

Nanobiosynthesis

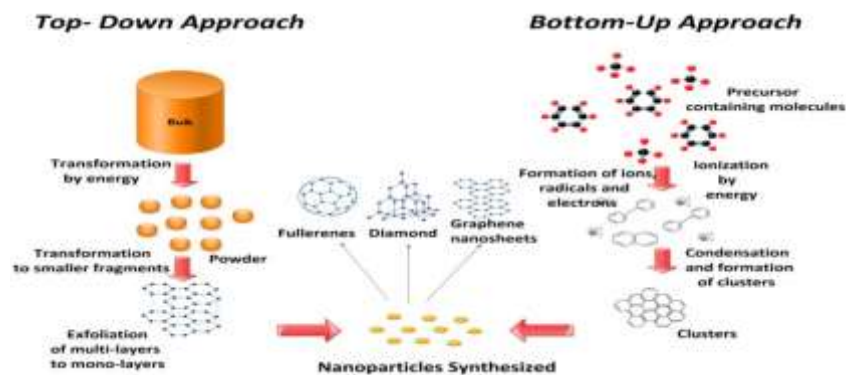
To date, there are numerous techniques for synthesizing nanoparticles. However, these techniques fall into two broad approaches and can be defined as either a top down approach or a bottom up approach.

- **The top down approach** starts with a material of interest, which then undergoes size reduction via physical and chemical processes to produce nanoparticles.

Importantly, nanoparticles are highly dependent on their size, shape, and surface structure and processing tends to introduce surface imperfections.

- **The bottom up approach** nanoparticles are built from atoms, molecules and smaller monomers.

In either approach, the resulting nanoparticles are characterized using various techniques to determine properties such as particle size, size distribution, shape, and surface area.



PHYSICAL AND CHEMICAL METHODS

Various physical and chemical processes have been exploited in the synthesis of several inorganic metal nanoparticles by wet and dry approaches.

The high energy requirement in physical methods of nanoparticle synthesis and the waste disposal problems in chemical synthesis, so both methods are costly and generate toxic by product are major demerits of the conventional nanoparticle synthesis.

However, these methods are burdened with various problems including:

- use of harmful chemical agents.
- production of hazardous property.
- expensive chemicals.
- and high energy consumption.

Biosynthesis of nanoparticles

Accordingly, there is a necessary need to extend for environmentally benign procedures for synthesis of nanoparticles.

A promising move towards to reach this objective is to develop the array of biological resources in nature.

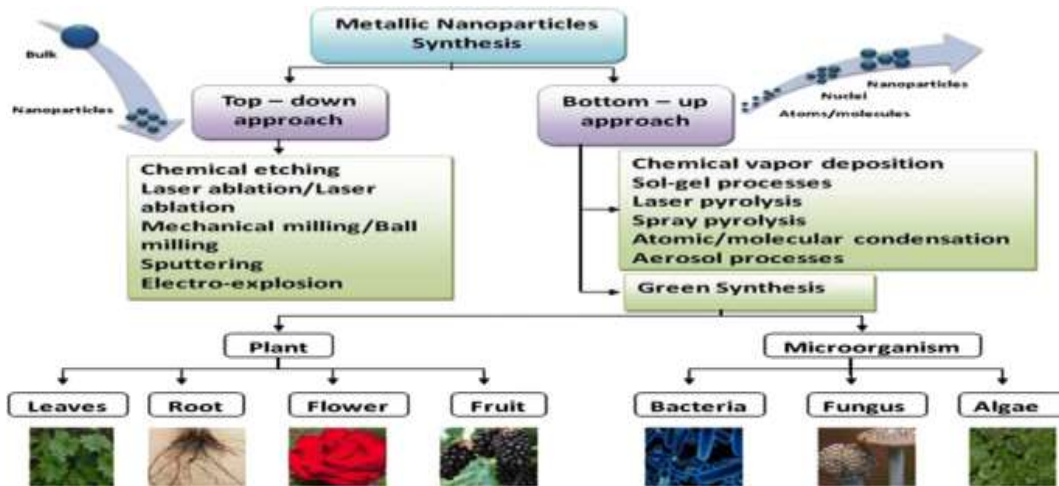
Such drawbacks demand the development of clean, nonhazardous, inexpensive, energy-efficient, and eco-friendly methods for nanoparticles synthesis.

Biosynthesis is the phenomena which take place by means of biological or enzymatic reaction.

The most adaptable location of biosynthesis of nanoparticles is biological cellular entities and their cell membrane.

Over the past several years, the biological method for the synthesis of nanoparticles employs use of biological agents like:

- Plants
- Algae
- Fungi
- Actinomycetes
- Yeast
- Bacteria
- and viruses have been used for production of nanoparticles.



The main interest is production of nanoparticles using a biological method from a cheap resource and uniform production of nanoparticles.

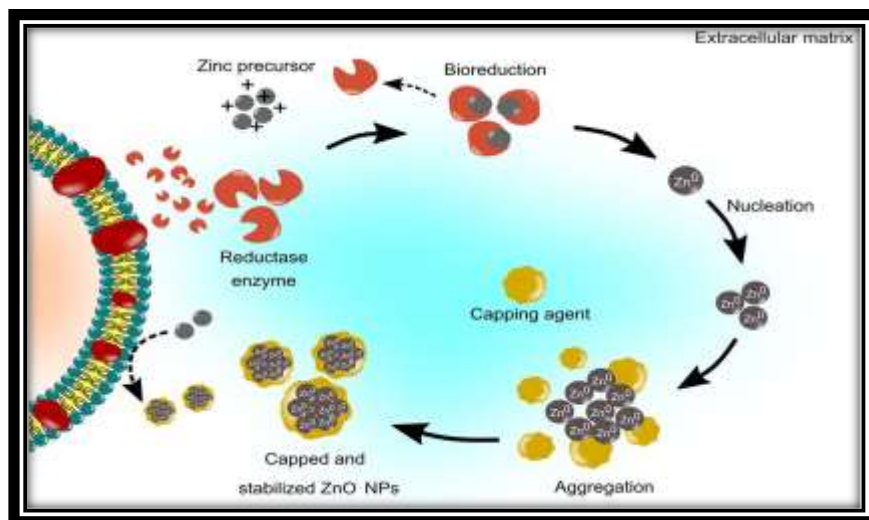
Utilizing a biological source gives an easy approach, easy multiplication, and easy increase of biomass.

A great deal of study has been carried out on synthesis of nanoparticles by prokaryotic bacteria since they are the easiest organisms to handle and can be manipulated most easily.

Nanoparticle synthesis by Bacteria

Nanoparticles are synthesized by microbes and have biological applications in the fields of bioremediation, bio-mineralization, bioleaching, and bio-corrosion.

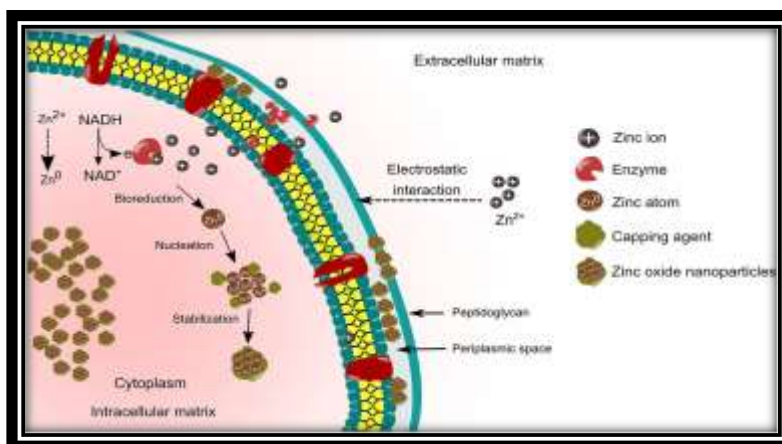
Bacteria are able to form nanoparticles both intracellularly via bioaccumulation and extracellularly on the cell wall using its enzymes.



Hence, extracellular production has more commercial applications in various fields.

Experiments show that the growth phase of the cells affect the formation rate of nanoparticles and is 20 times more in stationary phase than logarithmic phase.

To obtain intracellular particles from bacteria requires further processing steps like ultrasound treatment or reaction with suitable detergents.



This property can be exploited for extraction of precious metals from mine wastes.

When cell wall reductive enzymes or secreted enzymes are involved in the reduction of metal ions then it is logical to find the metal nanoparticles outside the cell.

The mechanisms which are considered for the biosynthesis of nanoparticles included:

- efflux system.
- alteration of solubility and toxicity via reduction or oxidation.
- bio-absorption.
- Bioaccumulation.
- and precipitation of metals.

A prokaryotic bacterium *Rhodopseudomonas capsulata*, was found to deposit gold nanoparticles of 10-20 nanometers at 7 pH and room temperature extracellularly.

Similarly, silver nanoparticles can be produced extracellularly using *Enterobacter culture supernatant*.

These bacteria secrete enzymes in their culture solutions which are able to reduce silver and assist in the formation silver nanoparticles.

When *Klebsiella aerogenes* is exposed cadmium ions in the growth medium it forms cadmium sulfide nanoparticles of 20-200 nanometers deposited on the cell surface.

Escherichia coli when incubated with cadmium chloride and sodium sulfide forms intracellular cadmium sulfide nanoparticles in crystal phase.

In the case of biological synthesis of nanoparticles, the aqueous metal ion precursors from metal salts are reduced and as a result a color change occurs in the reaction mixture.

This is the first qualitative indication that nanoparticles are being formed. Some of the spectroscopy and microscopy techniques routinely used.