Role of Nanotechnology in Iraq (Synthesis and Characterization): A Review

N. A. Thamer
Department of Dental Technical, College of Medical Technical, Al-Farahidi University, Al-Jadriyah Bridge, Baghdad, IRAQ

Corresponding Author: neran1958@yahoo.com

ABSTRACT
Nanotechnology has become the focus of attention in all basic sciences such as physics, chemistry, biology and others. It concerned with particle size range from 1-100 nanometer. In this review they give a brief description about Nanotechnology in Iraq, Types of synthesis, study the characterization and its application in various fields viz. medicine, industry, agriculture, electronic and in the oil field.

Keywords: Nanotechnology, Characterization, Synthesis, Metal nanoparticles.

I. INTRODUCTION
Nano science that science studies the molecules and compounds which size less than 100 nm. (1). The size of these materials can influence differ significantly properties (optical, electrical and magnetic) when compared with the same bulk materials. These unique features depended on shape, particle size, and high ratio of (surface/volume). In 1959, Richard Feynman wondered what would scientists do if they can control the movement of one atom and rearrange them, as they want. This was the beginning of the nano revolution (2). In 2009 despite all the circumstances, Iraq has managed to establish the first nanotechnology center at the University of Technology. To be the starting point in the field of this science. The center was supported by the Iraqi government. The Nanotechnology Center has directed its research activities towards the necessary needs of Iraqi institutions that have found the science of nanotechnology a useful and effective tool for solving scientific problems and developing research potential (3). In this review, we will study different methods of nanoparticles synthesis, characterizations, and application in different fields. This overview particularly depending on Iraqi Academic Scientific Journals.

II. CLASSIFICATION OF NANOPARTICLES
In general, the nanomaterials vary in source and according to their proportions, such as materials organic or inorganic, natural or synthetic (4). The development of nanotechnology has changed the medical rules used to prevent and diagnose diseases, treatment of cancer, to improve the industrial applications such as in the field of energy, electronics and water treatment (6).

Synthesis of nanoparticles
There are two general methods of producing nanomaterials first, starting from bulk materials then breaking or minimizing them until they reach very small pieces (of nanoscale) using mechanical or chemical methods. This method called top-down process. (5). In contrast, there is the bottom to top method which starting from atoms or molecules to be separated from each other and then aggregated to the nanoscale using chemical reactions or by the exchange of materials (6). Bottom-up method is better than top-down process to synthesize very-small sized particles because it has the possibility of obtaining a uniform size, shape and structure (7). Different methods are used for preparing, depending on building of atoms to get the results wanted. Chemical methods depend on the process of metal reduction such as, sol-gel, hydrothermal, co-precipitation, reduction method, electrochemical, inverse reduction, vapor deposition, and spray pyrolysis. These methods are required high temperature pressure, toxic solvents and non-ecofriendly methods. In physical methods different processes are using to synthesis of nanoparticles such as pulsed laser ablation, arc discharge, and micro wave assisted process. Therefore, the need for clean and environmentally friendly alternative methods has emerged. The use of material like plant extract (leave, bark, peels etc) and microorganism show eco-friendliness, simple, rapid, non-toxic and dependable methods (7-9). Table 1 shows some physical, chemical and biological methods used for synthesis of different types of metal nanoparticles which are used to produce nanoparticles in scientific researches inside Iraq.
### Table 1: Some important physical, chemical and biological methods for synthesizing of metal nanoparticles.

| Metal Nanoparticle | Physical Methods | Chemical Methods | Biological Methods | References |
|--------------------|-----------------|------------------|--------------------|------------|
| Silver             | Pulsed laser ablation |                |                    | 12         |
|                    | Pulsed laser ablation |                |                    | 13         |
|                    | Pulsed laser ablation | cinnamon zeylanicum(bark) |                  | 15         |
|                    | Pulsed laser ablation | Olive leaves |                    | 16         |
|                    | Pulsed laser ablation | PLEUROTUSOSTREATUS fungus |                 | 17         |
|                    | Reduction methods |                |                    | 20         |
|                    | Reduction methods |                |                    | 22         |
|                    | Pulsed laser ablation | Lactobacillus spp(bacteria) |              | 23         |
|                    | Pulsed laser ablation | Malvaparviflora leaves |                | 24         |
| Sol-gel            | Reduction methods | Eucalyptus Bicolor bark |                | 26         |
|                    | Reduction method |                |                    | 27         |
|                    | Arc discharge | Electrochemical |                | 28         |
|                    | Arc discharge | Banana peel extract |                | 29         |
|                    | Arc discharge | Teucrium polium (aerial part) |              | 30         |
|                    | Arc discharge | Trichoderma harzianum(fungus) |          | 31         |
|                    | Arc discharge | Aspergillus niger(fungus) |                | 32         |
| Zinc Oxide         | Pulsed laser ablation | Sol-gel |                | 33         |
|                    | Co-precipitation |                |                    | 34         |
|                    | Hydrothermal |                |                    | 35         |
|                    | Pulsed laser ablation | Sol-gel |                | 36         |
| Gold               | Pulsed laser ablation | Inverse-reduction | Orchid and Gum Arabic | 37         |
|                    | Pulsed laser ablation | Spray pyrolysis |                | 38         |
| Iron Oxide         | Microwave irradiation |                |                    | 39         |
|                    | Co-precipitation | Lactobacillus rhamnosus |                | 40         |
|                    | Lactobacillus rhamnosus | Lemon |                | 41         |
| Carbon             | Arc-discharge | vapor deposition |                | 42         |
|                    | Pulsed laser ablation |                |                    | 43         |
|                    | Pulsed laser ablation |                |                    | 44         |
|                    | Pulsed laser ablation |                |                    | 45         |

### III. DESCRIPTION TECHNIQUES

Different techniques were used to study the nanoparticles of the prepared materials. Some of these techniques are Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM) Transmission Electron Microscopy (TEM), Atomic Force Microscope (AFM) and UV-Visible spectrophotometer.

**Fourier Transform IR Spectroscopy:**

Fourier Transform Infrared Spectroscopy (FTIR) is an important technique to study and understand...
nanoparticle surfaces. This technique is used to determine the effective groups aggregates on the surface of nanoparticles by measuring the vibrational frequencies of chemical bonds. An example the FTIR spectrum of zinc oxide nanostructures are shown in figure (1). Bands of 417, 437, and 740 cm$^{-1}$ spectra of ZnO and 1540.1, 1492.9, 1357, 1043.49, 833.25 a companion with expansion oscillation of crystalline hexagonal ZnO expansion vacillation (44). Another example figure (2) shows the FT-IR spectrum of the prepared Fe$_3$O$_4$ coated with oleic acid (OA). The two new bands at 1639 and 1541 cm$^{-1}$ were assigned to the asymmetric (COO$^-$) and symmetric (COO$^-$) stretching vibrations. This indicates that oleic acid has been both physically and coordinatively adsorbed on the surface of magnetite nanoparticles. The absorption peak observed at 584 cm$^{-1}$ identical to the Fe–O stretching vibration related to the magnetic phase (38).

X-ray Diffraction:

X-Ray Diffraction (XRD) is one of the most important techniques in studying the size, shape and arrangement of nanoparticles. The particles size can be determined from the width of the X-ray peaks using the Scherer equation. The diffracted patterns explain whether the sample materials are pure or contain impurities. An example, the XRD pattern of Fe$_3$O$_4$ nanoparticles obtained using solve-hydrothermal reaction assisted by microwave irradiation method showed five main diffraction peaks were observed at 2$\Theta$ =30°, 35.6°, 43.3°, 54°, 57.1°, correspond respectively to the planes (220, 311, 400, 422, and 511 respectively) of Fe$_3$O$_4$ nanostructures figure (3). The calculated crystal average size is (25.5) nm (38). Another example figure (4) the diffraction peaks of gold NPs gold observed at 38.14°, 44.06°, 64.92° and 77.7°, representing the index as (111), (200), (220) and (311), respectively, which verified the polycrystalline face-centered cubic structure (21).
Scanning electron microscopy:

It is another technique giving structural examination with two-dimension imagination. It has the ability to analyze different sizes of nanoparticles, size distributions, shapes, and the surface morphology of the synthesized particles at the micro scales. So that SEM may offer, better performance for surface and shape for nanoparticles analysis. Figure 5 shows the SEM images of the prepared AgNPs at different reaction temperatures. Figure 5 (a) citrate-AgNPs have prepared by 0.005M of AgNO₃ reduction at T=100°C for 2h. It was observed that the particles with a size ranging from (80.7 to 413.2) nm with mean average of 202 nm. From Figure5 (b) it has noted that the agglomerations of nanoparticles have the biggest. Figure 5 (c) shows SEM micrograph at temperature 200°C for 2h with the same concentration silver nitrate. The image observed spherical and irregular particles with a size ranging from 22.3 to 99.5 nm (20). Another example figure (6) shows SEM micrograph with different enlargement Fe₃O₄. It is obvious from the shapes that there are dense chips of particles that appear irregularly and gather irregular particles to form a large part of them. There are other smaller ones with irregular sizes shown by the image that there is agglomerate. The shape of the nanoparticles was either spherical or semi-spherical or possessed other forms (45).

Transmission Electron Microscopy (TEM):

Transmission Electron Microscopy is one of the methods that used to determine nanomaterials size, distribution and morphology. Particles as small as a few angstroms (10–10⁻¹⁰ m), which is near atomic levels can be viewed in TEM. Figure 7 display the size of the gold nanoparticle was 44 nm with different particles formats (clusters, spherical, branched chain) and the average size between (20 - 50) nm (47). Another example figure (8) shows TEM image colloidal silver nanoparticles prepared by electrochemical method. Average size of the particles is (a) (10-12) nm (b) 15 nm, (c) (15-20) nm, (d) (30-44) nm. (31).
Atomic Force Microscope (AFM):

It is another technique used to image the surface of nanoparticles on a nm and to measure surface forces. The surface is scanned according to the force between tip of sample and the vibration to study the surface characteristics of the sample. Figure 9 shows an example of AuNPs which have grossness surface large particles diameter distribution and the mean particle size was (68 nm) (47). Another example Figure 10 shows the 2D and 3D AFM images of zinc oxide colloidal NPs. The micrographs obviously show that zinc oxide nanoparticles have spherical shape and grain size in the range of (5-39 nm) in diameter. A root mean square (RMS) roughness of nanoparticles was 2.97 nm with average size 24.6 nm (25).

![AFM image of GNPs 2D, 3D by using orchid as reducing agent (Ref. 47)](image1)

![2D and 3D AFM images of ZnONPs using laser ablation (25)](image2)

UV-Vis Spectroscopy:

In particular, metal such as noble metals Plasmon resonance is an optical property of the nanoparticles. This SPR peak is shown in UV absorption spectra. The magnitude of peak, wavelength and spectral bandwidth associated with nanoparticles are dependent on size, shape and material composition (54). Due to Mie, theory one band of SPR means spherical metal nanoparticles (55). For example, figure (11) three UV–Vis spectra for AuNPs were piloted in different time intervals and observed that the color changed (no color-yellow-ruby red) of the gold nanoparticles with a time. The peaks shifted not much with time from (552.50 nm) to (550.00 nm) with increase in absorbance from (0.694) to (1.490) were revealed a linked point between the more reduction reaction and formation nanoparticles (56). The figure(12) has shown the UV–vis spectra of silver nanoparticles recorded at temperature of 100-200°C. The absorbance band was broadened and positioned at 442.28, 423.5 nm and 421.41 nm at the temperature of 100 C, 150 C and 200 C, respectively for showing that silver nanoparticles have produced at a low temperature. By temperature increasing, the strongest absorption bands gradually shift to a higher wavelength. Then, it has concluded that the nanoparticles size has decreased with increasing of reaction temperature(22).
The characteristics of silver nanoparticles in the body recognize and attack it. Enzyme activity increased by increasing... sperm in male albino mice testes, showed therapies are not effective, silver and silver nanoparticles in infections in bacteria diseases(65). The preparation of drugs used against different type of activity and for that reason it has get a great probability when compared with the basic materials.

Silver nanoparticles (AgNPs):

Many studies have begun to investigate their therapeutic efficacy as inhibitors for the growth of parasitic pathogens, fungal pathogens, and bacteria pathogens. Silver nanoparticles showed anti-parasitic activity against E. histolytica trophozoite where it causes millions of cases of dysentery and liver abscess each year. In Iraq the Cutaneous leishmaniasis (CL) is the most widespread disease in Iraq. Macrophages are the main inhabitant cell for Leishmania; they phagocyte and allow parasite multiplying. To elimination, the effect of Leishmania parasites phagocytosis is the main factor. Ag NPs has the ability to activate the macrophages and enhanced inhibitory effects on L. tropica promastigotes and amastigotes in vitro following the infection after 48 hrs. of treatments (63). The powerful bioactivity of Ag NPs leads towards the clinical use as antifungal(35,64).

Silver nanoparticles showed high antibacterial activity and for that reason it has get a great probability in the preparation of drugs used against different type of bacteria diseases(65). The increasing of acquired infections in hospital and community, present antibiotic therapies are not effective, silver and silver nanoparticles showed strong effect against microbial (66-73).

Silver nanoparticles effect on the weights of the testes, epididymides and effect on the characteristics of sperm in male albino mice (74). It also observed histological change on the ovary of female albino mice (75). Histological change on liver of Coturnix coturni after exposure to different concentration of silver nanoparticles (76). Silver nanoparticles had positive effect in enhance burn healing when it’s applied locally (77).

The central nervous system is the most important system; it includes brain and spinal cord. It is very sensitive to any accidental infection during ontogenesis. The cerebellum is the second largest part of the brain after cerebrum and it’s very sensitive to the abnormal changes during the embryological development. Silver nanoparticles at concentration range (2-20) mg/kg/day can produce many histological toxicities to the embryo’s hindbrain and cerebellum when administrated to the dams during pregnancy period (78).

Silver nanoparticles have a significant effect on increasing the activity of lymphocytes, cytokines levels in mice. IgG concentration and phagocytes. It can be used as an effective adjuvant to improve the immune protection (79).

Acid phosphatase enzymes has been used in the detection of prostatic carcinoma. The activity of enzyme decreases by using nanoparticles like silver and gold. The inhibition of enzyme activity increased by increasing nanoparticles concentration (80).

Nanoparticles genotoxicity is a subject have got a great attention as a result of wide application of nanotechnology in many sections which in contact with human health. The genotoxicity of silver nanoparticles in the treated animals showed that the spleen cells were the less DNA damaged cells while the lymphocytes and bone marrow cells more effective manner (81).

In multiple myeloma plasma cells fight the germs by making antibodies that recognize and attack it. By using silver nanoparticles the phagocyte of cells increase which indicate that nanoparticles of silver do something like immune modulators and then the process of ingesting bacteria increases (82).

Shape of nanoparticles:

Several shapes of nanoparticles were synthesized such as spherical (57), Quantum Dots (58), thin films (59), nanoporous (60), nanowires (61) and nanotube (52, 53).

IV. APPLICATION OF NANOPARTICLES

Nanoparticles have much consideration to researchers in the field of medicine, agriculture, electronic, and industry due to their optical, physical and chemical properties gained when compared with the basic materials.
AgNPs act as an anti-oxidant factor by inhibition the formation of free radicals and scavenging all species of (ROS) from the irradiation water samples in certain range of concentration of Ag NPs (83).

**Gold nanoparticles (AuNPs):**

AuNPs have certain to be strong tools in various nanomedicine applications such as in drug delivery, diagnosis and therapeutics. AuNPs promoting radiotherapy treatment of ovary cancer cells (84) and brain cancer (85).

Colloidal Au and Ag nanoparticles interact with functional groups of GGT enzyme, resulting in protein denaturation and inactivate it. Gold nanoparticles was more interact with enzyme and inhibited it than silver nanoparticles, so that using of gold nanoparticles for detection and therapy of cancer is better than silver nanoparticles (86).

**Zinc oxidenanoparticles (ZnONPs):**

Zinc oxide nanoparticles ZnO showed the ability toward Mice Mammary Adenocarcinoma cancer cells, this toxicity correlated directly with ZnO nanoparticles concentrations. This toxicity correlated directly with ZnO nanoparticles elevated concentrations (87).

One of the most important challenges to treating diseases is the appereance of new strains that are resistant to antibiotics. ZnONPs combination with some antibiotics showed interactive and hostile effect for different bacterial isolate (32). Zinc oxide Nanoparticles was synthesized to act as antifungal agents to overcome the developed of fungi resistance to many conventional fungicides (33).

Zinc oxide nanoparticles were used to reduce acidity and maintain soil temperature (88).

**Carbon nanoparticles:**

In electronics, the Nano electronic device, which is formed from carbon nano tube, proved that it is better than ordinary devices. These Nano devices have some advantages compared to complementary metal oxide semiconductor transistors for example higher ability to move electrons, smaller size, and lower power consumption (89).

To increase drilling efficiency, multi wall carbon nanotube and silicon oxide nanoparticles were used in drilling fluids to make drilling smooth and efficient. Nano particles can work to activate other characteristics of drilling fluids, like viscosity, gel strength, filter loss control, and friction reduction (90).

**Aluminum oxide nanoparticles (AL2O3NPs)**

The nanoparticle shows a good catalyst when blended with fuel diesel. Nanoparticles of AL2O3 increase the surface to volume ratio and increase the calorific value, that’s leading to reduction in ignition delay and extra completely combustion so blended diesel fuel with nanoparticles of AL2O3 show reduction in Brake Specific Fuel Consumption (BSFC) and enhancement in thermal efficiency and when increase the ratio of nanoparticle shows more reduction in BSFC and thermal efficiency (91).

Steel structures are exposed to external erosion due to soil components. The repair of defects in the structures was repaired by using alumina nanomaterials, which prolonged the life of the carbon steel structures when compared to the use of red paint as an anti-corrosion (92).

AL2O3 nanoparticles and polypropylene fiber were used to get better properties of denture base material such as roughness and hardness of the surface, thermal properties and Power of influence (93).

**Iron oxide nanoparticles (Fe3O4NPs)**

Fe3O4 nanoparticles could be considered as promising killing agents in antimicrobials system. Also, biosynthesis of iron oxide nanoparticles had antibacterial effect against some pathogenic bacteria (94,95).

Nanotechnology for cancer had get a great attention for diagnosis, treatment, and monitoring the different type of cancer. Iron oxide nanoparticles induced cell cytotoxicity at all concentration when exposed to (Hela, RD and AMN3) cancer cell lines against REF normal cell line. Dose dependent effects of iron oxide nanoparticles have been confirmed with different cell types (96).

Corrosion processes are responsible for severe losses in the oil industry. Although organic and inorganic materials and mixed materials inhibitors have been used for a long time to control or reduce corrosion. Nano materials are good corrosion inhibitors because they have many advantages such as high efficiency of inhibition, low cost, minimum toxicity and effortless production. Zinc and nickel ferrite nano materials (ZnFe2O4, Zn0.6Ni0.4Fe2O4) have been act an efficient corrosion inhibitors of carbon steel in local Iraqi bentonite mud as a source of the corrosion (97).

**REFERENCES**

[1] Gondwal M., and Pant G J N. (2013). Biological evaluation and green synthesis of silver nanoparticles using aqueous extract of calotropis procera. Int J Pharm Bio Sci. 4 (4):635–643.

[2] Feynman, Richard P.(1959). Plenty of room at the bottom. California institute of technology Archives.

[3] Journal of Economic and Administrative Sciences (2016), 92 (22): 400–414

[4] Kumari AB., and Sobha K.(2013).Nanobiotechnology as a prospective approach for safe enviromental remediation- a review”.Int J Pharm Bio Sci. 4(4):69-95.

[5] Bigall NC., and Eychmuller A.(2010). Synthesis of noble metal nanoparticles and their non-ordered superstructures”. Phil. Trans. R. Soc. A. 368:1385–1404.

[6] Xu Z, P,Z.Q.P., Lu G Q. andYu A B. (2006).Inorganic nanoparticles as carriers for efficient cellular delivery. Chem Eng Sci. 61:1027-1040.

[7] R. F. Pease, and S. Y. Chou.(2008). Lithography and other patterning techniques for future electronics,” Proceedings of the IEEE 96,248
[8] L. Grill, M. Dyer, L. Lafferentz, M. Persson, M. V. Peters and S. Hecht.(2007). Nano-architectures by covalent assembly of molecular building blocks. Nature Nanotechnology 2: 687 – 691.

[9] Colvin VL, Schlamp MC, Alivisatos A.(1994). Light emitting diodes made from cadmium selenide nanocrystals and a semiconducting polymer. Nature. 370:354–357

[10] Wang Y, Herron N.(1991). Nanometer-sized semiconductor clusters: materials synthesis, quantum size effects, and photophysical properties. J Phys Chem.95:525–532.

[11] Schmid G.(1992). Large clusters and colloids. Metals in the embryonic state. Chem Rev. 92:1709–1027.

[12] Amer T. Tawfee.(2014).Diluted concentrations of large (above one hundred nanometer) silver nanoparticles inhibited the growth of different types and origin of cancer cells. Iraqi Journal of Cancer and Medical Genetics .7(1):69-76

[13] Amer T. Tawfeeq.(2013).Pulsed laser ablation synthesized silver nanoparticles induce apoptosis in human glioblastoma cell line and possess minimal defect in mice brains.Iraqi Journal of Biotechnology.12(2):92-106

[14] Amer T. Tawfeeq, Husam Al-Deen Mohammed Kadhim,Nahi Yusif Yseen, Saba K. Kalil.(2015). Targeting Mice Mammary Adenocarcenoma Cells with Zinc Oxide Nanoparticles. Journal of Biotechnology Research Center. 9 (2):14-20.

[15] O. M. S. Ibrahim, A. H. Saliem and S. I. Salih.(2016).Antibacterial activity of silver nanoparticles synthesized by Cinnamom zeylanicum bark extract against Staphylococcus aureus. Al-Anbar J. Vet. Sci. 9 (1):22-36.

[16] Ahmad N. A. Salih, Orooba M.S. Ibrahim, Mohammad J. Ees.(2017).Antibacterial activity of biosynthesized silver nanoparticles against Pseudomonas aeruginosa in vitro. The Iraqi Journal of Veterinary Medicine.41 (1) :60-65.

[17] Rusol, M. Al-Bahrani, Jenan Atiyah Ghafi.(2016). .Evaluation of inhibition activity of silver nanoparticles activity againstpathogenic bacteri.Iraqi Journal of Science. 57.(3C):2203-2220.

[18] Zainab I. Abd-Alwahab, Bassam G. Rasheed.(2015). Antibacterial Silver Nanoparticles produced by Nd:YAG Laser.Al-Nahrain University, College of Engineering Journal. 18 (2):315 - 321.

[19] Zainab A. Wajih, Ziad T. Al-dahan and Ayyad Al shahwan.(2015).Antimicrobial Effects of Silver Nanoparticles Produced by Laser Ablation.Iraqi Journal of Science.56 (3B): 2170-2186.

[20] K.S.Shake, M.A. Muh,M.Sh. Khala,H.L. Mansou (2017).Preparation of Silver Nanoparticles by Chemical Reaction Method at Different Reaction Temperatures and the Study of their Antibacterial Activity.Engineering and Technology Journal. 35 (2).

[21] Falah A-H. Mytlak, Majid S. Jabir, Uday M. Nai, Hind Imad Fadhil.(2017).Synthesis and characterization of Au nanoparticles for nanomedicine application.Iraqi Journal of Physics.15(35):109-116.

[22] Khitam S. Shake(2016).Synthesis and characterizations of silvernanoparticles using chemical reactionmethod.Diyala Journal of EngineeringSciences.Vol. 09, No. 01, pp. 113-120.

[23] Abdulrahman Khalaf Ali, Dayah N. Raouf,(2011).Preparation of Silver Nanoparticles by Pulsed Laser Ablation in Liquid Medium. Eng. & Tech. Journal. 29 , (15).

[24] Jehan Abdul Sattar Salman.(2013).Synthesissof silver nanoparticles by some locally.Lactobacillus spp.and detection of their antibacterial activity.Al-Mustansiriyah Journal for Pharmaceutical Sciences.13 (2): 163-173.

[25] Ahlam M. Farhan, Rasha A. Jassim, Nafeesa J. Kadhim, Wesen Adel Mehdi,Atteer Awad Mehde.(2017).Synthesis of Silver Nanoparticles from Malva parviflora Extract and Effect on Ecto-5'-Nucleotidase(5'-NT), ADA and AMPDA Enzymes in Sera of Patients with Arthrosclerosis.Baghdad Science Journal,14(4).

[26] Tagreed M. Al-Saadi Luay J.k. Alsaady(2017).Preparation of Silver Nanoparticles by Sol - Gel Method and Study their Characteristics.Ibn Al- Haritham Journal for Pure and Applied Science. 28(1): 301-310.

[27] Raghad kwater Maeah,(2018).Biosynthesis of silver nanoparticles using eucalyptus bicolor bark and their antimicrobial activity. Diyala journal for pure sciences. 14(1).

[28] Ali AL- Abed,(2017).Synthesis and study silver nanoparticles by chemical method. Diyala journal for pure sciences.13 (1): 127-138.

[29] Hussein Thamer Salloom(2017). Third order optical nonlinearity of silver nanoparticles prepared by chemical reduction method. Journal of Al-Nahrain University, 20 3:99-104.

[30] Halah H. Rashed.(2016).Silver nanoparticles prepared by electrical arc discharge method in DIW. Engineering and Technology Journal, 34 (B2).

[31] M J Haider, MS Mahdi.(2015). Synthesis of silver nanoparticles by electrochemical method. Engineering and Technology Journal, 33 (7): 1361-1373.

[32] Shahad M.Tawfeeq, Mohammed N. Maaroorf , Israa Al-Ogaidi.(2017).Synergistic effect of biosynthesized silver nanoparticles with antibiotics against multi-drug resistance bacteria isolated from children with diarrhoea under five years. Iraqi Journal of Science, 58(1A):41-52.

[33] Yaseen Hasan Kadhim, Nihad Abdul Ameer, Abbas Abd Latteef.(2017).Synthesis and characterization of ZnO and Ag nanoparticles.Journal of University of Babylon. 25 (3): 1010-1017.

[34] Wasmnaa Hatif Mohammed, Suhad A. Ahmed,Rana Shamil Noori , Nadia Imad Abdulwahhab.(2014).Effect of silver nanoparticles on microbial activity of Tricirium Polium extracts.Engineering and Technology Journal. 32(2): 208-216.

[35] Saba A. Al- Ziadi(2015).Antifungal Activity of Silver Nanoparticles synthesized by Tuchoderma harizanum.Journal of Al-Qadisiyah For Pure Science.1 (20): 1-10.
[36] Hussain A. Abod, kalif I.Bander , Salah S. Zain-Al-Abdeen.(2017).The effect of silver nanoparticles prepared using Aspergillus niger in some pathogenic bacteria. Kirkuk University Journal for Scientific Studies. 12 (1): 1-16.

[37] Noor R. Abdulhameet, r. Hyder A. Sali, Khaleel I. Hassoo, A. K. Ali. (2014).Plasmonic absorption of gold and silver nanoparticles in water. Engineering and Technology Journal. 32(6).

[38] Ahlam Jameel Abdulghani Waled Madhloom Al-Ogedy. (2016). Synthesis and characterization of multishapes of Fe3O4 nanoparticle by solve-hydrothermal method using microwave radiation. Baghdad Science Journal. 13(2).

[39] Ahmed Faiq Al-Alawy, Entisar Eliwi Al-Abodi. (2018). Synthesis and characterization of magnetic iron oxide nanoparticles by-co-precipitation method at different conditions. Journal of Engineering. 10 (24).

[40] Jehann Abd AlSataar Salmon, Basim Basim AlFraghee. Weesam Adnan Dary. (2016). Biosynthesis of iron oxide nanoparticles using Lactobacillus rhamnosus and antibacterial activity against pathogenic bacteria. Al-Mustansiriya Journal of Science.27 (3) :22-25.

[41] Nada K.Abass1, Zainab J. Shanani1 Teeba H. Mohammed, Lamia K. Abbas. (2018). Fabricated of Cu doped ZnO nanoparticles for solar cell application. Baghdad Science Journal. 15(2).

[42] Dunia K M Al Nasrawy, Mohammed H.K. AL-Mamoori, Ahmed.K. Kodearyi (2015). Determine the structural and optical properties of ZnO nanoparticles prepared by hydrothermal method. Journal of Kerbala University, 13(3).

[43] Amna Ali Slman. (2012). Antibacterial activity of zno nanoparticle on some gram-positive and gram-negative bacteria. Iraqi Journal of Physics, 10(18):5-10.

[44] A. J. Bohan, E.D. Alhtheal, Kh. S. Shaker(2017).Synthesis nano zinc oxide materials and their activity on fungus growth. Engineering and Technology Journal.35 (1).

[45] Osamah. A. Salman, Kanaan. K.Ahmed. Ayad Shatti. (2018). Preparation and characterization of iron oxide nanoparticles by using lemonIraqi plant extracts. Journal of the College of Basic Education. 24(100).

[46] Adawiya J. Haider, Dhelal A. Shabeeb, Abdullah Th. Mohammed(2016).Synthesis and stabilization of gold nanoparticles by inverse reduction method using sodium citrate and sodium boro hydride as reducing agent. Journal of University of Anbar for Pure Science. 10(1).

[47] Dhelal A. Shabeeb, Abdulalah Th. Mohammed, and Adawiya J. Haider. (2017). Preparation eco-friendly and characteristic of gold nanoparticles by orchid and gum arabic as a reducing agent. Diyala Journal for Pure Sciences. 13 (2).

[48] Isam M. Ibrahim, Niran F. Abdul-Jabar, Abeer H. Fezzaa, (2018). The effect of gold nanoparticles on WO3 thin film. Iraqi Journal of Physics, 16(36): 11-28.

[49] Abdul Qader D. Faisal, Aysar S. Keiteb& Dr. Mufeed A. Jaleel. (2011). Synthesis of carbon nanomaterials in deionized water with and without catalyst using arc discharge technique. Engineering and Technology Journal. 29(2).

[50] Kahtan Kalaf Al-Khazraj, Ali Hussain Ataaw, Mayyadah S. Abed Al-Fatlaw. (2015). Different shapes of carbon nanotubes via water assisted chemical vapor deposition. Engineering and Technology Journal. 33(2).

[51] Mayyadah H. Mohsi Khawla S. khasha. (2016). Spectroscopy and formation of carbon nitride by pulse laser ablation in liquid of graphite target. Engineering and Technology Journal. 34 (1)

[52] Khawla S. khasha, Mayyadah H. Mohsi(2014). Preparation of carbon nanotube by pulse laser ablation of graphite target in deionized water. Engineering and Technology Journal. 32(1)

[53] Khawla S. khasha, Mayyadah H. Mohsi. (2013). Carbon nanotube prepared by pulse laser ablation of graphite target in iso-propanol solution. Engineering and Technology Journal. 31(16)

[54] Mulvaney P. Langmuir,12 (1996) 788.

[55] Mie G, Ann Phy, 25 (1908) 377.

[56] Zaid.S. Al-mawlawi, Hind. H. Obaid(2017). Antibacterial activity of synergistic effect of colicin and gold nanoparticles against pseudomonas aerugens. Iraqi Journal of Science, 58 (3C): 1020-1027.

[57] Abdul Qader D. Faisal, Zainab N. Jameel, Ahmed A. Moosa. (2014). Preparation of silver and gold nanoparticles by using Nd - YAG pulse laser ablation. Engineering and Technology Journal. 32 (1): 138-144.

[58] Lina ZhukovMichael Dybiec, Sergey Ostapen, Natalia Korsunsk. (2009). Spectroscopic photoluminescence of quantum dots for cancer biomarker panels. Iraqi Journal of Applied Physics Letters. 2 (4).

[59] Maha Al-Kinany, Ghaleb AL-Dahash, Jassim Mohammed Jassim. (2015). Effect of laser fluence energy on morphological, structural and optical properties of gold and silver thin film prepared by pulse laser deposition method. Engineering and Technology Journal. 33(9): 1561-1570.

[60] Ali J Addie. (2016). Preparation of nanoporous alumina by anodization method and study of their structural properties. Engineering and Technology Journal. 34 (5): 176-185.

[61] Su-aad.S. Shake. (2016). Production of silver nanowires from silver nanoparticles by thermal treatment. Engineering and Technology Journal. 34 (2).

[62] Zahra’a A. Ahmed, Thikra A. Mustafa, Naksheen M. Ardalan, Ekhas M. Ida. (2017). In vitro toxicity evaluation of silver nanoparticles on entamoeba histolytica trophozoite. Baghdad Science Journal. 14 (3).

[63] Rawia F. H. Al-Saeedi, Entsar J. Saheb. (2017). Effect of silver nanoparticles on macrophage cytotoxicity upon exposure to Leishmania tropica in vitro. Iraqi Journal of Science, 58(3): 1419-1427.

[64] Moamin I. Issa, Nabeel Abdul-Fattah. (2015). Evaluating the effect of silver nanoparticles incorporation on antifungal activity and some properties of soft denture.
lining material. Journal of Baghdad College of Dentistry. 27 (2): 17-23.

[65] Najah Ali Mohammed,(2012). Antibacterial activity of silver nanoparticles using stem bark of juglans regia against, streptococcus mutans, streptococcus. sanguis and, porphyromonas gingivalis Mustansiria Dental Journal. 9 (2): 184-189.

[66] Noura Burhan Aldeen Abdulrahman,Zainab Muhammad Nssair.(2016). Antimicrobial activity of zinc oxide, titanium dioxide and silver nanoparticles against mithicillin-resistant staphylococcus aureus isolates. Tikrit Journal of Pure Science.21(3).

[67] Najah Ali Mohammed, (2012).Antibacterial activity of silver nanoparticles using stem bark of juglans regia against, streptococcus mutans, streptococcus, sanguis and porphyromonas gingivalis. Mustansiria dental journal, 9 (2): 184-189.

[68] Israa Ali Zaidan Al-Ogaid(2017). Detecting the antibacterial activity of green synthesized silver (Ag) nanoparticles functionalized with ampicillin (Amp). Baghdad Science Journal .14(1).

[69] Thanaa Majied Al-Nori.(2012). Antibacterial activity of silver and gold nanoparticles against streptococcus, staphylococcus aureus and Ecoli. Al-Mustansiriya J. Sci 23(3).

[70] Abdulhadi kadhim AL-Ogaili, Abdulrahman K. AliTamir H.Ali.(2015). Preparation of silver nanoparticles and study the optical and antibacterial properties. Engineering and Technology Journal. 33 (3): 478-487.

[71] Anfal Ali Shakir, Iman fadhil Abdul-Husin, Rawa’a Safaa Abbas(2018). Synthesis silver nanoparticles as antibacterial against escherichia coli and staphlococcus aureus as a model of gram- negative and gram- positive bacteria. Journal of Babylon UniversityPure and Applied Sciences2(26).

[72] Maha Adel Mahmood (2012). The antibacterial effect of silver nanoparticles on some bacterial pathogens. Iraqi Journal of Physics,10(18):56-61 .

[73] Marwa H. M. Al-Khafaj(2017). The inhibition activity of silver nanoparticles compared with d-glycin and imipenem effect on the biofilm formation by food-origin salmonella isolates. Iraqi Journal of Science, 58(2): 836-84.

[74] Mohammed N. Taha,Ameer M.J. Ali(2015).Changes in the weights of the testes and epididymes as well as sperm characteristic of male albino mice treated with silver nanoparticles. Ibn Al-Haitham J. for Pure and Applied Sciences 28 (3).

[75] Gazwa D.Al –Nakeeb, Noor Mahdi Fatheel.(2017).Effec of the silver nanoparticles on the histology of albino mouse ovaries. Baghdad Science Journal. 14 (4):662-668.

[76] Gazwa D. Al-Nakeeb, Abeer S. Abd Ali,(2015). Effect of silver nanoparticles in the liver of female quail (Coturnix coturnix).Baghdad Journal of Science 12(4).

[77] A. N. A. SalihO, M. S. Ibrahim, M. J. Eesa(2016). Biosynthesis of silver nanoparticles and evaluate its activity in promoting burns healing in rabbits. Al-Anbar Journal of Veterinary Sciences. 9 (2): 47-58.

[78] Esraa H. Ali, Lina A. Salih. Effect of maternal exposure of silver nanoparticles on the histogenesis of cerebellum in post-implantation of albino rats' embryos.(2018). Iraqi Journal of Science. 59(1): 271-277.

[79] Rand M. Abd AL-Rhman, Shaim R. Ibraheem, Israa AL-Ogaidi.(2016).The effect of silver nanoparticles on cellular and humoral immunity of mice in vivo and in vitro. Iraqi Journal of Biotechnology. 15(2): 21-29.

[80] Eaman A.S.AL-Rubae, Abdulrahman K Ali, Amenah Ali Salman, Zainab A. Salman.(2015). Inhibition effect of noble metals nanoparticles on acid phosphate activity in sera of healthy subject. Engineering and Technology Journal. 33 (1): 1-11.

[81] Amer T. Tawfeeq, Husam Al-Deen M. Kadhim, Nahi Y. Yaseen, Saba K. Kalil, Aseel F. Ghedan, Rasha A.Hussein,(2015). Genotoxity of silver nanoparticles synthesized by laser ablation method in vivo. Iraqi Journal of Cancer and Medical Genetics. 8(1).

[82] Majid Sakhi Jabir, Zainab Jihad Taqi, Imman Ismael Jabbar, Mohammed Shammel Ali, Shamma Abd-Alsattar, Mayssa Adil Ali.(2015). The effect of Punica granatum silver nanoparticles in phagocytic cells in patients with Multiple Myeloma. Engineering and Technology Journal. 33 (9): 1702-1711.

[83] Asia H. Al-Mashhadan, Rama M. Ya.(2015). Silver nanoparticles as free radical scavengers for protection from nuclear radiation hazards.Engineering and Technology Journal.33(6).

[84] Talib Abedulridha Abdulwahid.(2013). Using gold nanoparticles with high energy gamma photons (6MeV) to treat ovary cancer.Journal of Kerbala University.(1): 13-21.

[85] Ali H. A. Jalaukhan and Abdulhussain A. Khadyeir.(2015).Using gold nanoparticles with high energy gamma photons (12MeV) to treat brain cancer. Journal of University of Thi- Qar. 10 (4).

[86] Salma Abdul Rudha Abbass,Amer Hasan Abdullah, Abdulrahman K. Ali,(2012).Effects of Gold and Silver colloidal on gama glutamate transferase enzyme activity in blood serum.Int. J. Chem. Res.1(4): 1-11

[87] Amer Talib Tawfeeq, Husam Al-Deen Mohammed Kadhim, Nahi Yousif Yaseen, Saba K.Kalil, Teeba H.Jafer.Aseel F Ghedan, Rasha A.Hussein.(2015).Exposure of silver nanoparticles on the activity in promoting burns healing in rabbits. Al-Anbar Journal of Veterinary Sciences. 9 (2): 47-58.

[88] Alaa A. Abdul-Hameed , Ammar M. Hasan, Shatha Riyath Ahmed izzat.(2016)Study the effect of ZnO nanopowder in fertilizer. The Iraqi Journal for Mechanical and Material Engineering, 16(4).

[89] Hanan A. R. Akkar, Sarmad Khalooq(2014). Characteristics and evaluation of nano electronic devices.Engineering and Technology Journal, 32(3).

[90] Faleh H. M. Al-Mahdawi and Karrar Saad.(2018).Enhancement of drilling fluid properties
using nanoparticles. Iraqi Journal of Chemical and Petroleum - Engineering. 19 (2): 21 – 26.
[91] H.A. Dhahad, A.S. Hamadi, S.A. Ali.(2017). Effect of Aluminum Oxide Nanoparticles Fuel Additives on the Performance and Emissions of Diesel Engine. Engineering and Technology Journal. 35(9)
[92] R. A. Anae, H. A. Abdulla, Gh. Z. Alsandoor. (2017). Alumina nanoparticle/polypyrrole coating for carbon steel protection in simulated soil solution. Engineering and Technology Journal. 35 (9).
[93] Omar R. Muklif, Intisar J. Ismail, (2015). Studying the effect of addition, a composite of silanizedNano-AI2O3 and plasma treated polypropylene fibers on some physical and mechanical properties of heat cured PMMA denture base material. J Bagh College Dentistry. 27(3).
[94] Jinan Abdul Sattar Salman, Bassem Faraji Wissam Adnan Dari. (2018). The biosynthesis of iron oxide nanoparticles using Lactobacillus rhamnose US and its antibacterial effect. Journal of science of Mustansiriya. 27 (3).
[95] Saba Abdul Hadi Mahdy Microbicidal effect of Fe2O nanoparticles in antimicrobial agent system. Journal of Engineering. 22 (10): 52-61.
[96] Shatha Salah Asad, Khalid Mahdi Salih Nahi yousi, yassen.(2017). Cytotoxic effect of iron nanoparticles in vitro on some cell lines. Iraqi Journal of Cancer and Medical Genetics. 10 (1)
[97] N.A. Al-Rubaie, F.S. Kadhi, A.A. Ati.(2017). Nano ferrites as corrosion inhibitors for carbon steel in local Iraqi bentonite mud. Engineering and Technology Journal. 35 (8).