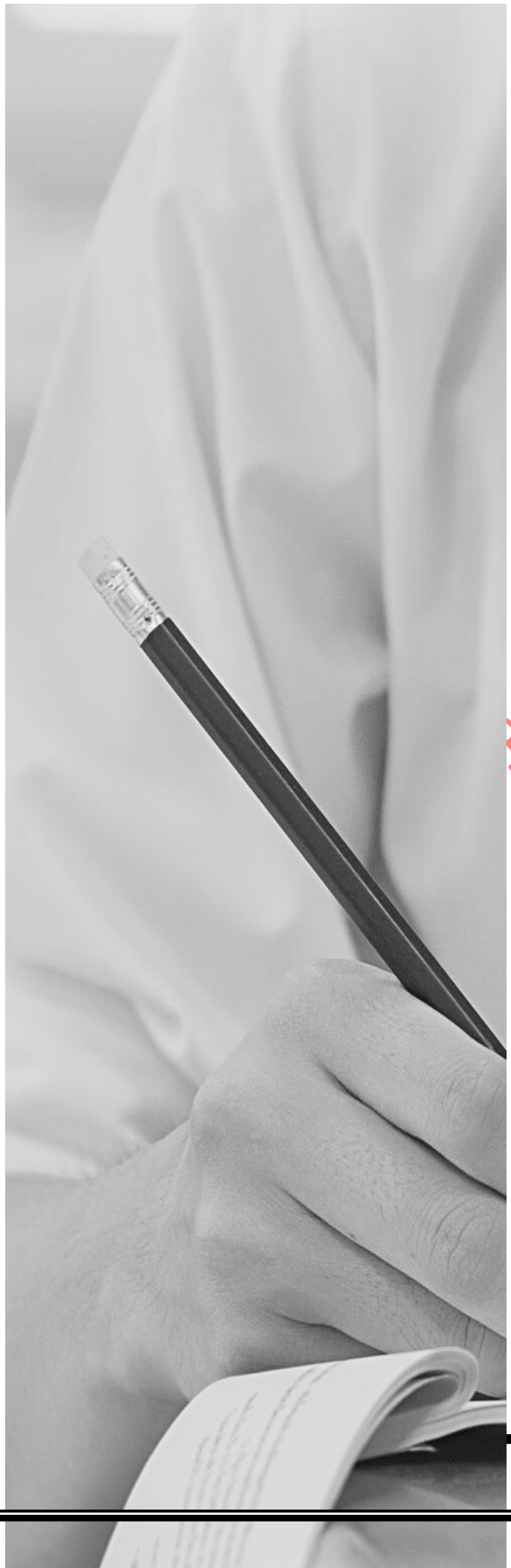

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Lect.3.

Preparation of Nanoparticaies by Biological method:

Microorganisms-mediated synthesis of NPs.

An alternative way of synthesizing NPs is by using living organisms such as bacteria, fungi, and yeast.

Magnetotactic bacteria are used in the production of magnetic oxide NPs that possess unique superparamagnetic properties.

The formation of nanoparticles by organisms was a green method that used fungi, bacteria, and viruses' enzymes and secondary metabolites.

These kinds of organisms provide primary substances for the synthesis and manipulation of better-organized nanoparticles

Biosynthesis is a green technique that involves metal atoms creating clusters and eventually nanoparticles, and it synthesized from the bottom-up method.

Chemical reduction is related to the biosynthetic idea, although green materials are used instead of expensive and toxic chemicals to synthesis nanoparticles.

Lect.3.

The preparation of nanoparticles using biological methods, often referred to as "green synthesis," is an eco-friendly and sustainable approach that leverages biological entities such as microorganisms, plants, and enzymes.

These methods are advantageous due to their cost-effectiveness, low toxicity, and ability to produce nanoparticles with unique properties. Below is an overview of the biological methods for nanoparticle synthesis, along with key references for further reading.

BIOLOGICAL (Green synthesis)

Green synthesis 3 types:

1-Use of microorganisms like fungi, yeats(eukaryotes) or bacteria

actinomycetes(prokaryotes).

2-Use of plant extracts or enzymes .

3-Use of templates like DNA, membranes, viruses and diatoms

The metal nanoparticles synthesized using fungal species is referred to as 'mycogenic nanoparticles' while those synthesized using bacterial species is known as 'bacterioform nanoparticles.

Even higher plants.

have been shown to be effective in synthesizing silver and gold nanoparticles and the amount of reports available in this topic is too large to be summarized.

Lect.3.

2-Microbial Synthesis of Nanoparticles .

Microorganisms such as bacteria, fungi, and yeast can reduce metal ions to form nanoparticles. These organisms produce enzymes and biomolecules that act as reducing and stabilizing agents.

Bacteria: Certain bacteria, such as *Pseudomonas aeruginosa, Bacillus subtilis*, and Escherichia coli*, can synthesize metal nanoparticles (e.g., silver, gold, and iron oxide) by reducing metal ions extracellularly or intracellularly.

Fungi: Fungi like *Fusarium oxysporum, Aspergillus niger*, and Trichoderma viride are widely used for nanoparticle synthesis due to their high secretion of enzymes and proteins.

Mechanism:

Microbial enzymes (e.g., nitrate reductase) and biomolecules (e.g., proteins, peptides) reduce metal ions (e.g., Ag^{+}, Au^{3+}) to their corresponding nanoparticles (e.g., Ag^{0}, (Au^{0}).

Lect.3.

2-Plant-Mediated Synthesis of Nanoparticles .

Plant extracts are rich in phytochemicals such as flavonoids, terpenoids, and polyphenols, which act as reducing and capping agents for nanoparticle synthesis. This method is simple, cost-effective, and scalable.

Examples: Extracts from plants like *Azadirachta indica* (neem), *Aloe vera*Ocimum sanctum* (tulsi), and *Camellia sinensis* (green tea) have been used to synthesize silver, gold, zinc oxide, and iron oxide nanoparticles.**

Mechanism: Phytochemicals reduce metal ions and stabilize the nanoparticles, preventing aggregation.

.Lect.3.

3-Enzyme-Mediated Synthesis .

Enzymes such as nitrate reductase, laccase, and dehydrogenase can catalyze the reduction of metal ions to form nanoparticles.

This method offers high specificity and control over nanoparticle size and shape.

Examples: The enzyme nitrate reductase from *Fusarium oxysporum has been used to synthesize silver nanoparticles.

Mechanism: Enzymes reduce metal ions directly or indirectly through cofactors like NADH.

Lect.3.

4-Algae and Actinomycetes-Mediated Synthesis .

Algae and actinomycetes are also used for nanoparticle synthesis due to their ability to produce bioactive compounds.

Actinomycetes: These filamentous bacteria, such as Streptomyces spp., are known for their ability to produce metal nanoparticles.

5-Advantages of Biological Methods .

Eco-friendly: Minimal use of toxic chemicals**

Cost-effective: Utilizes renewable biological resources**

Biocompatibility: Produces nanoparticles suitable for biomedical applications.**

Scalability: Can be scaled up for industrial production.**

Applications of Biologically Synthesized Nanoparticles

Medical: Drug delivery, antimicrobial agents, cancer therapy.

Environmental: Water purification, pollutant degradation.**

Industrial: Catalysis, sensors, and coatings.

Lect.3.

Biological Synthesis of Metal Nanoparticles via Plants

It has long been known that plants have the potential to hyperaccumulate and biologically reduce metallic ions .

Because of these environment-friendly route for biologically synthesizing metallic nanoparticles and for detoxification applications.

Plant extracts containing bioactive alkaloids, phenolic acids, polyphenols

proteins and sugars are believed to have an important role in first

reducing the metallic ions and then stabilizing them.

Plants and Plant extracts as a tool for biosynthesis nanoparticles:

Provides single step biosynthesis process.

Protocols involving free from toxicants and natural capping agents.

Can generate bimetallic silver and gold shell nanoparticles.

Excellent stability and size control.

cost-effective large-scale production of metallic.

semiconductor and metal oxide nanoparticles.

Lect.3.

Nanoparticles via Plants

It has long been known that plants have the potential to hyperaccumulate and biologically reduce metallic ions.

Because of these interesting properties, plants have been considered a more environment-friendly route for biologically synthesizing metallic nanoparticles and for detoxification applications.Plant extracts containing bioactive alkaloids, phenolic acids, polyphenols, proteins and sugars are believed to have an important role in first reducing the metallic ions and then stabilizing them.

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