Lec 6- Biosynthesis of Nanoparticles from Plants

Biological (Green) synthesis:

Microscopic: Bacteria, Actinomycetes, Fungi, microalgae, viruses.

Macroscopic: Algae, Seaweeds, Plant Extracts (Leaves, Bark, Stem, Shoots, Seeds, Latex, Secondary metabolites, Roots, Twigs, peel, fruit, seedlings, essential oils, Tissue cultures, Gum)

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, biocompatible, nonhazardous, inexpensive, energy-efficient, and eco-friendly methods for nanoparticles synthesis.

Phytonanotechnology

Phytonanotechnology has provided new avenues for the synthesis of nanoparticles and is an ecofriendly, simple, rapid, stable, and cost-effective method.

Phytonanotechnology has advantages, including: biocompatibility, Scalability, and the medical applicability of synthesizing nanoparticles using the universal solvent, water, as a reducing medium.

Mechanism of Biosynthesis

The exact mechanism and the components responsible for plant-mediated synthetic nanoparticles remain to be elucidated.

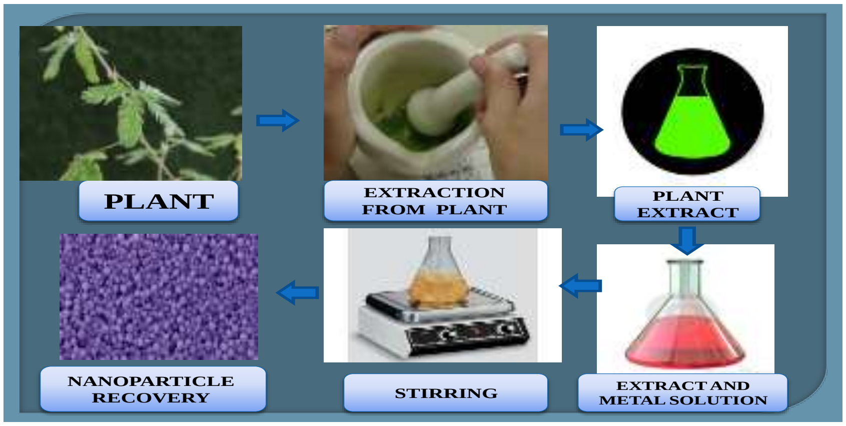
It has been proposed that proteins, amino acids, organic acid, vitamins, as well as secondary metabolites, such as flavonoids, alkaloids, polyphenols, terpenoids, heterocyclic compounds, and polysaccharides, have significant roles in metal salt reduction and, furthermore, act as capping and stabilizing agents for synthesized nanoparticles.

Reports also suggest that different mechanisms for synthesizing nanoparticles exist in different plant species. Additionally, various plant parts, including leaves, fruits, stems, roots, and their extracts, have been used for the synthesis of metal nanoparticles

Plant extracts

The reduction method using plant extracts is one step, low cost and eco-friendly, hence considered as the most preferred way for the synthesis of metal nanoparticles. Thus, this method may be included in the class of green technology.

Among various nanometals explored so far, nanoparticles of silver, gold, copper, zinc, palladium, titanium, nickel, indium etc. have been prepared by using a wide variety of plant extracts



Leaf extracts

The leaves of plants like *Mentha, Ocimum, and Eucalyptus were reported for the synthesis of* gold nanoparticles. The gold nanoparticles were polymorphic, stable, size 30–130 nm in non agglomerated form.

Seed extracts

The synthesis of silver nanoparticles through seeds of the plant *Elaeocarpus granitrus Roxb. (Rudraksha)* was reported. The synthesis of silver nanoparticles was reported using aqueous seed extract of *Jatropha curcas. The stable silver* nanoparticles at different concentration of AgNO3 were spherical in shape with diameter ranging from 15 to 50 nm.

Essential oils

The synthesis of gold nanoparticles with essential oils extracted from the fresh leaves of *Anacardium occidentale* was reported. The NPs synthesized at room temperature were hexagonal in shape while at higher temperature were a mixture of an isotropic particles.

Peel extract

The biosynthesis of silver nanoparticles (AgNPs) from *Citrus sinensis peel extract was* reported. The synthesized AgNPs were an effective antibacterial agent against *Escherichia coli, Pseudomonas aeruginosa and Staphylococcus aureus*.

The aqueous extracts from the peels of Citrus fruits (orange, grapefruit, tangelo, lemon and lime) were used for the synthesis of AgNPs using microwave technology; the synthesis was successful for the orange peel extract.

Secondary metabolites

The plant broth of *Phyllanthus amarus* containing secondary metabolites was used for the formation of silver nanoparticles (AgNPs). The coconut water was used for synthesis of gold nanoparticles through microwave irradiation.

Stem extracts

The stem extract of *Breynia rhamnoides* was used for synthesis of gold and silver nanoparticles was reported. The nanoparticles showed antibacterial property against multi-drug resistant bacteria such as *Streptococcus pyogens, Pseudomonas aeruginosa, Escherichia coli, Bacillus subtilis* and *Staphylococcus aureus.*

Fruit extracts

Tribulus terrestris L. fruit bodies were used for synthesis of silver nanoparticles. The nanoparticles were spherical shaped with 16-28 nm of size.

Latex extracts

The latex of *Jatropha curcas was used in* silver nanoparticles synthesis. The particles radius was 10–20 nm.

Tissue culture extracts

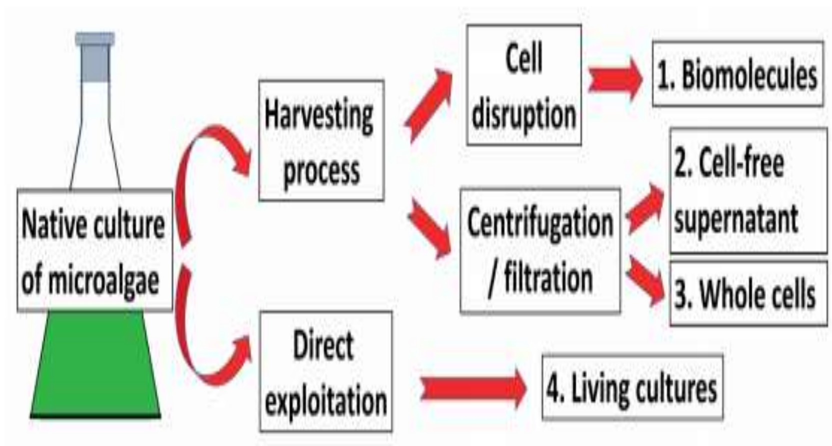
The extracts from tissue culture-derived callus and leaf of the salt marsh plant (*Sesuvium portulacastrum L.)* used in the synthesis of silver nanoparticles. The callus extract was able to produce antimicrobial silver nanoparticles than leaf extract. The silver nanoparticles synthesized were spherical in shape with size 5 to 20 nm. The silver nanoparticles inhibited clinical test strains of bacteria and fungi.

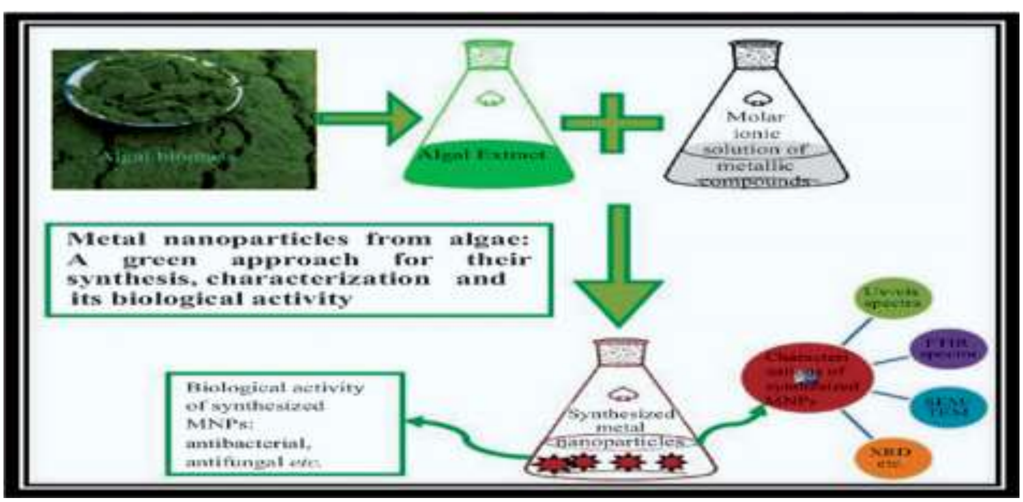
Phyconanotechnology

Nanosynthesis by algae. Microalgae are microorganisms of choice in biotechnology due to their wide range of potential bio-applications, such as:

- Over-expression of pigments.
- Bioremediation.
- Biofuel production.
- Nanomaterial production.

Different methodologies devised for the exploitation of microalgae in the biosynthesis of nanomaterials





NPs of the different parameters such as dispersion, surface properties, agglomeration and de-agglomeration can be controlled using :

ultrasonication, ionic strength and pH of aqueous solutions, physiological buffers, and cell culture media.