iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 10 **Issue:** X **Month of publication:** October 2022

**DOI:** https://doi.org/10.22214/ijraset.2022.46986

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 10 Issue X Oct 2022- Available at www.ijraset.com*

# Nanoparticles, Their Synthesis, Effects and Their Applications in Nanotechnology

Sushma J Ballal[1], Yashwanth C[1], Chethana BR[1], Dr. Anuroopa[2]
[1]*PG Students, Department of Microbiology, Nrupatunga University, Government Science College, Bangalore-01, India*
[2]*Associate Professor, Department of Microbiology, Nrupatunga University, Government Science College, Bangalore-01, India*

***Abstract:*** ***Nanoparticles are defined as the particles at the scale measuring from 1-100 nanometers. Nanotechnology is embedded in the operation of all miniscule particles measuring in factor of $10^{-9}$. These materials have a significant role in medicine, pharmacy, biotechnology, environment and other fields. Nanoparticles are used as agents in drug and gene delivery for the treatment of certain tumor and cancer treatment. However, nanoparticles are environmentally toxic and pose challenges to the society with respect to their removal. This review would present a well refined knowledge of the nanoparticles, types, synthesis by chemical and biological methods, with their applications. Along with them the review presents about the nanotechnology, the fields it's being utilized and techniques involved, and the recent updates in this evolving branch of science.***
***Keywords: Nanoparticles, nanotechnology, toxic, types, synthesis, chemical, biological method, applications, effects, recent updates.***

## I. INTRODUCTION

Understanding and maneuvering the particles at nano scale has its own applications, like in the field of medicine (Salata, 2004), industries (Stark et.al, 2014), agriculture, etc; There are many types of nanoparticles for example; gold, silver, copper, fluorescent nanoparticles like cadmium containing quantum dots, fluorescent carbon nanoparticles (FCNPs) (Sanni et.al, 2021) etc. Knowledge of the various kinds of nanoparticles, their synthesis, also their applications will lead to appropriate use of them in various fields. The techniques employed for the preparation are physical methods like laser ablation, evaporation-condensation etc.(Iravani et.al, 2013), chemical methods like chemical reduction, solvothermal method, polyol process etc.,and biological methods makes use of living biological systems to synthesize nanoparticles. This is called biogenic synthesis and is done from various bacteria, fungi, algae, yeasts, actinomycetes, viruses and plants (Sastri et.al, 2003).

The advancement in this field has brought various beneficial and harmful effects on the environment (Soares et.al, 2021), micro-organisms (Theivasanthi et.al, 2011) and to human beings. Like the star clusters that build up the galaxies these nanoparticles build up the nanotechnology where it is used as a prominent tool for diagnostics, in agriculture, in industries etc;Nanotechnology ideas and concepts were first introduced by American physicist Richard Feyman. The invention of scanning tunneling microscope in 1981 led to the unfolding of the manipulation and control over the individual atoms.The tools and techniques involved and the recent updates in this field, through this review can prove helpful in having a better understanding of nanoparticles and nanotechnology, and its wide application.

## II. TYPES OF NANOPARTICLES

1) *Silver:* Silver is known to be highly reflective and easy to work with, this nanoparticle can be synthesized biologically by bacteria, plants, fungi and algae e.g. *Spirulinaplatensis*, *Azadirachtaindica etc;* (Iravani et.al, 2013) or even by chemical and physical methods. Due to its versatile applications in numerous fields like medicine, textile industries (Hasan, 2015) and environmental applications (Vithiya et.al, 2011) etc; their synthesis is considered to be on top in the list.
2) *Gold:* Gold, like silver, can be synthesized by biological, chemical, and physical methods (Rafiyabano et.al, 2022). It is proven that gold nanoparticles can increase shelf-life of food products in association with bacteriocins (Sulthana et.al, 2020), and they are also used in the field of microscopy (Dykman et.al, 2011). Gold Nanoparticles have been used to combat Tuberculosis by coating them on the outer membrane vesicles of Mycobacterium which mediated immune response (George et.al, 2022)
3) *Copper:* Copper, due to its low cost, its synthesis is necessary and of high priority. Their antibacterial property against pathogenic bacteria like *Klebsiella pneumoniae* (Chaudhary et.al, 2019) makes it an important nanoparticle in the field of medicine. They can be chemically synthesized by various techniques like reduction (khan et.al) and even biologically.

4) *Silica:* Silica nanoparticles have great stability and pore size which makes them amicable for construction of composites and drug delivery. They are synthesized by various green methods (Karande et.al, 2021). Nano SiO2 induced model has shown its value in the field of research in studying granulomas and fibrosis (Guan et.al, 2022)
5) *Fluorescent Nanoparticles:* These particles emit specific wavelength of light upon exposure. They may be organic or inorganic, amorphous or crystalline particles. There are of different types like semiconductor quantum dots (SQDs), fluorescent carbon nanoparticles (FCNPs) and rare-earth doped nanoparticles etc; They are used in bacterial enhancement imaging, chemical sensing, animal cellular tracing etc.(Farkkila et.al, 2021).

## III. BIOLOGICAL AND CHEMICAL SYNTHESIS OF NANOPARTICLES

### A. Chemical Synthesis

This is basically a bottom up approach, where the atoms form clusters, resulting in the formation of nanoparticles (Abid et.al, 2021). Chemical synthesis is basically using certain chemicals to obtain a desired product.

There are various methods that have been developed to procure the desired nanoparticles:

1) *Template / Surface Derivatized Methods:* Using a pattern, like in this case it can be a soft template, where surfactants (Fernandez et.al, 2007) or organic molecules (Poolkkandy et.al, 2020) are used and the next one is hard template where meso-channels are filled (Hernandez et.al, 2019) and these are made from porous solids like silica (Fernandez et.al, 2007).
2) *Chemical Reduction Method:* Reduction itself gives us a clue of the usage of a reducing agent in this method like sodium borohydride ($NaBH_4$), N,N-dimethylformamide (DMF), ascorbate etc; used in AgNP synthesis. Primarily reduces the $Ag^+$ ions to Ag metal followed by cluster formation which is then stabilized by certain agents and the AgNP is obtained (Chugh et.al, 2021).
3) *Solvothermal Methods:* There is a usage of surfactant agent that is added after the metals are thermally decomposed by boiling or under high pressure (Fernandez-Garcia et.al, 2007). Mainly used for ferrite and their corresponding composites (Shaikh et.al, 2020)
4) *Polyol Process:* In this method a glycol solvent like ethylene glycol is used (Chugh et.al, 2021) and upon several hours of heating is needed to synthesize NPs. Semiconductor NPs, Metallic oxides, alloy NPs are synthesized using this method (Bensebaa, 2012)
5) *Tollen's Method:* This method is easy where there is usage of tollen's reagent $[Ag(NH_3)_2]^+$ , $Ag^+$ as source and as a stabilizing agent for the synthesis of AgNPs (Chugh et.al, 2021). There has also been a hybrid technique that has come up where tollen's method is used in combination with phytochemicals using olive leaf extracts and rosemary leaf extracts to synthesize silver nanoparticles (Abudalo et.al, 2019).

### B. Biological or Green Synthesis

This is also a bottom up approach of synthesis. As chemical synthesis involves usage of chemicals, few of them are hazardous; it was more apt for the usage of biological organisms for the synthesis of nanoparticles for its more natural and has become more attractive than other traditional methods.

There are two ways in this synthesis:

1) *Extra Cellular Synthesis:* Where the process of synthesis takes place outside the living cells. Cell biomass filtrate synthesis of NPs (Hamida et.al, 2021) cell-free, culture medium based synthesis of NPs.
2) *Intracellular Synthesis:* Mainly the production of NPs is inside the living cell as to the counterpart synthesis. This is more complicated than the former synthesis as there can be errors or complications during this method but both are eco-friendly ways.
3) *Green Synthesis System:* This involves the usage of the pigments, proteins, lipids, carbohydrates etc; for the NPs production. Eg; pigments like C-phycoerythrin, carotenoid etc; are used in the NPs production (Hamida et.al, 2021).

### C. Living Organisms for NPs Synthesis

This involves using plants, fungi, bacteria, viruses (Kapoor et.al, 2021), lichens (Hamida et.al, 2021), actinomycetes, diatoms etc; for NPs synthesis.

The nanoparticles synthesized for these beings will possess the same property as the chemical or physically synthesized ones like AMA, antioxidants and for characterization UV visible spectroscopy, Fourier transform infrared spectroscopy, X-ray diffraction etc; are used (Baran et.al, 2021) e.g.; Using virus, the quantum dots can be produced, this is used in DNA engineering & in pharmaceutal industry, and marine microbes like *Oscillatoriawillei* are utilized for inorganic nanoparticle production (Kapoor et.al, 2021).

## IV. EFFECTS OF NANOPARTICLES

The types and synthesis of nanoparticles can lead us into the next section of the review, regarding their effects that they can cause to the environment, human beings and microorganisms.

The first thing to be considered is the source of nanoparticles. They can be stationary sources like coal, oil, and gas fired stationary combustion sources (Biswas et.al, 2005), mobile emissions like diesel, LPG, CNG Vehicles, occupational setting like industrial processes, cleaning, disposal etc.

### *A. Effects on Human Health*

These nanoparticles can get deposited in respiratory regions for e.g., Fine PM2.5 (Particulate Matter 2.5) particles leading to fatal respiratory problems. (Biswas et.al, 2005), Airborne nanoparticles have high mobility leading to their deposition in the alveolar tissue causing adverse effects, like chronic bronchitis, the NPs like TiO2 can also induce aging (Wu et al, 2009), Translocation occurs at the interstitial sites in the olfactory pathways and HT29 (Human colorectal adenocarcinoma) cells had reduced viability due to AuNPs. (Sani et al, 2021)

### *B. Effects on Environment*

The nanoparticles can get released into the environment from industries, waste management or from the other sources mentioned above.

They can get accumulated in the soil disrupting the soil enzymes like nitrate reductase, β- galactosidase etc. The research also revealed that NPs oxidation lead to the ROS production in living cells.

There have toxic influences on plant physiology like lowering of transpiration rate, decline in the growth and development of the zooplanktons and phytoplankton (Khanna et al, 2021).

### *C. Effects on Microorganisms*

NPs have shown negative effects on the pure cultures of *E.coli, Bacillus subtilis* etc. (Khanna et al, 2021). There has been cell wall damage in *S.cerevisiae* due to the exposure of ZnO NPs (Soares et.al, 2021), there was even loss of membrane integrity and apoptic cell death. CuO and $Fe_3O_4$ showed negative impact on soil microbial population in the exposed soil region (Khanna et.al, 2021). The ZnO and Ag NPs inhibit the natural gut microflora (Yoo et.al, 2021).

There are not all harmful outcomes of NPs, they have helped mankind and there have been a lot of developments in the technology and strategies like material substitution, sensor detection, process emission control etc; to overcome the above-mentioned problems. There are devices or instrumentation to collect these NPs like Thermophoretic collection, Electrostatic collection, filtration etc. (Biswas et.al, 2005).

### *D. Nanotools*

To recognize and understand the data we have in this field various tools and software. There have been various algorithms like GTDWFE that is used for prediction; PARGT is a software that was created using R software and Python (Nahvi et.al, 2022). This helped in learning the potentiality of chemotherapy with nanotechnology efficacy.

There has been utilization of bacteriophages and whole virions for pathogenic bacterial detection for biosensors have been used as the nanotools for diagnostics e.g., when T4 phage was seen successfully oriented on to the Au surface (biosensor) (Richter et.al, 2018) (Paczesny et.al, 2020) (Agnihotri et.al, 2022).

There are even tools that is previously mentioned for characterization of the nanoparticles like UV-spectroscopy, TEM, SEM, AFM, for the production of biofuel and bioenergy and numerous other fields (Nalluri et.al, 2021) and there are a few lithography and fabrication systems as well (Tinker, 2004).

*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 10 Issue X Oct 2022- Available at www.ijraset.com*

## V. APPLICATIONS AND RECENT UPDATES IN NANOTECHNOLOGY

There are numerous latest applications in this field that are generating and being found every single day in numerous fields.

### A. *Medicine*

1) Using *Proteusmirabilis* which is a gram-negative bacterium, the silver nanoparticles synthesized from them are being used in treatment of burn infections induced by bacteria like *Klebsiellapneumoniae, Staphylococcusaureus* etc. (Yasr et.al, 2022).
2) Chitosan nanoparticles have proved to have good pharmaceutical properties and also help in stimulation of interferon synthesis by macrophages to act against antiviral infections (Boroumand et.al, 2021).
3) *Hemophilusinfluenzae* that causes numerous diseases and infections like septicemia, cellulitis, and meningitis can be detected much early without time consuming by loop mediated isothermal amplification associated with nanoparticle-based lateral flow biosensor assay (Cao et.al, 2022).
4) Rapid detection of Brucellosis infection by biosensors with functionalized nanoparticles i.e., Nano biosensors have been promising (Ahangari et.al, 2021).
5) Copper oxide NPs synthesized from *Streptomyces* sp MHM38 has proven effective against Paracetamol - induced liver and kidney damage and against Paracetamol-induced oxidative stress (Bukhari et.al, 2021).

### B. *Agriculture*

Metal Nanoparticle products obtained by green synthesis approach like Nano fertilizers, Nano pesticides, Nano fungicides have shown increase in the productivity of yield (Bahrulolum et.al, 2021).

### C. *Industrial Applications*

1) Super paramagnetic iron oxide nanoparticles synthesized by precipitation have been useful in drug delivery, magnetic imaging and many more.
2) With the soluble nanoparticles and the robust template methods they have been beneficial in fuel cells and multiphase systems (Stark et.al, 2012) and solar panels (Mughal et.al, 2021).
3) Organic nanoparticles (lipid, liposomes etc) are helpful in xenobiotics, essential oils production (Kutawa et.al, 2021).
4) Carbon nanoparticles in the orthopedic implants, atomic force microscopes probe (Kutawa et.al, 2021).

### D. *Miscellaneous*

1) Antimicrobial activity: Biosynthesis of Copper NPs using a psychrophilic marine bacterium has shown AMA (antimicrobial activity) according to the studies (John et.al, 2021) proven beneficial to biomedical science. Copper NPs have shown similar AMA property synthesized from ginger roots (Abbas et.al, 2022) against *E.coli* and *S.aureus.* Similarly Silver NPs from *Lactobacillus gasseri* bacteria (Jabbar et.al, 2021).
2) There has been a study showing micropolar fluid having nanoparticles in coalesce with gyrotactic microorganisms of microelements to understand the dynamics of hydromagnetic flow of the micropolar fluid which is beneficial in microbial enhanced oil recovery by bioconvection (Koriko et.al, 2022).
3) Silver and Copper NPs have shown a positive consequence in inhibiting biofilm formation by the Mastitis pathogens. (Lange et.al, 2021) (Hussein et.al, 2021).

There are a few companies like Alnis Bioscience, Inc., BASF, Immunicon, Nanosphere, Inc.,NanoPharm AG that commercializes nanomaterials for bio and medical applications (Salata, 2004).

## VI. CONCLUSION

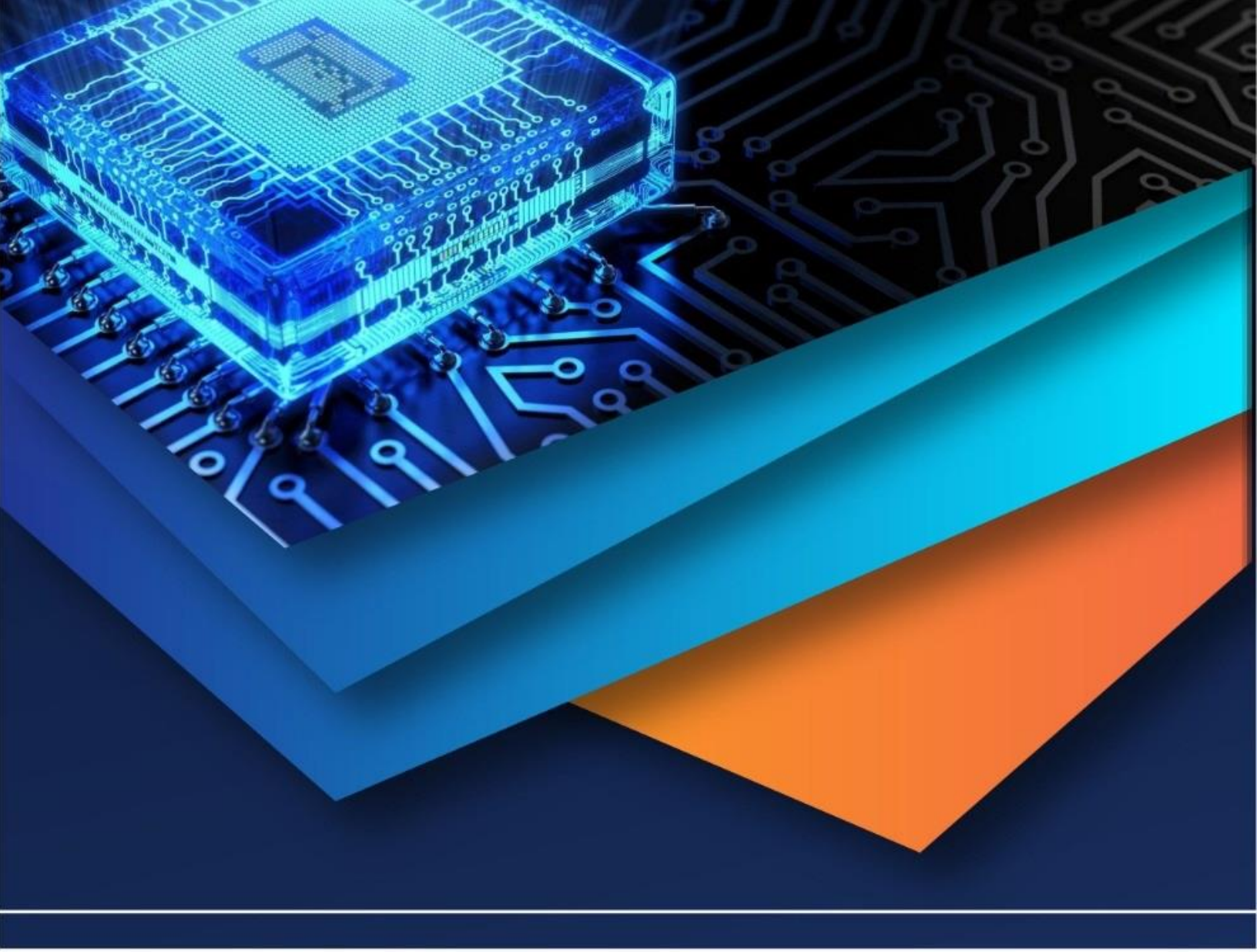
Even though Nanotechnology requires high intricate methods and proficient skills to handle and work with, their evolving applications in heterogenous fields are worth the effort, but their risks should also to be kept in mind while using them. Although the availability of raw products to produce the NPs are many, their processing and commercializing will take time and is not a layman's forte. Their types, synthesis, effects of NPs, tools and software used, applications can be a holistic view in comprehending them for universal betterment with minimal consequences.

## REFERENCES

[1] Adel H A and Nada Y F. "Characterization, Biosynthesis of copper nanoparticles using ginger roots extracts and nvesting of its antimicrobial activity." Elsevier (2 November 2021): Procedings 61 908-913.
[2] Adulaziz B K, et al. "Trends in Nanotechnology and its potentialities to control plant pathogenic fungi." MDPI Biology (2021): 05-13.
[3] Agata L, et al. "Silver and Copper Nanoparticles Inhibit Biofilm Formation by Mastitis Pathogens." MDPI Animals (24 June 2021).
[4] Ahmed A Y and Syoof K A. "The use of silver nanoparticles synthesized by Proteus mirabilis in treating of induced bacterial burn infections." International Journal of Health Sciences (18 May 2022): 6 (S1) 11977 and 11982.
[5] Alagar M and Theivasanthi T. "Studies of Copper Nanoparticles effects on MIcroorganisms." arXiv Physics (2011).
[6] Ami Y, Mengshi L and Azlin M. "Zinc Oxide and Silver Nanoparticle Effects on Intestinal Bacteria." MDPI Materials (12 May 2021).
[7] Anees A A, Vijay K T and Guanying C. "Functional upconversion Nanoparticles: New strategy towards FRET- based luminescence bio-sensing." (19 January 2021): 1,6,11.
[8] Archer A C and Sulthana R. "Bacteriocin nanoconjugates: boon to medical and food industry 131, 1056-1071." Journal of Applied Microbiology (2020): 1056-1065.
[9] Ayesha K, et al. "A Chemical reduction approach to the synthesis of Copper nanoparticles." Springer (9 November 2015): 01-02.
[10] Azam A, Pezhaman M and Abdolmajid M. "Biosensors functionalized with nanoparticles for Rapid detection of Brucella." Authorea (4 May 2021).
[11] Bilal M, et al. "Biogenic Nanoparticles: Synthesis, Characterisation and Applications." MDPI Applied Sciences (15 March 2021): 03-11.
[12] Deeksha C, Vishwamalya V S and Bannhi D. "Green Synthesis of Silver nanoparticles with Algae and the importance of capping agents in the process." Journal of Genetic Engineering and Biotechnology ((2021) 19:126): 03-06.
[13] Edna G, et al. "Immunomodulatory effect of mycobacterial outer membrane vesicles coated nanoparticles." Elsevier (2022).
[14] Guan Y I, et al. "Pathological Comparison of Rat Pulmonary Models Induced by Silica Nanoparticles and Indium-Tin Oxide Nanoparticles." International Journal of Nanomedicine (15 September 2022).
[15] Hasan and Saba. "A Review on nanoparticles: their synthesis and types." Research Journal of Recent Sciences (2015).
[16] Homa B, et al. "Chitosan-Based nanoparticls against Viral infection." Frontiers in Cellular and Infection Microbiology (17 March 2021).
[17] Howra B, et al. "Green Synthesis of metal nanoparticles using microorganisms and their application in the agrifood sector." Journal of Nanotechnology 19:86 ((2021)): 05 & 14.
[18] Insha N, Irum N and Suriya R. "Nanotechnology and Multidrug Resistance." Springer Nanotechnology for Infectious Diseases (2022).
[19] Irvani S, et al. "Synthesis of Silver Nanoparticles: Chemical, Physical, Biological method. 9(6) 385-406." Research in Pharmaceutical Sciences (October 2013): 385-386.
[20] Jainhong W, et al. "Toxicity and Penetration of TiO2 nanoparticles in Hairless mice and porcine sin after subchronic dermal exposure." Elsevier Journals (December 2009).
[21] Jyoti C, et al. "Synthesis and Biological function of Nickel and Copper Nanoparticles." Elsevier (29 May 2019): 01 & 04.
[22] Khlebtsov N G and Dykman L A. "Gold nanoparticles in biology and medicine: Recent advances and prospects." Acta Naturae (21 February 2011).
[23] Knika K, et al. "Enthralling the impact of Enginered nanoparticles on soil microbiome: A concentric approach towards environmental risks and cogitation 112459." Elsevier (23 June 2021): 03-11.
[24] Maria S J, et al. "Biogenic Synthesis of Copper Nanoparticles Using Bacterial Strains Isolated from an Antartic Consortium Associated to a Psychrophilic Marine Ciliate: Characterization and Potential Application as Antimicrobial Agents." MDPI Marine Drugs (8 May 2021).
[25] Mariana M H and Vilagran D. "Mesoporous composite nanoparticles for dye removal and other applications." Elsevier (January 2019).
[26] Mehmet F B, et al. "Environmentally Friendly Rapid Synthesis of Gold Nanoparticles from Artemisia absinthium Plant Extract and Application of Antimicrobial activities 11(1)." Journal of the Institute of Science and Technology (2021): 365-375, 366.
[27] Menamparambath, Rasha R P and Mini M. "Soft-Template-assisted synthesis: a promising approach for the fabrication of transition metal oxides." Nanosacle Advances (2020).
[28] Muna A A, et al. "Synthesis of Silver Nanoparticles using a Modified Tollen's method in conjunction with phytochemicals and assessment of their antimicrobial activity." PeerJ (2019).
[29] Murali S, et al. "Biosynthesis of Metal nanoparticles using Fungi and Actinomycete VOL 85. NO.2." Current Science (25 July 2003): 165.
[30] Namar A, et al. "Synthesis of Nanoparticles using various top-down and bottom-up approaches, influencing factors, advantages and disadvantages 102597." Elsevier (29 December 2021): 4, 12, 14.
[31] Nehia N H and Mina M K. "Evaluation of the Biosynthesized Silver Nanoparticles Effects on Biofilm formation VOL 1. NO.1." Journal of Applied Sciences and Nanotechnology (24 April 2021).
[32] Olubode K K, et al. "Insight into dynamics of hydromagnetic flow of micropolar fluid containing nanoparticles an gyrotactic microorganisms at weak and strong concentrations of microelements: Homotopy Analysis Method, 12, 267-282." American Journal of Computational Mathematics (28 June 2022): 267-268.
[33] Pandya, Ansari R and Trupti. "Biosynthesis of silver nanoparticles from bacteria and its application." International Journal of Research in Engineering and Science (2022): Volume 10 issue 6 1508,1510, 1511,1516.
[34] Pankaj K T, et al. "Synthesis of Silver and Gold Nanoparticles: Chemical and Green Synthesis Method and its Toxicity Evaluation against Pathogenic Bacteria Using the Toxtrak Test." Journal of Nanomaterials (30 December 2021): 01-02.
[35] Pratim B and Chang Y W. "Nanoparticles and the Environment." Journal of the Air and Waste Management Association (2005).
[36] Qilong C, et al. "Detection of Haemophilus influenzae by loop- mediated isothermal amplification coupled with nanoparticle-based lateral flow biosensor assay 22:123." BMC Microbiology (2022).
[37] Raghad A J and Nehia N H. "Evaluation the Antibacterial Activity of Biosynthesis Silver Nanoparticles by Lactobacillus Gasseri Bacteria VOL.1, NO.3." Journal of Applied Sciences and Nanotechnology (15 September 2021).
[38] Raham S H, et al. "Lichens- A Potential Source for Nanoparticles Fabrication: A Review on Nanoparticles biosynthesis and their Prospective Applictaions." MDPI Journal of Fungi (12 April 2021): 05-13.

[39] Rishi R K, et al. "Thermo-solutal Marangoni impact on bioconvention in suspension of Gyrotactic microorganisms over an inclined stretching sheet." ASME Journal of Heat Transfer (2021).
[40] Riti T, et al. "Exploration of Microbial Fcatories for Synthesis of Nanoparticles - A Sustainable Approach for Bioremediation of Environmental Contaminants." Frontier in Microbiology (04 June 2021): 04-08.
[41] Rodriguez, Marcos F G and Jose A. "Metal oxide nanoparticles." Nanoparticles : Inorganoic and Bioinorganic Perspectives (October 2007).
[42] Salata O V. "Applications of Nanoparticles in Biology and Medicine." Journal of Nanotechnology (30 April 2004): 04.
[43] Sani A, Cao C and Cui D. "Toxicity of Gold particles (AuNPs): A Review." Elsevier (2021): 03-05.
[44] Sanni M A F, et al. "Fluorescent nanoparticles as tools in ecology and physiology 96,pp.2392-2424." Biological Reviews (2021): 2394-2397.
[45] Sarah I B, et al. "Biosynthesis of copper oxide nanoparticles using Streptomyces MHM38 and its biological applications." Journal of Nanomaterials (18 December 2021).
[46] Sen S and Vithiya K. "Biosynthesis of Nanoparticles volume 2 (11) 2781-2785." International Journal of Pharmaceutical Sciences and Research (25 October 2011): 2783-2784.
[47] Shoyebmohamad F S, et al. "Types, Synthesis, Methods and applications of ferrites." Elsevier (2020).
[48] Soarea V M, Eduardo V S and Helena M. "Harmful Effects of Metal(loid) oxide nanoparticles." Springer Applied Microbiology and Biotechnology ((2021) 105): 1381-1388.
[49] Stark W J, et al. "Industrial Applications of Nanoparticles." Chemical Society Reviews (30 October 2014).
[50] Sudip D k, et al. "Green and Sustainable Synthesis of Silica nanoparticles 6:29." Springer Nanotechnology for Environmental Engineering (26 May 2021): 01-02.
[51] Theivasanthi T. "Studies of Silver nanoparticles effects on micro-organisms." Annals of Biolocal Research (2011).
[52] Tinker and Nathan. "Tools and Instrumentation for Nanotechnology." Market and INdustry Analyses Reports. 2004.
[53] Wided N M, Robert D A and Brain S C. "Safe Nanoparticles: Are we there yet?" MDPI International Journal of Molecular Sciences (2021).



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY