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A Review On Analytical Techniques for Herbal Anticancer Nano Medicine

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Abstract: An entirely different corporate age is beginning, and thanks to the fusion of discussion topics of nanotechnology, biological science, technological advances, and instrumentation. The herbal medication is shaped into nano-carriers to capitalize on the expanding demand for medicinal products for an array of disciplines and to increase therapeutic value. Herbal medications were the primary component in their development in nanotechnology to encourage their behavior at the targeted location. This review article aims to provide an overview of the state-of-the-art analytical methods for synthesizing, identifying, and characterizing nanomaterials. Developing analytical methods to characterize nanomaterials using a physical or chemical approach presents difficulties. The principal methods are transmission electron microscopy, scanning electron microscopy, magnetic nanoparticles and HPLC, and atomic force microscopy. The most common techniques are atomic force microscopy, electron microscopy with scanning electrons, magnetic nanoparticles, HPLC, and transmission electron microscopy: X-ray photoelectron spectroscopy and capillary electrophoretic separations. Nanomaterials are under investigation for their wide range of conceivable usage in optics, electronics, magnetism, catalysis, biomedicine, chemical sensing, microreactors, and medicines.

Keywords: Nanotechnology, Nano-carriers, Microreactor, Nanoparticles, Biomedicine.

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1. INTRODUCTION

Herbal nanomedicines (HNMs) are micron-sized drugs made of enriched parts, gathers, or diagnostic components of medicinal plants. Higher bioavailability and decreased toxicity of HNMs are advantages[1]. A type of material known as nano-size atoms has fragments that are smaller than 100 Angstroms in size. Polymeric herbal nanoparticles, solid lipid nanoparticles, phytosomes, nano-micelles, self-nano emulsifying drug delivery systems, nanofibers, liposomes, dendrimers, ethosomes, nano-emulsion, nanosuspension, and carbon nanotubes are examples of herbal nanomedicines. Nanoparticles are currently produced with numerous scientific uses, including biosensors, medication transport, drugs, and healthcare products. Nanoparticles' effectiveness and interactions with ecosystems are greatly influenced by their physical and chemical characteristics. With regards to their excellent stability, substantial specificity, excessive drug storage capacity, capability for controlled dispersion, the potential of being utilized in varied administrative methods, and ability to deliver both hydrophilic and hydrophobic drug molecules, nanoparticles may provide major benefits over standard drug delivery.

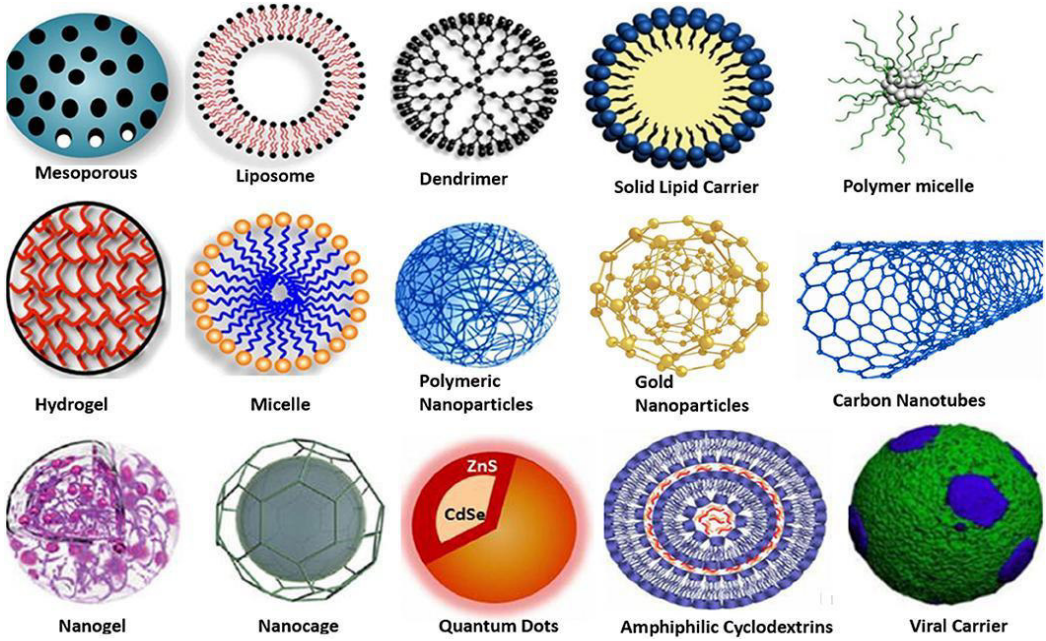

Fig 1: Different types of nanocarriers (nanoparticles) serve as drug delivery[1].

Natural medication is shaped into nano-carriers to capitalize on the expanding demand for pharmaceuticals for an array of disciplines and to increase therapeutic value. Medicinal products served as the primary component in its development in nanotechnology can stimulate its action at its intended spot. Because of a greater engaged surface power, there are numerous opportunities to increase the bioavailability and interaction target discrimination, which will improve the active entity's potency and safety. Nanoparticle is crucial for the therapy since the action of herbal remedies breaks down in the abdomen's extremely acidic PH or is processed through the liver[2]. To enhance pharmacokinetics and pharmacodynamics components of drug molecules in a biological system before entering the circulatory system.

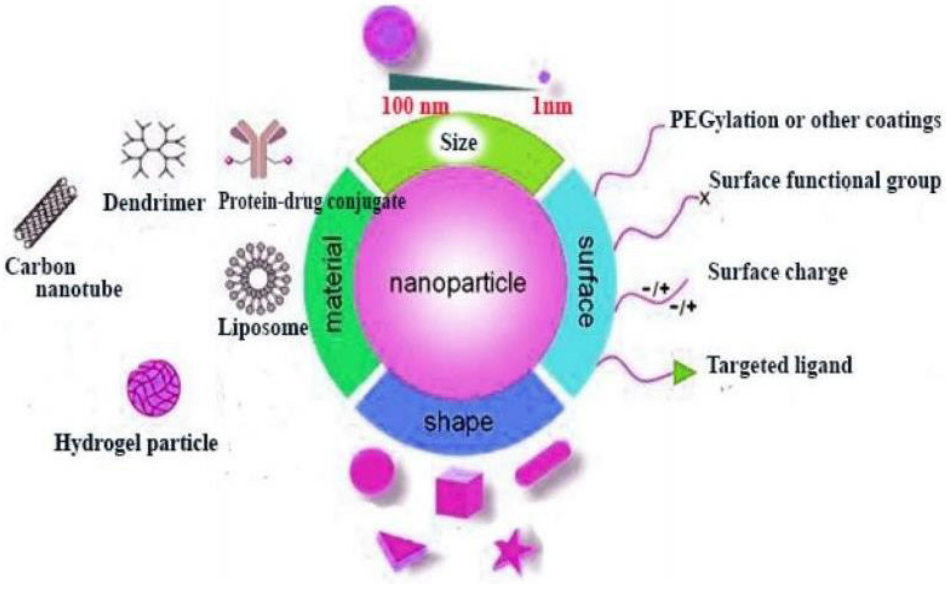

Fig 2: Different nanoparticle[2]

1.1 A Nano-formulation technology that contains an active herbal component

Solid nanoparticles of lipids, magnetic nanoparticles, polymeric micelles, phospholipid micelles, and polymeric nanoparticles To enhance the dissolution of water & delivery of drugs to the diseased location, metallic and inorganic nanoparticles, colloidal nano-liposomes, and dendrimers are implemented. Nanoparticles made of a Metal-Organic Framework (MOF) improve the immunotherapy of several medicinal drugs. During each in-vitro and in-vivo experiment, the micelle carriers increases photothermal efficiency towards the cancer cells. Techniques for loading nanoparticles

1. The hot homogenization procedure
2. The Cold homogenization procedure.
3. The High-pressure homogenization procedure.
4. Complex coacervation procedure.
5. Coprecipitation procedure.
6. Salting out procedure
7. Solvent emulsification diffusion procedure.
8. Supercritical fluid procedure
9. Nanoprecipitation procedure

(1) The hot homogenization procedure:

The hot homogenization process, performed at temperatures over the lipid's melting point, is called emulsion homogenization[3]. High-shear mixing equipment (Ultra-Turrax) produces a pre-emulsion of the drug-loaded lipid melt and the aqueous emulsifier phase (both at the same temperature). It is preferable to acquire droplets near a few micrometers since the pre-emulsion's efficiency significantly influences the overall performance of the finished product. Higher temperatures often lead to smaller particle sizes because the inner phase's viscosity is reduced. High temperatures, however, also hasten the pace at which the medicine and the carrier degrade. Multiple iterations of the homogenization process are possible. Therefore, it must constantly be contained. High-pressure homogenization raises the sample's temperature (by around 10°C for 500 bar).

(2) The Cold homogenization procedure:

The cold homogenization procedure, meanwhile, entails the pressurized processing of an emulsion despite utilizing an emulsified lipid[3]. Adequate temperature monitoring and control are necessary to ensure the lipid is in an unmolten condition since a spike in temperature occurs during homogenization. The hot homogenization method's three shortcomings prompted the invention of cold homogenization. 1. Technology that exposes pharmaceuticals to temperature-related degradation. 2. Drug dispersion into the aqueous phase throughout homogenization 3. The intricate crystallization stage of the nanoemulsion may cause several modifications or pressure from melts that have undergone supercooled.

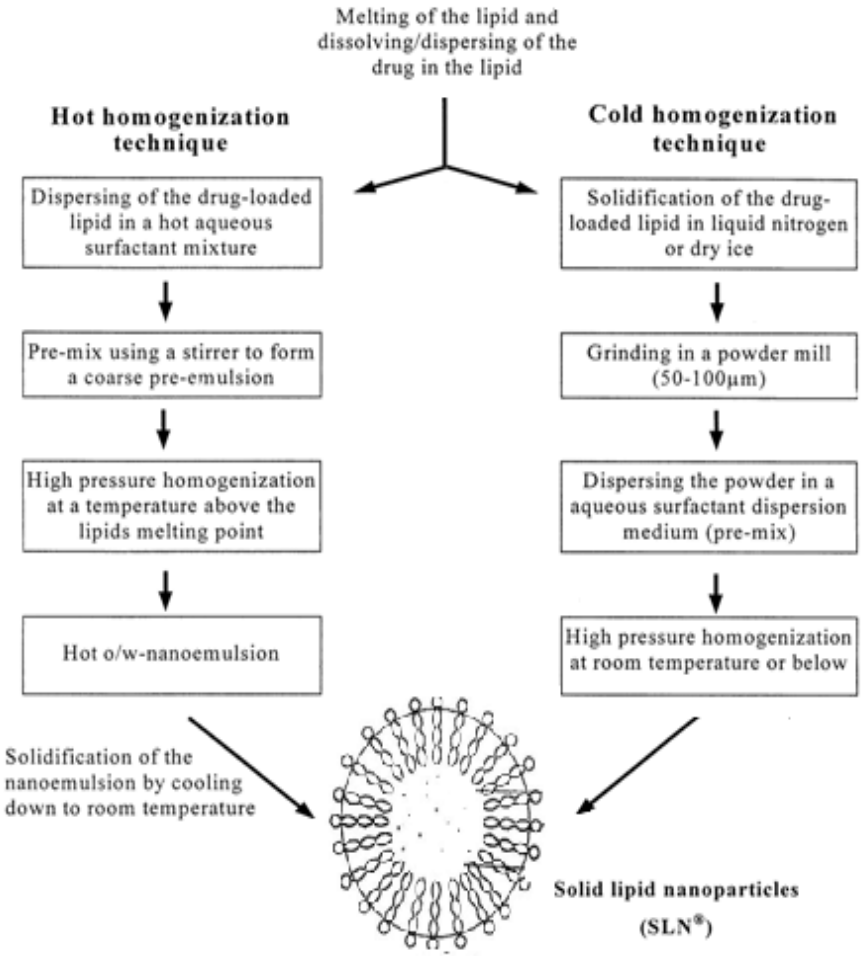

Fig 3: Hot and cold homogenization technique[3]

(3) The High-pressure homogenization procedure.

It is a reliable and effective method used for the first time to produce SLNs. High-pressure homogenizers force a liquid through a small opening (a few microns wide) under high pressure (100–2000 bar). About a very short distance, the fluid accelerates to a very high velocity (about 1000 km/h). Cavitation pressures and extremely high shear stresses cause the particles to break into submicron sizes. Although up to 40% lipid content has also been researched, 5-10% is often utilized.

(4) The Complex coacervation procedure.

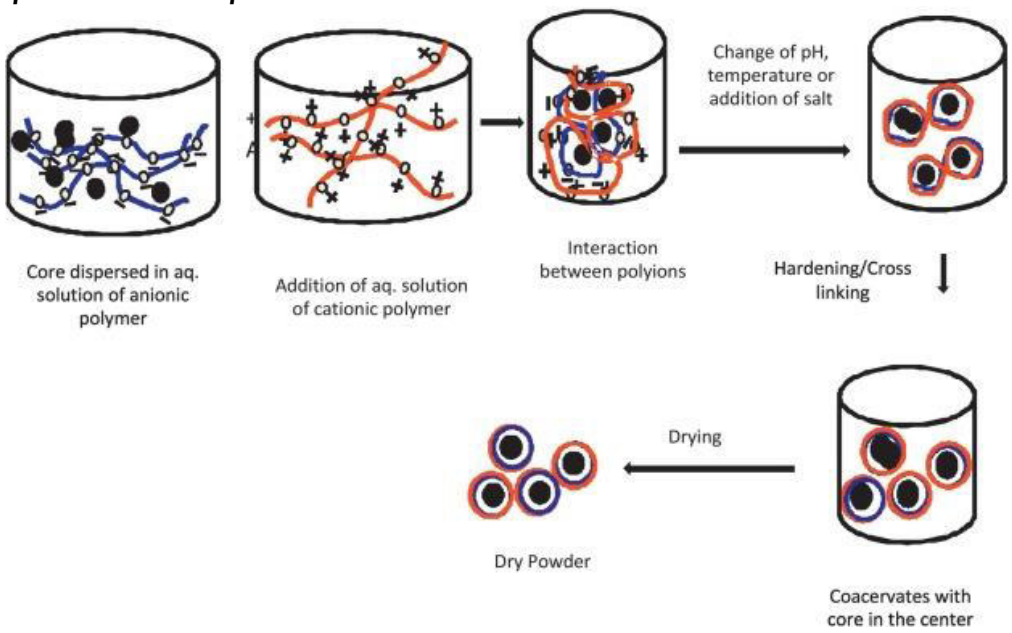

Fig 4: Complex Coacervation Method.[4]

(5) Coprecipitation procedure

Another way of producing solid lipid nanoparticles is through precipitation, characterized by the requirement for solvents. For example, an organic solvent (like chloroform) could be dissolved using glycerides, and an aqueous phase will be utilized to emulsify the result. The lipid will precipitate out of the organic solvent once it has evaporated, creating nanoparticles.

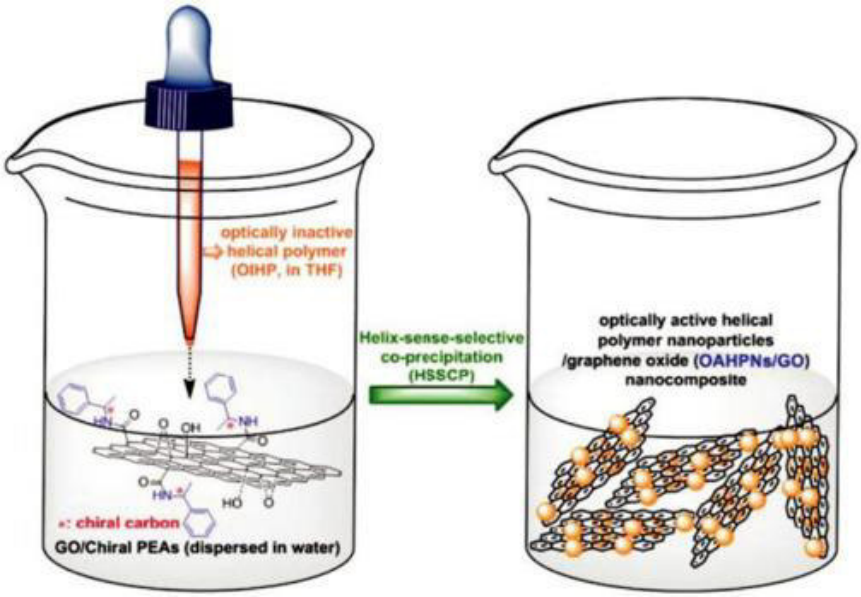

Fig 5 *Coprecipitation procedure*[5]

(6) Salting Out Procedure [6]

Polymers and medicine are primarily dispersed into a solvent, including salting out agents (electrolytes like calcium chloride and magnesium chloride or sucrose as non-electrolytes) and hydroxy ethyl cellulose as a colloidal stabilizer. The oil mentioned above in water dispersion has been mixed with water to promote liquid propagation, triggering the emergence of nanospheres.

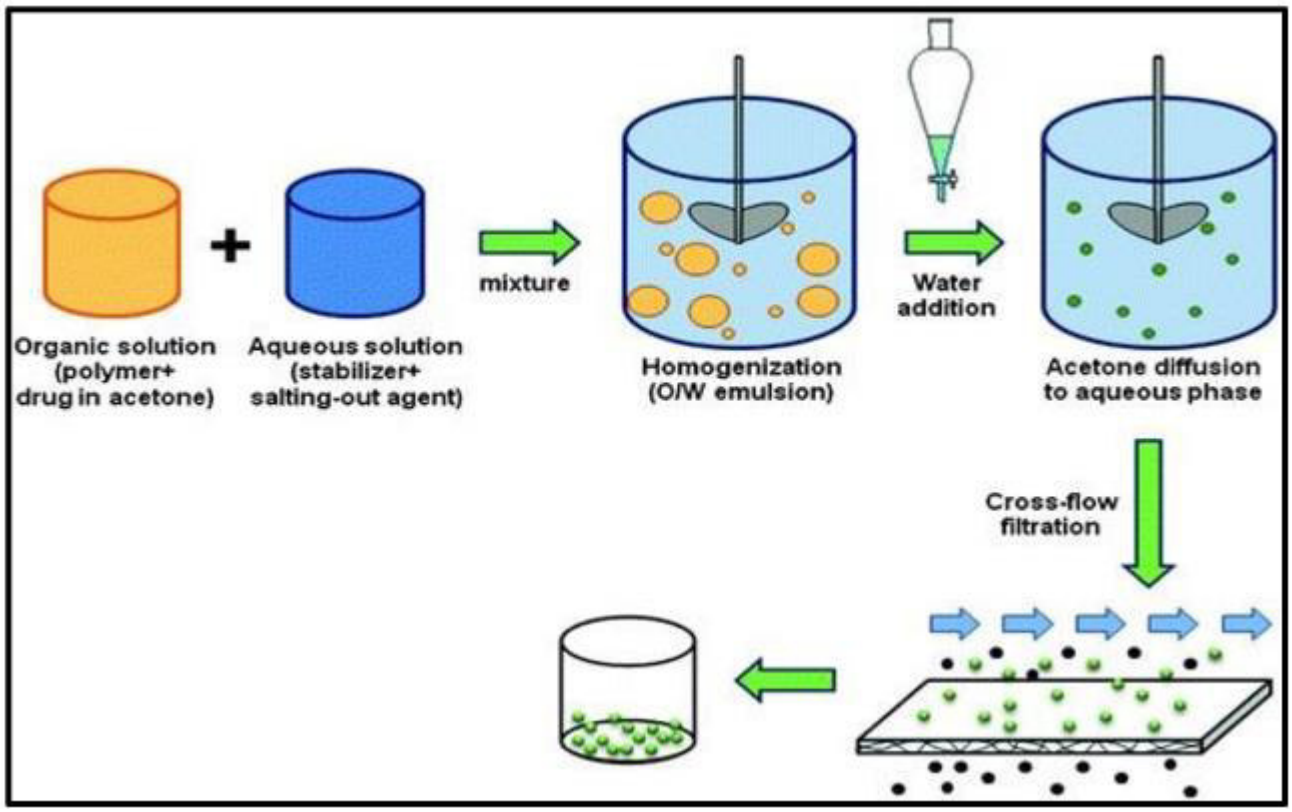

Fig 6 Salting out Methods[6]

(7) Solvent emulsification diffusion procedure.

This technique allows for the emergence of granules with characteristic diameters between 30 and 100 nm. The lack of heat during preparation is the key advantage of this procedure. The zeta potential changes and SLN coacervation is produced using an acidic aqueous phase. This process generally involves dissolving the lipid in the organic phase in a water bath heated to 50 °C. The two phases are then separated using centrifugation. The SLN suspension came into being quick. The entire dispersed system can be reabsorbed in distilled water afterward centrifuging it.

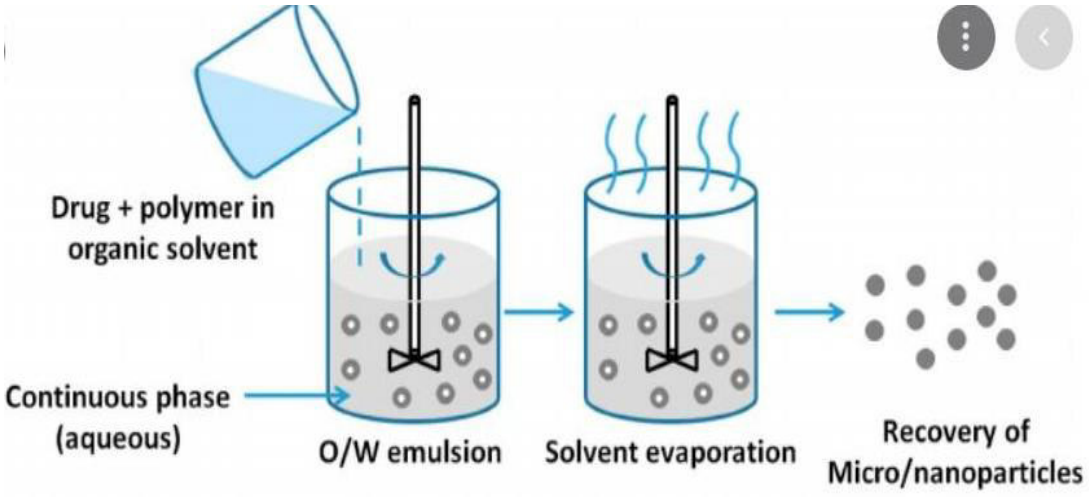

Fig 6 Solvent emulsification diffusion method for nanoparticle preparation[7]

(8) Supercritical fluid procedure

This brand-new procedure for making SLN has the advantage of making it requiring the necessity of solvents. There are multiple variations of this platform technology for producing powder and nanoparticles. For example, SLN may be created using the explosive growth of supercritical carbon dioxide solutions (RESS) technology. Therefore, performing this treatment using carbon dioxide (99.99%) as the solvent was a good idea.

1.2 Analytical Techniques Employed in Nanotechnology

1.2.1 Transmission electron microscopy (TEM[8])

Projection of a diluted sample, including the object to be studied, onto backing grids, may quickly yield substances with dimensions sufficiently small to be electron transparent, including powders or Nanotubes. The electron beam is

focused and controlled by electrostatic and electromagnetic "lenses" in the electron microscope. The transmission of an electron beam via an incredibly thin specimen as it engages with the material is a technique. The electrons that pass via the specimen are converted into an image, which is then enlarged and focused by an objective lens and shown on an imaging screen. It is aware of faults in the stretched crystal lattice.

1.2.2 Scanning electron microscopy (SEM)[9]

This technique creates magnified images using electrons instead of light waves. When the beam of electrons interacts with the atoms of the sample, signals in the form of secondary electrons, backscattered electrons, and characteristic x- rays are generated that contain information about the sample's surface composition, topography, etc. In its main detecting mode, i.e., it can generate exceptionally high-resolution photographs of a sample surface, exposing features 1 to 5 nm in size. Imaging using secondary electrons. Detectors collect these X-rays, backscattered electrons, and secondary electrons and convert them into a signal sent to a screen similar to a television screen.

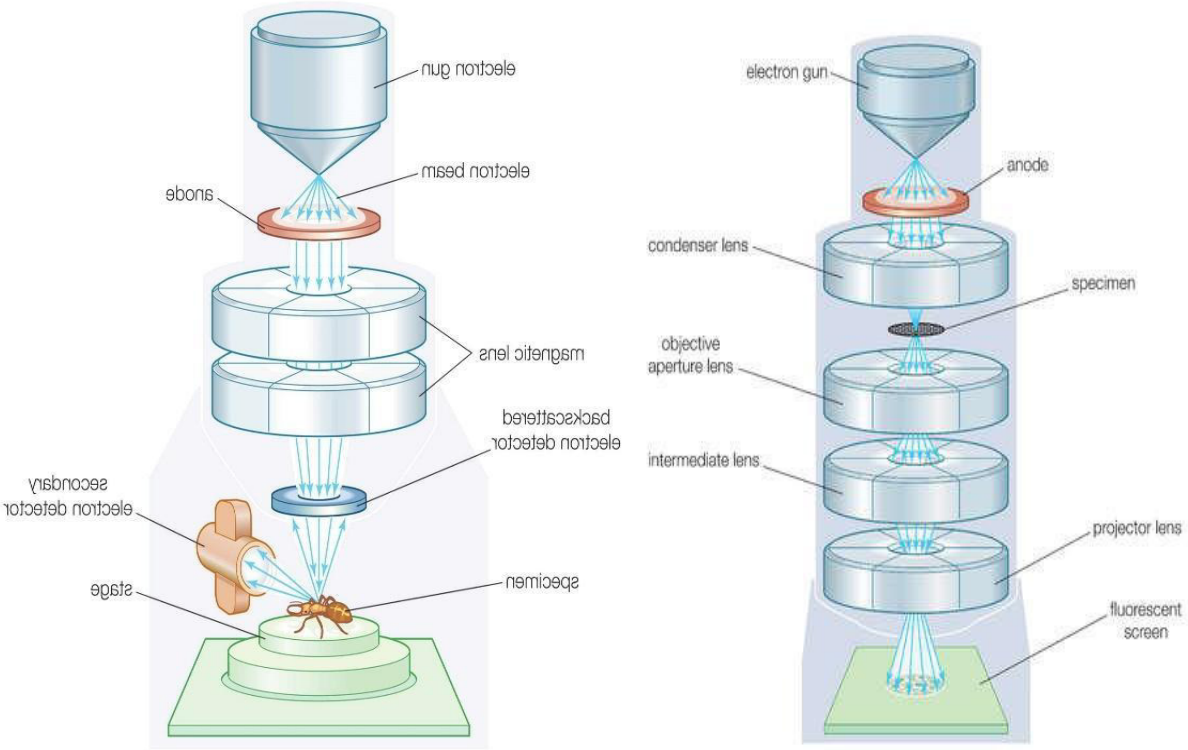

Figure 7 Scanning electron microscopy (SEM)[9]

1.2.3 Magnetic nanoparticles and HPLC[10]

A microextraction approach employing Ag modified-magnetic nano Particles (ag-maps) and high-performance liquid chromatography (HPLC) is used to detect ceftriaxone in plasma. They used a mild solution method to create magnetic nanoparticles. To characterize the produced nanoparticles, several techniques, including X-ray diffraction (XRD), transmission electron microscopy (TEM), FTIR, and ultraviolet-visible (uv-vis) spectroscopy, were used.

1.2.4 Atomic force microscopy (AFM)[11]

AFM is the best tool for evaluating the surface roughness at the nanoscale scale and for visualizing surface nano-texture on many different material surfaces, including textiles and polymer nanocomposites with polished or coated surfaces. Utilizing piezoelectric scanners, an AFM probe with a pointed tip that has a specified tip radius of 10 nm is placed close to the end of a cantilever beam and raster scanned across a specimen's surface. In addition, a place-sensitive photodiode in an optical lever detection system is frequently used to track modifications to the tip specimen interface.

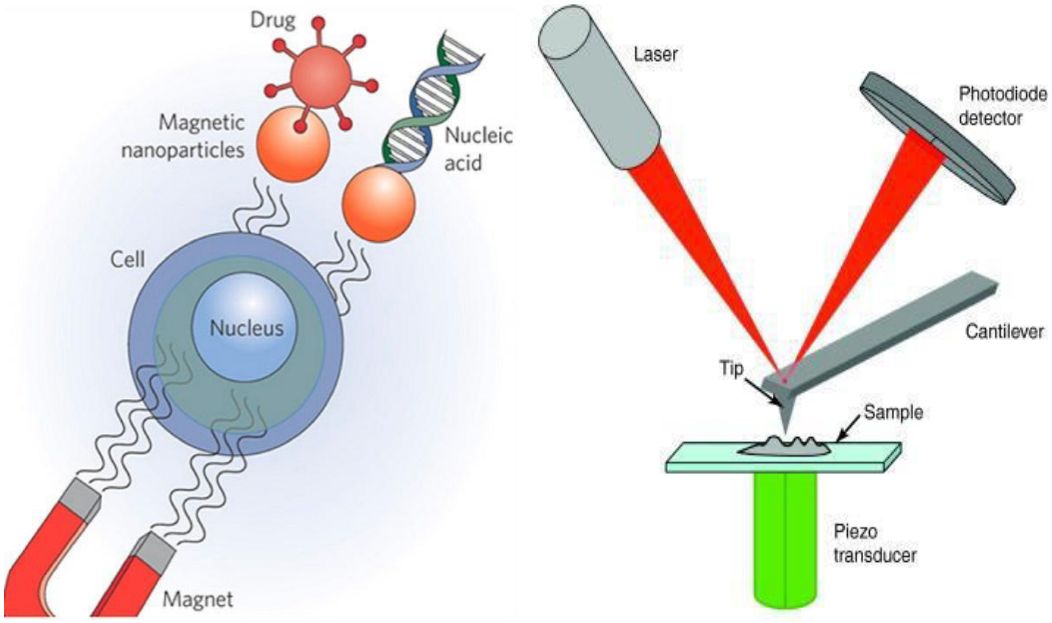

Fig 8: Atomic force microscopy[12]

1.2.5 Capillary electrophoretic separations [13]

Microchip capillary electrophoresis (MCE) and capillary electrophoresis in a capillary procedures are among the best and most effective for DNA analysis. They discussed using nanomaterials and chip-based nanostructures for DNA separation in MCE and CE. Several innovative chip-based techniques are being created for the separation of DNA, particularly for long DNA molecules, which utilize the dependency of the mobility of DNA molecules on the size and form of nanostructures. In addition, utilizing nanostructures eliminates the need for sieving matrices, unlike traditional CE and MCE procedures.

1.2.6 X-ray photoelectron spectroscopy[14]

XPS determines the elements and the quality of those elements present within ~ 10 nm of the sample surface. It also detects the contamination, if any, in the surface or The bulk of the sample. If the material is free of Excessive surface contamination, XPS can generate empirical formula of the sample, and the chemical state of one or more elements can be identified. It can also determine the thickness of one or more thin layers (1-8 nm) of different materials within the Top 10 nm of the surface. It can also measure the uniformity of the elemental composition of textile Surfaces after nano-level etching, finishing, or coating of the surfaces.

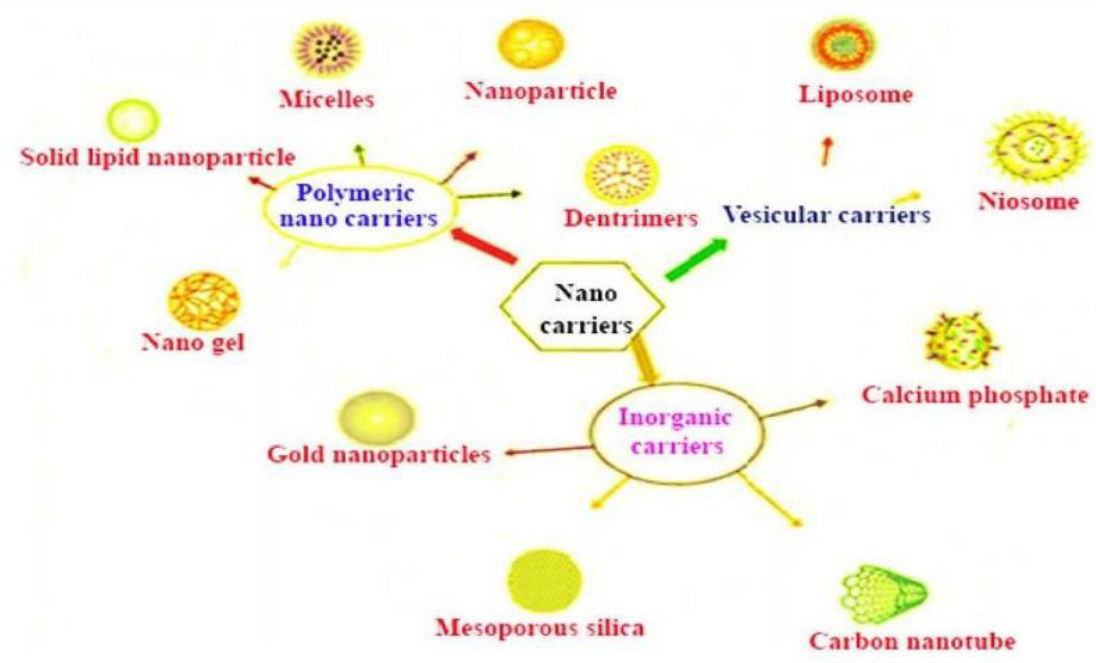

Fig 9: Nano-carriers[15]

Fig 10: Nano medicines[16]

1.3 Nanotechnology in Medicine - Nanoparticles in Medicine

1.3.1 Drug Delivery[17].

Presently in development, nanotechnology in healthcare involves using nanoparticles to transport medications, heat, light, or other chemicals to particular cell types (like cancer cells). In addition, it is possible to directly treat damaged cells using particles designed to attach to certain cells. This method identifies early illness and lessens harm to the body's healthy cells. One example is creating a way to distribute cardiac stem cells to injured heart tissue. To boost the number of stem cells supplied to damaged tissue, they connect nanovesicles drawn to the lesion to the stem cells[18].

1.3.2 *Antibacterial Treatments[19].*

It is creating a method that uses infrared light and gold nanoparticles to destroy microorganisms. This technique could result in better equipment maintenance in medical facilities.

1.3.3 Diagnostic Techniques

A detection device that can quickly provide results when utilized with hand-held testing equipment and can identify COVID-19 and other viruses is produced using nanoimprint lithography[20]. Carbon nanotubes in chips are coupled with antibodies to find cancer cells in the bloodstream. The researchers think this technique might be used for quick lab tests that could find cancer cells in circulation early. In addition, creating a test for the early recognition of kidney injury is ongoing. The technique uses gold nanorods that have been functionalized to bind to the kind of protein produced by damaged kidneys. The color of the nanorod changes as protein builds up on it. The test will be performed rapidly and affordably for early problem identification.

1.3.4 Wound Treatments

Researchers have exhibited a bandage that uses electricity generated by the patient's Nanogenerators to apply electrical pulses to a wound[21]. There is an imperative for a different strategy to stop blood loss in trauma patients who have internal bleeding. Synthetic platelets are made of polymer nanoparticles. Injection of these artificial platelets considerably lowers blood loss, according to laboratory testing[22].

1.3.5 Cancer Treatments

A reusable solution that may administer chemotherapeutic medications to the skin to treat melanoma has been created using silicon Nano needles. We have created nanoparticles with chemicals coupled to a radioactive core that bind to lymphoma tumor cells[23]. According to the researchers, this technique prevents the main tumor from spreading malignancy[24]. Researchers have shown a nanoparticle that destroys lymphoma cancer cells. They employ a nanoparticle with a gold nanoparticle in its center that resembles HDL cholesterol. The cancer cell is starved when this nanoparticle binds to a lymphoma cell and prevents the cancer cell from adhering to actual HLD cholesterol[25]. The organization has shown how to send a protein that kills cancer cells to the cancer cells themselves. They utilize a polymer nanoshell to get the protein inside the cancer cells. The cancer cell self-destructs when the protein builds up in the nucleus of the cancer cell[26]. It has been demonstrated that heating cancer tumors using iron-oxide nanoparticles and a magnetic field stimulates the immune system to fight cancer cells in other regions of the body[27]. While other methods are utilized to treat localized tumors, researchers think this technology may help halt the spread of cancer cells.

1.3.6 Artemisinin (ART)

Chitosan, gelatin, and alginate encapsulated ART crystals to provide controlled release[28]. Using the layer-by-layer method, these polyelectrolytes were alternately placed on ART crystals of a size of around 766 nm. We examined the ART nanocapsule's swelling characteristics, size distribution, and zeta potential. Transmission electron microscopy was used to study the morphology of the ART nano-capsules after they had dissolved. Phosphate buffer solution (Ph 7.4) was used to test the release property of ART nano-capsules. The ART nanocapsule's good aqueous solution dispersion was demonstrated[29]. The disclosed approach is practical for achieving sustained drug release through self-assembling poly electrolytes on natural drug crystals.

1.3.7 Food Safety

Food safety will be impacted by nanotechnology. Electronic equipment is becoming smaller due to nanotechnology, which enhances computing, communication, and information processing[30]. Food goods may be tracked via smart labels or packaging, protecting legitimacy and enabling traceability. Compounds used in food interaction that prevent microbial contamination are created using nanotechnology. The consumption of particular mineral particle nanomaterials, which might remain and amass in the body due to the creation and dumping of items containing nanomaterials, is at the center of the debate over the regulation of nanotechnology. The extensive use of antimicrobial products, which may promote the emergence of microbe resistance, is another issue of concern. Nanotechnology-enabled imaging and diagnostic technologies are opening the door to earlier identification, more personalized treatment options, and higher therapeutic

success rates. In one method, scientists developed a nanoparticle that resembles high-density lipoprotein, the body's "good" cholesterol that aids in plaque reduction[31]. Researchers are looking into carbon nanotube "scrubbers" and membranes to extract carbon dioxide from power plant exhaust. Researchers in nanomedicine are examining methods that nanotechnology might enhance vaccinations, including needle-free vaccination administration.

4. REFERENCES

1. Kajani, A. A., Zarkesh-Esfahani, S. H., Bordbar, A. K., Khosropour, A. R., Razmjou, A., and Kardi, M. (2016). Anticancer effects of silver nanoparticles encapsulated by *Taxus baccata* extracts. *J. Mol. Liq.* 223, 549–556. doi: 10.1016/j.molliq.2016.08.064
2. Sandhya V, Ubaidulla U. A review on herbal drug loaded into pharmaceutical carrier techniques and its evaluation process. Future Journal of Pharmaceutical Sciences. 2020 Dec;6:1-6.
3. V R Charan Teja*, V. Harini Chowdary, Y. Prasanna Raju, N. Surendra, R. Vishnu Vardhan, B. Kiran Kumar Reddy: A Glimpse on solid lipid nanoparticles as drug delivery systems, Journal of Global Trends in Pharmaceutical Sciences, 5(2): 1649-57. (2014
4. Yakindra Prasad Timilsena, Taiwo O. Akanbi, Nauman Khalid, Benu Adhikari, Colin J. Barrow, Complex coacervation: Principles, mechanisms, and applications in microencapsulation. Biomac (2018), doi:10.1016/j.ijbiomac.2018.10.144.
5. Farooq, S., Ngaini, Z., & Farooq, S. (2021). Manufacturing and design of smart polymer composites. *Smart Polymer Nanocomposites*, 27-84. https://doi.org/10.1016/B978-0-12-819961-9.00003-7
6. Abdelkader A, Fathi HA, Hamad MA, Elsabahy M. Nanomedicine: a new paradigm to overcome drug incompatibilities. Journal of Pharmacy and Pharmacology. 2020 Oct;72(10):1289-305.
7. Reis CP, Neufeld RJ, Ribeiro AJ, et al. Nanoencapsulation I. Methods for preparation of drug-loaded polymeric nanoparticles. Nanomedicine: Nanotechnology, Biology, and Medicine 2006; 2(1): 8–21.
8. Song C.X., Labhasetwar V., Murphy H., Qu X., Humphrey W.R., Shebuski R.J., Levy R.J., Formulation and characterization of biodegradable nanoparticles for intravascular local drug delivery, J. Control. Rel., 1997, 43(2-3),197-212.
9. Wang ZL. New developments in transmission electron microscopy for nanotechnology. Advanced Materials. 2003 Sep 16;15(18):1497-514.
10. Mohammed A, Abdullah A. Scanning electron microscopy (SEM): A review. In Proceedings of the 2018 International Conference on Hydraulics and Pneumatics—HERVEX, Băile Govora, Romania 2018 Nov 7 (Vol. 2018, pp. 7-9).
11. Khodadadi M, Malekpour A, Mehrgardi MA. Aptamer functionalized magnetic nanoparticles for effective extraction of ultra-trace amounts of aflatoxin M1 before its determination by HPLC—Journal of Chromatography A. 2018 Aug 24;1564:85-93.
12. Trache A, Meininger GA. Atomic force microscopy (AFM). Current protocols in microbiology. 2008 Feb;8(1):2C-
13. Plank C: Nanomedicine: Silence the target. Nature Nanotechnology. 2009, 4:544 – 545
14. Lu G, Crihfield CL, Gattu S, Veltri LM, Holland LA. Capillary electrophoresis separations of glycans. Chemical reviews. 2018 Mar 12;118(17):7867-85.
15. Hollander JM, Jolly WL. X-ray photoelectron spectroscopy. Accounts of chemical research. 1970 Jun 1;3(6):193-200.
16. W.C.W. Chan, S. Nie, "Quantum dot bioconjugates for ultrasensitive nonisotopic detection," *Science*, 281:2016-18, 1998.
17. Sandhiya, V., Ubaidulla, U. A review on herbal drug loaded into pharmaceutical carrier techniques and its evaluation process. *Futur J Pharm Sci* **6**, 51 (2020). https://doi.org/10.1186/s43094-020-00050-0
18. Zhang L, Gu FX, Chan JM, Wang AZ, Langer RS, Farokhzad OC. Nanoparticles in medicine: therapeutic applications and developments. Clinical pharmacology & therapeutics. 2008 May;83(5):761-9.
19. Qi C, Liu X, Zhi D, Tai Y, Liu Y, Sun Q, Wang K, Wang S, Midgley AC, Kong D. Exosome-mimicking nanovesicles derived from the efficacy-potentiated stem cell membrane and secretome for regeneration of injured tissue. Nano Research. 2022 Feb;15:1680-90.
20. Rex JH, Eisenstein BI, Alder J, Goldberger M, Meyer R, Dane A, Friedland I, Knirsch C, Sanhai WR, Tomayko J, Lancaster C. A comprehensive regulatory framework to address the unmet need for new antibacterial treatments. The Lancet Infectious Diseases. 2013 Mar 1;13(3):269-75.
21. Chou SY, Krauss PR, Renstrom PJ. Nanoimprint lithography. Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures Processing, Measurement, and Phenomena. 1996 Nov;14(6):4129-33.
22. Sharma A, Panwar V, Mondal B, Prasher D, Bera MK, Thomas J, Kumar A, Kamboj N, Mandal D, Ghosh D. Electrical stimulation induced by a piezo-driven triboelectric nanogenerator and electroactive hydrogel composite, accelerate wound repair. Nano Energy. 2022 Aug 1;99:107419.
23. Veien M, Sørensen JV, Madsen F, Juelsgaard P. Tranexamic acid given intraoperatively reduces blood loss after total knee replacement: a randomized, controlled study. Acta Anaesthesiologica Scandinavica. 2002 Nov;46(10):1206-11.
24. Farahani E, Patra HK, Jangamreddy JR, Rashedi I, Kawalec M, Rao Pariti RK, Batakis P, Wiechec E. Cell adhesion molecules and their relation to (cancer) cell stemness. Carcinogenesis. 2014 Apr 1;35(4):747-59.
25. Rotman J, Koster BD, Jordanova ES, Heeren AM, de Gruijl TD. Unlocking the therapeutic potential of primary tumor-draining lymph nodes. Cancer Immunology, Immunotherapy. 2019 Oct;68:1681-8.

2. AUTHORS CONTRIBUTION STATEMENT

Author R. Swethasri contributed to this article by gathering the resources, and Author K. Chaitanya, Mogili.Sumakanth drafted the manuscript and revised it. All authors approved the manuscript's published form after they had read it.

3. CONFLICT OF INTEREST

Conflict of interest declared none.

26. Sharma S, Bhatia A, Gakkhar N. Nanotechnology in cancer therapy: An overview and perspectives. Int J Pharmaceut Chem Anal. 2019;6(4):110-4
27. Tripathi R, Kumar A. Application of nanorobotics for cancer treatment. Materials Today: Proceedings. 2018 Jan 1;5(3):9114-7.
28. Soetaert F, Korangath P, Serantes D, Fiering S, Ivkov R. Cancer therapy with iron oxide nanoparticles: Agents of thermal and immune therapies. She advanced Drug Delivery Reviews. 2020 Jan 1;163:65-83.
29. Bock N, Dargaville TR, Woodruff MA. Electrospraying of polymers with therapeutic molecules: State of the art. Progress in polymer science. 2012 Nov 1;37(11):1510-51.
30. Checot F, Lecommandoux S, Klok HA, Gnanou Y. From supramolecular polymersomes to stimuli-responsive nano-capsules based on poly (diene-b-peptide) diblock copolymers. The European Physical Journal E. 2003 Jan;10:25-35.
31. Mamalis AG. Recent advances in nanotechnology. Journal of Materials Processing Technology. 2007 Jan 1;181(1-3):52-8.