapies of high efficacy and smart diagnostics tools for early-stage disease diagnostics along with monitoring. keeping these advancement and challenges in mind, this perspective article mainly highlights the contribution and possibilities of bio-nanotechnology to manage the covid-19 pandemic, even in a personalized manner. authors also pinpoint barriers to the utilization of current bio-

nanotechnology to facilitate a more accurate understanding of covid-19 and to lead the way toward personalized health and wellness. furthermore, we follow the discussion of the features and challenges in upcoming bio-nanotechnology approaches for covid-19 management. in this progressive option report, bio-nanotechnologies that have been enriched with the power of artificial intelligence and optimized at the personalized level have been found to lead to a sustainable treatment and cure strategy at a global population scale."
Campos, E. V. R., Pereira, A. E. S., De Oliveira, J. L., Carvalho, L. B., Guilger-Casagrande, M., De Lima, R., & Fraceto, L. F.. (2020). How can nanotechnology help to combat COVID-19? Opportunities and urgent need. Journal of Nanobiotechnology

Plain numerical DOI: 10.1186/s12951-020-00685-4
DOI URL
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"Incidents of viral outbreaks have increased at an alarming rate over the past decades. the most recent human coronavirus known as covid-19 (sars-cov-2) has already spread around the world and shown r0 values from 2.2 to 2.68. however, the ratio between mortality and number of infections seems to be lower in this case in comparison to other human coronaviruses (such as severe acute respiratory syndrome coronavirus (sars-cov) and middle east respiratory syndrome coronavirus (mers-cov)). these outbreaks have tested the limits of healthcare systems and have posed serious questions about management using conventional therapies and diagnostic tools. in this regard, the use of nanotechnology offers new opportunities for the development of novel strategies in terms of prevention, diagnosis and treatment of covid-19 and other viral infections. in this review, we discuss the use of nanotechnology for covid-19 virus management by the development of nano-based materials, such as disinfectants, personal protective equipment, diagnostic systems and nanocarrier systems, for treatments and vaccine development, as well as the challenges and drawbacks that need addressing.[figure not available: see fulltext.]"
Tavares, J. L., Cavalcanti, I. D. L., Santos Magalhães, N. S., & Lira Nogueira, M. C. de B.. (2022). Nanotechnology and COVID-19: quo vadis?. Journal of Nanoparticle Research

Plain numerical DOI: 10.1007/s11051-022-05452-0
DOI URL
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"The pandemic covid-19 has worried everyone due to the high mortality rate and the high number of people hospitalized with severe acute respiratory syndrome caused by sars-cov-2. given the seriousness of this disease, several companies and research institutions have sought alternative treatment and/or prevention methods for covid-19. due to its versatility, nanotechnology has allowed the development of protective equipment and vaccines to prevent the disease and reduce the number of severe covid-19 cases. thus, this article combined the main works and products developed in a nanotechnological field for covid-19. we performed a literature search using the keywords 'covid-19,' 'sars-cov-2,' 'nanoparticles,' 'nanotechnology,' and 'liposomes' in the scielo, scifinder, pubmed, sciencedirect, clinicaltrials, and nanotechnology products databases database. the data survey

indicated 48 articles, 62 products, and 32 patents. the use of nanotechnology against covid-19 has brought benefits in several parameters of this disease, helping develop rapid diagnostic tests that release the result in 10 min, as well as developing vaccines containing genetic material from sars-cov-2 (dna, mrna, and protein subunits). nanotechnology is an exceptional ally against covid-19, contributing to the most diverse areas, helping both prevent, diagnose, and treat covid-19."
Vahedifard, F., & Chakravarthy, K.. (2021). Nanomedicine for COVID-19: the role of nanotechnology in the treatment and diagnosis of COVID-19. Emergent Materials

Plain numerical DOI: 10.1007/s42247-021-00168-8
DOI URL
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"Severe acute respiratory syndrome coronavirus 2 (sars-cov-2) has caused the recent outbreak of coronavirus 2019 (covid-19). although nearly two decades have passed since the emergence of pandemics such as sars-cov and middle east respiratory syndrome coronavirus (mers-cov), no effective drug against the cov family has yet been approved, so there is a need to find newer therapeutic targets. currently, simultaneous research across the globe is being performed to discover efficient vaccines or drugs, including both conventional therapies used to treat previous similar diseases and emerging therapies like nanomedicine. nanomedicine has already proven its value through its application drug delivery and nanosensors in other diseases. nanomedicine and its components can play an important role in various stages of prevention, diagnosis, treatment, vaccination, and research related to covid-19. nano-based antimicrobial technology can be integrated into personal equipment for the greater safety of healthcare workers and people. various nanomaterials such as quantum dots can be used as biosensors to diagnose covid-19. nanotechnology offers benefits from the use of nanosystems, such as liposomes, polymeric and lipid nanoparticles, metallic nanoparticles, and micelles, for drug encapsulation, and facilitates the improvement of pharmacological drug properties. antiviral functions for nanoparticles can target the binding, entry, replication, and budding of covid-19. the toxicity-related inorganic nanoparticles are one of the limiting factors of its use that should be further investigated and modified. in this review, we are going to discuss nanomedicine options for covid-19 management, similar applications for related viral diseases, and their gap of knowledge."
Singh, P., Singh, D., Sa, P., Mohapatra, P., Khuntia, A., & Sahoo, S. K.. (2021). Insights from nanotechnology in COVID-19: Prevention, detection, therapy and immunomodulation. Nanomedicine

Plain numerical DOI: 10.2217/nnm-2021-0004
DOI URL
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"The outbreak of sars-cov-2 infection has presented the world with an urgent demand for advanced diagnostics and therapeutics to prevent, treat and control the spread of infection. nanotechnology seems to be highly relevant in this emergency due to the unique physicochemical properties of nanomaterials which offer versatile chemical functionalization to create advanced biomedical tools. here, nano-intervention is discussed for designing effective strategies in developing advanced personal

protective equipment kits, disinfectants, rapid and cost-effective diagnostics and therapeutics against the infection. we have also highlighted the nanoparticle-based vaccination approaches and how nanoparticles can regulate the host immune system against infection. overall, this review discusses various nanoformulations that have shown clinical relevance or can be explored in the fight against covid-19."
Hasanzadeh, A., Alamdaran, M., Ahmadi, S., Nourizadeh, H., Bagherzadeh, M. A., Mofazzal Jahromi, M. A., … Hamblin, M. R.. (2021). Nanotechnology against COVID-19: Immunization, diagnostic and therapeutic studies. Journal of Controlled Release

Plain numerical DOI: 10.1016/j.jconrel.2021.06.036
DOI URL
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"The emergence of severe acute respiratory syndrome coronavirus 2 (sars-cov-2) in early 2020 soon led to the global pandemic of coronavirus disease 2019 (covid-19). since then, the clinical and scientific communities have been closely collaborating to develop effective strategies for controlling the ongoing pandemic. the game-changing fields of recent years, nanotechnology and nanomedicine have the potential to not only design new approaches, but also to improve existing methods for the fight against covid-19. nanomaterials can be used in the development of highly efficient, reusable personal protective equipment, and antiviral nano-coatings in public settings could prevent the spread of sars-cov-2. smart nanocarriers have accelerated the design of several therapeutic, prophylactic, or immune-mediated approaches against covid-19. some nanovaccines have even entered phase i?/ii? clinical trials. several rapid and cost-effective covid-19 diagnostic techniques have also been devised based on nanobiosensors, lab-on-a-chip systems, or nanopore technology. here, we provide an overview of the emerging role of nanotechnology in the prevention, diagnosis, and treatment of covid-19."
Weiss, C., Carriere, M., Fusco, L., Fusco, L., Capua, I., Regla-Nava, J. A., … Delogu, L. G.. (2020). Toward Nanotechnology-Enabled Approaches against the COVID-19 Pandemic. ACS Nano

Plain numerical DOI: 10.1021/acsnano.0c03697
DOI URL
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"The covid-19 outbreak has fueled a global demand for effective diagnosis and treatment as well as mitigation of the spread of infection, all through large-scale approaches such as specific alternative antiviral methods and classical disinfection protocols. based on an abundance of engineered materials identifiable by their useful physicochemical properties through versatile chemical functionalization, nanotechnology offers a number of approaches to cope with this emergency. here, through a multidisciplinary perspective encompassing diverse fields such as virology, biology, medicine, engineering, chemistry, materials science, and computational science, we outline how nanotechnology-based strategies can support the fight against covid-19, as well as infectious diseases in general, including future pandemics. considering what we know so far about the life cycle of the virus, we envision key steps where nanotechnology could counter the disease. first, nanoparticles (nps) can offer alternative methods to classical disinfection protocols used in healthcare settings, thanks to their

intrinsic antipathogenic properties and/or their ability to inactivate viruses, bacteria, fungi, or yeasts either photothermally or via photocatalysis-induced reactive oxygen species (ros) generation. nanotechnology tools to inactivate sars-cov-2 in patients could also be explored. in this case, nanomaterials could be used to deliver drugs to the pulmonary system to inhibit interaction between angiotensin-converting enzyme 2 (ace2) receptors and viral s protein. moreover, the concept of 'nanoimmunity by design'can help us to design materials for immune modulation, either stimulating or suppressing the immune response, which would find applications in the context of vaccine development for sars-cov-2 or in counteracting the cytokine storm, respectively. in addition to disease prevention and therapeutic potential, nanotechnology has important roles in diagnostics, with potential to support the development of simple, fast, and cost-effective nanotechnology-based assays to monitor the presence of sars-cov-2 and related biomarkers. in summary, nanotechnology is critical in counteracting covid-19 and will be vital when preparing for future pandemics."
Rangayasami, A., Kannan, K., Murugesan, S., Radhika, D., Sadasivuni, K. K., Reddy, K. R., & Raghu, A. V.. (2021). Influence of nanotechnology to combat against COVID-19 for global health emergency: A review. Sensors International

Plain numerical DOI: 10.1016/j.sintl.2020.100079
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"Covid 2019 is spreading and emerging rapidly all over the world as a new social disaster. this virus is accountable for the continuous epidemic that causes severe respiratory problems and pneumonia related to contamination of humans, which leads to a dangerous condition of life. due to the increasing threatening number of cases all over the world, the world health organization (who) declared coronavirus as a global health emergency. the pandemic disease affected nearly 80 million people positive cases were reported worldwide till now and cause the death of more than 1.7 million people. the virus has novel characteristics types of pathogens. many clarifications are done and much more are still unknown and pending. the collaborative research will be useful during this pandemic time in order to meet the improvement of global health improvement. it will also help to know about the knowledge of this covid-19. recent advancements in nanotechnology proved that they can help in the production of vaccines in a brief timeframe. in this review, the requirement for quick immunization improvement and the capability and implementation of nanotechnology combat against coronavirus disease were discussed."
Chintagunta, A. D., Sai Krishna, M., Nalluru, S., & Sampath Kumar, N. S.. (2021). Nanotechnology: an emerging approach to combat COVID-19. Emergent Materials

Plain numerical DOI: 10.1007/s42247-021-00178-6
DOI URL
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"The recent outbreak of coronavirus disease (covid-19) has challenged the survival of human existence in the last 1 year. frontline healthcare professionals were struggling in combating the pandemic situation and were continuously supported with literature, skill set, research activities, and technologies

developed by various scientists/researchers all over the world. to handle the continuously mutating severe acute respiratory syndrome coronavirus-2 (sars-cov-2) requires amalgamation of conventional technology with emerging approaches. nanotechnology is science, engineering, and technology dealing at the nanoscale level. it has made possible the development of nanomaterials, nano-biosensors, nanodrugs, and vaccines for diagnosis, therapy, and prevention of covid-19. this review has elaborately highlighted the role of nanotechnology in developing various detection kits such as nanoparticle-assisted diagnostics, antibody assay, lateral flow immunoassay, nanomaterial biosensors, etc., in detection of sars-cov-2. similarly, various advancements supervene through nanoparticle-based therapeutic drugs for inhibiting viral infection by blocking virus attachment/cell entry, multiplication/replication, and direct inactivation of the virus. furthermore, information on vaccine development and the role of nanocarriers/nanoparticles were highlighted with a brief outlining of nanomaterial usage in sterilization and preventive mechanisms engineered to combat covid-19 pandemic."
Cardoso, V. M. de O., Moreira, B. J., Comparetti, E. J., Sampaio, I., Ferreira, L. M. B., Lins, P. M. P., & Zucolotto, V.. (2020). Is Nanotechnology Helping in the Fight Against COVID-19?. Frontiers in Nanotechnology

Plain numerical DOI: 10.3389/fnano.2020.588915
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"The novel coronavirus disease (covid-19) pandemic represents an unprecedented public health concern. the disease, which has an incredibly high spreading rate, was discovered in late december 2019, in wuhan, hubei province, china. the virus that causes covid-19, known as severe acute respiratory syndrome coronavirus 2 (sars-cov-2), is responsible for the infection of more than 21.8 million individuals and more than 772 thousand deaths in 216 countries, numbers which are still rising. currently, there are no vaccines or antiviral treatments officially approved for the prevention or treatment of covid-19. since its appearance, several therapeutic approaches have been tested, including the use of repurposing drugs, such as broad-spectrum antivirals, nucleoside analogs, protease inhibitors, immunomodulators, and plasma therapies, among others. however, these strategies have not shown great clinical benefits and are only administered to attenuate the symptoms. although many therapeutic strategies are being tested against covid-19, more efforts should be devoted to fighting the virus. nanomaterials represent a powerful tool against covid-19 since they can be designed to act directly toward the infection, increase the effectiveness of conventional antiviral drugs, or even to trigger the immune response of the patient. advances in nanotechnology over the past decades allow us to develop new nanomaterials and step forward in the application of new technological tools. this review addresses aspects related to the structural characteristics of the virus, the mechanisms involved in the infection, and therapies that are currently used against covid-19. this review discusses nanotechnology-based strategies for the prevention, diagnosis, and treatment of covid-19, including nanomaterials for face masks and surface sterilization, adjuvants, vaccine delivery nanosystems, and point-of-care tests, providing a perspective on how nanotechnology could be an applied in the fight against covid-19."
Tavakol, S., Zahmatkeshan, M., Mohammadinejad, R., Mehrzadi, S., Joghataei, M. T., Alavijeh, M. S., & Seifalian, A.. (2021). The role of nanotechnology in current COVID-19 outbreak. Heliyon

Plain numerical DOI: 10.1016/j.heliyon.2021.e06841
DOI URL
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“COVID-19 has recently become one of the most challenging pandemics of the last century with deadly outcomes and a high rate of reproduction number. it emphasizes the critical need for the designing of efficient vaccines to prevent virus infection, early and fast diagnosis by the high sensitivity and selectivity diagnostic kits, and effective antiviral and protective therapeutics to decline and eliminate the viral load and side effects derived from tissue damages. therefore, non-toxic antiviral nanoparticles (nps) have been under development for clinical application to prevent and treat covid-19. nps showed great promise to provide nano vaccines against viral infections. here, we discuss the potentials of nps that may be applied as a drug itself or as a platform for the aim of drug and vaccine repurposing and development. meanwhile, the advanced strategies based on nps to detect viruses will be described with the goal of encouraging scientists to design effective and cost-benefit nanoplatforms for prevention, diagnosis, and treatment.”
Du, L., Yang, Y., Zhang, X., & Li, F.. (2022). Recent advances in nanotechnology-based COVID-19 vaccines and therapeutic antibodies. Nanoscale

Plain numerical DOI: 10.1039/d1nr03831a
DOI URL
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“COVID-19 has caused a global pandemic and millions of deaths. it is imperative to develop effective countermeasures against the causative viral agent, sars-cov-2 and its many variants. vaccines and therapeutic antibodies are the most effective approaches for preventing and treating covid-19, respectively. sars-cov-2 enters host cells through the activities of the virus-surface spike (s) protein. accordingly, the s protein is a prime target for vaccines and therapeutic antibodies. dealing with particles with dimensions on the scale of nanometers, nanotechnology has emerged as a critical tool for rapidly designing and developing safe, effective, and urgently needed vaccines and therapeutics to control the covid-19 pandemic. for example, nanotechnology was key to the fast-track approval of two mrna vaccines for their wide use in human populations. in this review article, we first explore the roles of nanotechnology in battling covid-19, including protein nanoparticles (for presentation of protein vaccines), lipid nanoparticles (for formulation with mrnas), and nanobodies (as unique therapeutic antibodies). we then summarize the currently available covid-19 vaccines and therapeutics based on nanotechnology. this journal is”
Chaudhary, V., Royal, A., Chavali, M., & Yadav, S. K.. (2021). Advancements in research and development to combat COVID-19 using nanotechnology. Nanotechnology for Environmental Engineering

Plain numerical DOI: 10.1007/s41204-021-00102-7
DOI URL

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“The whole world is currently facing a global health crisis due to the coronavirus disease (covid-19) pandemic caused by sars coronavirus 2, which started in wuhan city, china, in december 2019. the pandemic has affected 235 countries, areas or territories and infected over 42 million people across the globe as per who update on 27 october 2020. more than 1.1 million people have died and the numbers are increasing daily. however, some drugs have been authorized for emergency treatment of patients, medication and vaccines with proven efficacy to prevent and treat the disease is still under various phases of development. the entire world is consistently making efforts to address three major challenges related to covid-19 including prevention of its spread, prompt and early diagnosis and treatment of patients to save lives. touted as one of the game-changing technologies of the century, nanotechnology has huge potential to develop solutions against these three major challenges of the disease. nanotechnology comprises of multidisciplinary prospects encompassing diverse disciplines including medicine, material science, artificial intelligence, environment, virology, physical sciences, chemistry and biology. the numerous challenges can be addressed through the engineering of the various physicochemical properties of materials presents in abundance in nature. various claims, studies and reports on research and development to combat these challenges associated with covid-19 have been collectively discussed in this article from the perspectives of nanotechnology.”
Rai, M., Bonde, S., Yadav, A., Bhowmik, A., Rathod, S., Ingle, P., & Gade, A.. (2021). Nanotechnology as a shield against covid-19: Current advancement and limitations. Viruses

Plain numerical DOI: 10.3390/v13071224
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“The coronavirus disease 2019 (covid-19) caused by severe acute respiratory syndrome coronavirus 2 (sars-cov-2) is a global health problem that the who declared a pandemic. covid19 has resulted in a worldwide lockdown and threatened to topple the global economy. the mortality of covid-19 is comparatively low compared with previous sars outbreaks, but the rate of spread of the disease and its morbidity is alarming. this virus can be transmitted human-to-human through droplets and close contact, and people of all ages are susceptible to this virus. with the advancements in nanotechnology, their remarkable properties, including their ability to amplify signal, can be used for the development of nanobiosensors and nanoimaging techniques that can be used for early-stage detection along with other diagnostic tools. nano-based protection equipment and disinfecting agents can provide much-needed protection against sars-cov-2. moreover, nanoparticles can serve as a carrier for antigens or as an adjuvant, thereby making way for the development of a new generation of vaccines. the present review elaborates the role of nanotechnology-based tactics used for the detection, diagnosis, protection, and treatment of covid-19 caused by the sars-cov-2 virus.”
Dube, A., Egieyeh, S., & Balogun, M.. (2021). A perspective on nanotechnology and covid-19 vaccine research and production in south africa. Viruses

Plain numerical DOI: 10.3390/v13102095
DOI URL
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“Advances in nanotechnology have enabled the development of a new generation of vaccines, which are playing a critical role in the global control of the covid-19 pandemic and the return to normalcy. vaccine development has been conducted, by and large, by countries in the global north. south africa, as a major emerging economy, has made extensive investments in nanotechnology and bioinformatics and has the expertise and resources in vaccine development and manufacturing. this has been built at a national level through decades of investment. in this perspective article, we provide a synopsis of the investments made in nanotechnology and highlight how these could support innovation, research, and development for vaccines for this disease. we also discuss the application of bioinformatics tools to support rapid and cost-effective vaccine development and make recommendations for future research and development in this area to support future health challenges.”
Tyagi, P. K., Tyagi, S., Kumar, A., Ahuja, A., & Gola, D.. (2021). Contribution of nanotechnology in the fight against covid-19. Biointerface Research in Applied Chemistry

Plain numerical DOI: 10.33263/BRIAC111.82338241
DOI URL
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“Coronavirus disease (covid-19) is a respiratory infectious disease caused by a newly discovered virus strain, severe acute respiratory syndrome coronavirus-2 (sars-cov-2). this pandemic spread quickly across nations with a high mortality rate in immunocompromised patients. this contagious disease posed a serious threat to health systems. it impacted the continents of the earth in a way that could not have been predicted. therefore, many leading funding agencies announced the call for proposal to diagnosis and treatment of covid-19 pandemic using advanced technology-based methods, including nanotechnology. the researchers coming from the nanotechnology community can contribute their efforts to cope with covid-19. as a community member of nanotechnology, we suggest some new research targets that can be designed and improved, optimized, and developed the existing/new materials in the sub-field of diagnostics and healthcare of nanotechnology. the potential research targets to fight against covid-19 includes point-of-care diagnostics (pocd), surveillance and monitoring, novel therapeutics, vaccine development, research, and development, repurposing existing drugs with potential therapeutic applications, development of antiviral nanocoating/antimicrobial spray-based coating for ppe, magnetic nanoparticles and viral rna and rapid detection kits.”
De M Ribeiro, L. N., & Fonseca, B. B.. (2020). The role of pharmaceutical nanotechnology in the time of COVID-19 pandemic. Future Microbiology

Plain numerical DOI: 10.2217/fmb-2020-0118
DOI URL
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“There is no effective therapy against covid-19 available so far. in the last months, different drugs have been tested as potential treatments for covid-19, exhibiting high toxicity and low efficacy. therefore, nanotechnology can be applied to improve the therapeutic action and minimize the toxicity of loaded drugs. in this review, we summarized the drugs tested as covid-19 treatment and the advantages of antiviral nanostructured drug-delivery systems. such systems have demonstrated low in vitro toxicity with better in vitro antiviral activity than free drugs. we believe that this approach should inspire novel nanostructured drug-delivery systems developments to find efficient covid-19 treatments. here, we discuss the remaining challenges for such promising nanosystems to be approved for clinical use.”
Chung, Y. H., Beiss, V., Fiering, S. N., & Steinmetz, N. F.. (2020). Covid-19 vaccine frontrunners and their nanotechnology design. ACS Nano

Plain numerical DOI: 10.1021/acsnano.0c07197
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“Humanity is experiencing a catastrophic pandemic. sars-cov-2 has spread globally to cause significant morbidity and mortality, and there still remain unknowns about the biology and pathology of the virus. even with testing, tracing, and social distancing, many countries are struggling to contain sars-cov-2. covid-19 will only be suppressible when herd immunity develops, either because of an effective vaccine or if the population has been infected and is resistant to reinfection. there is virtually no chance of a return to pre-covid-19 societal behavior until there is an effective vaccine. concerted efforts by physicians, academic laboratories, and companies around the world have improved detection and treatment and made promising early steps, developing many vaccine candidates at a pace that has been unmatched for prior diseases. as of august 11, 2020, 28 of these companies have advanced into clinical trials with moderna, cansino, the university of oxford, biontech, sinovac, sinopharm, anhui zhifei longcom, inovio, novavax, vaxine, zydus cadila, institute of medical biology, and the gamaleya research institute having moved beyond their initial safety and immunogenicity studies. this review analyzes these frontrunners in the vaccine development space and delves into their posted results while highlighting the role of the nanotechnologies applied by all the vaccine developers.”

Category

1. General

Tags

1. Nanobots
2. Nanoparticles
3. Nanotechnology

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