Nanomaterial Synthesis

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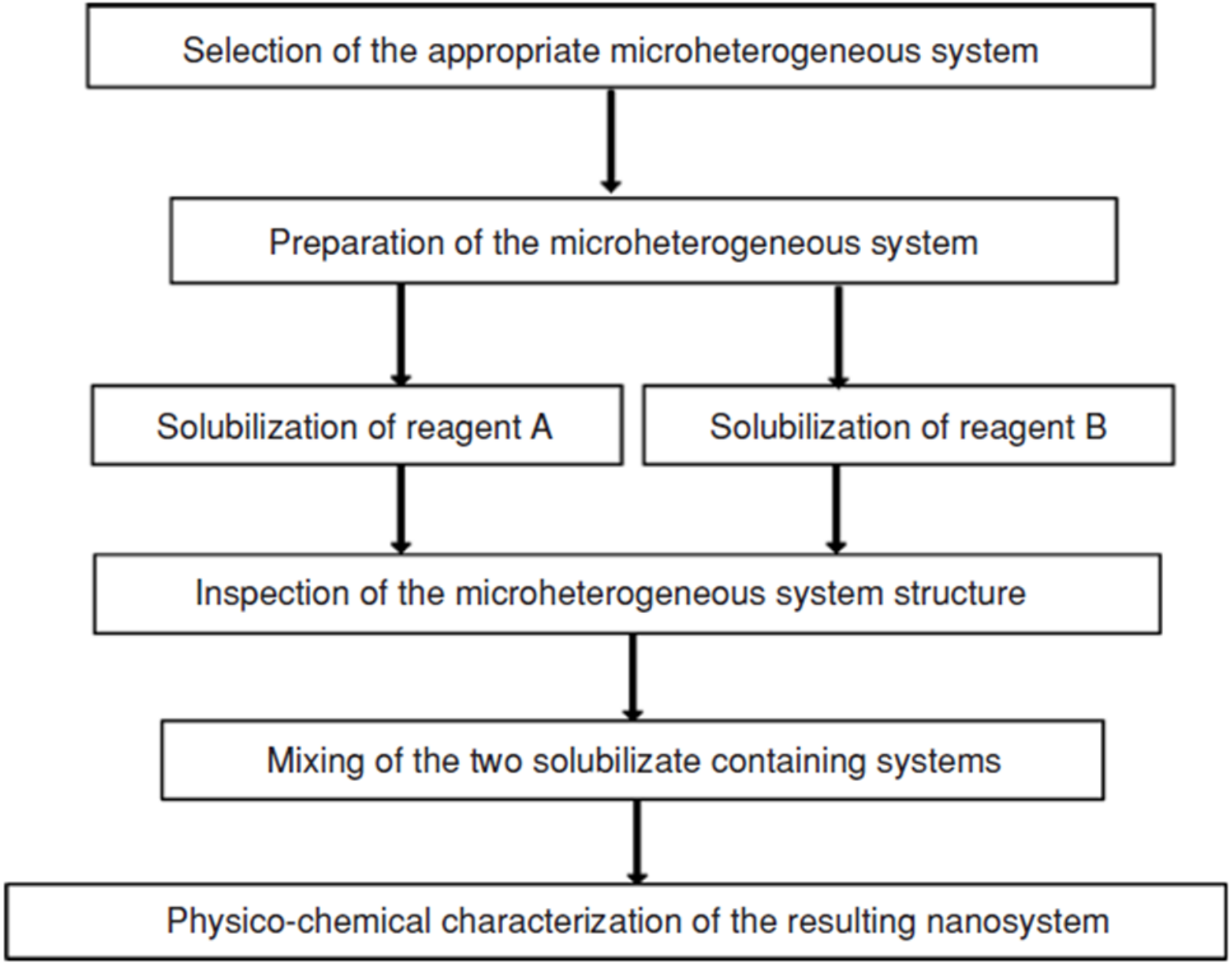
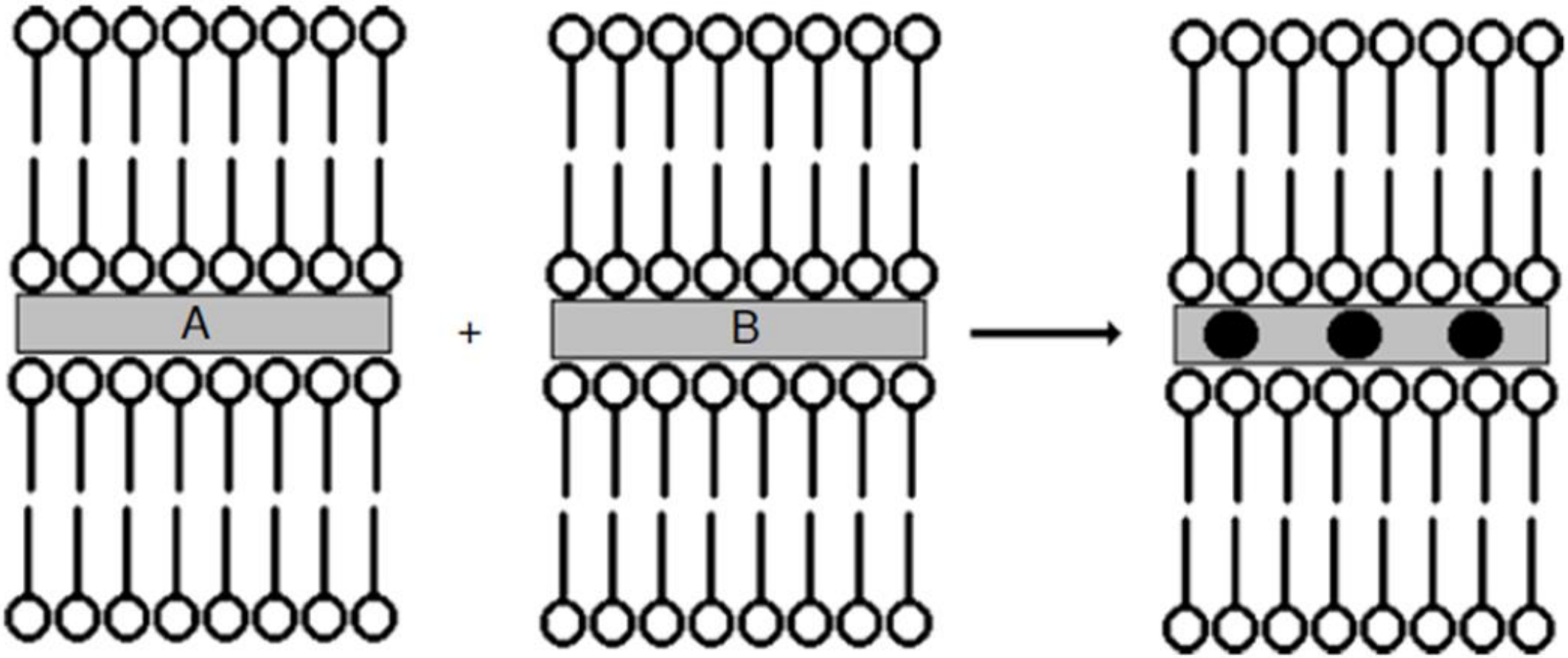


Block diagram of nanoparticle synthetic procedures.



Nanoparticles synthesis in liquid crystals

Zinc Oxide Nanostructures Green Synthesis

- Because of the availability of zinc element and the relatively easy conversion of its oxide to nanostructures, ZnO-based nanomaterials have been demonstrated to be of significant utility for various prominent applications from the beginning of nanoscience.
- ZnO, as nanoparticles, nanowires, nanofibers, and a variety of other advanced nanostructures, is currently one of the pioneer nanomaterials used in solar systems, fuel cells, and medicinal sectors.

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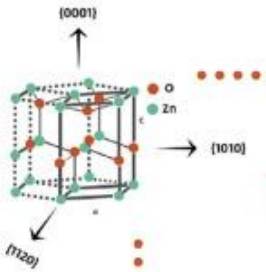
Methods of Zn/ZnO NPs synthesis

- Vapor/Gas Phase
- Liquid Phase
- Solid Phase

Physical methods

- Physical vapor deposition
- Arc plasma method
- Thermal evaporation
- Ultrasonic irradiation



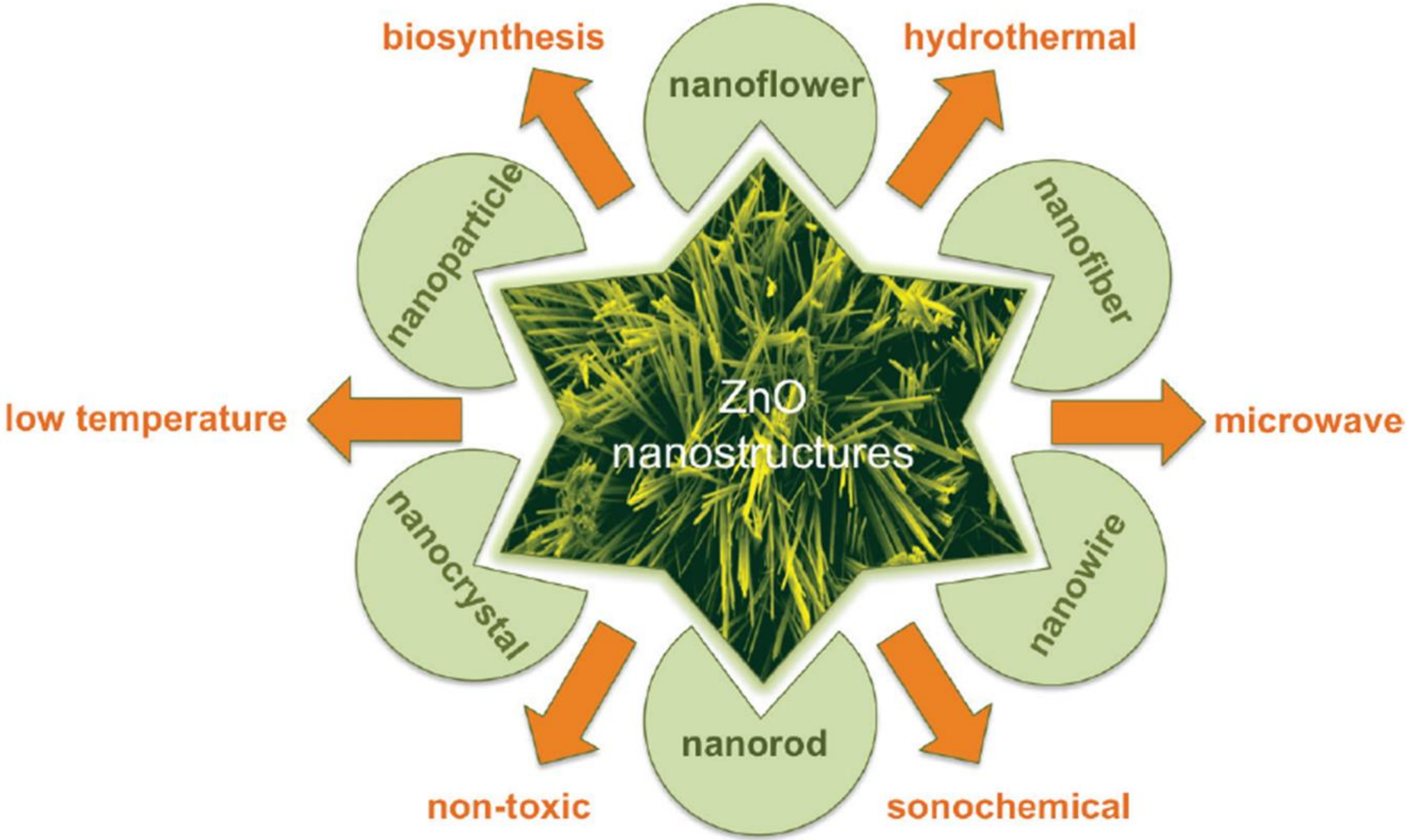
Biological methods

- Plant extracts
- Microorganisms
- Biotechnology
- Biochemistry methods

Chemical methods

- Microemulsion
- Sol-gel
- Precipitation
- Chemical reduction
- Hydrothermal method
- Solvothermal method
- Chemical vapor deposition

https://doi.org/10.1016/j.cis.2017.07.033

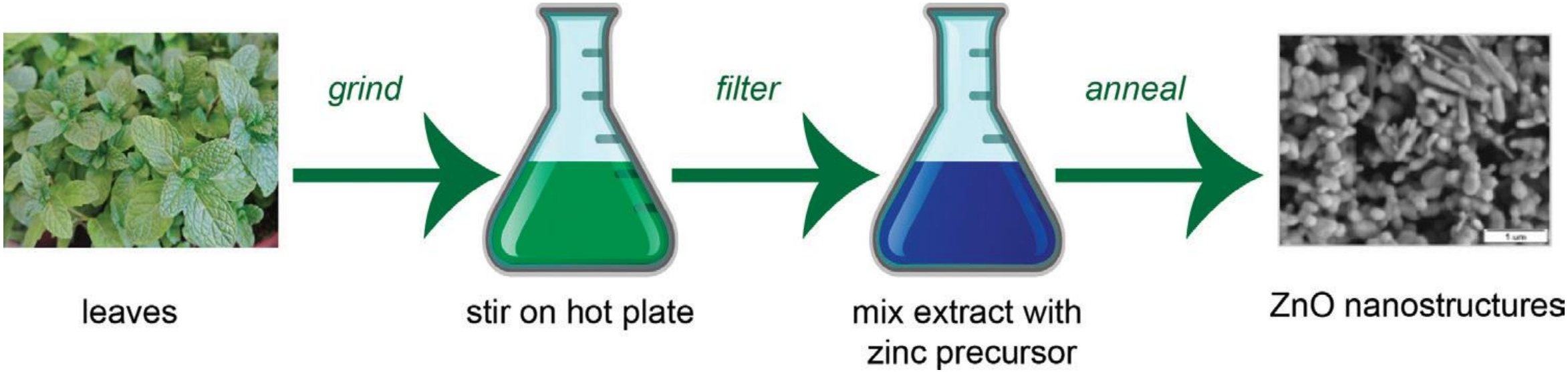


Green synthesis of ZnO nanostructures with diverse morphologies.

Biosynthesis of ZnO nanostructures

Natural extract-based ZnO nanostructures

- For many years, natural extracts (mostly **phytochemicals**) derived from plants, leaves, fruit peels, flowers, and seeds have been used in the green production of metal oxide nanoparticles.



ZnO nanostructures are synthesized from leaf extracts.

- The oxidation and reduction of the metal ion 'zinc' by phytochemicals contained in natural extracts is the essential process. The extracts of the leaves work as reducing and capping agents.

- The synthesis technique can be completed without the use of any chemical stabilizers when plant extracts are used.
- Nanoparticles synthesized by the green route exhibit better antibacterial performances due to the functional groups on their surfaces that come from phytochemicals

- Finally, the powders are washed with methanol or ethanol before being annealed at high temperatures to achieve purity.

The benefit of employing natural extracts for ZnO nanoparticle synthesis is that coating nanoparticles with diverse pharmacologically active biomolecules on the metal oxide surface allows nanoparticles to be conjugated with bacterial membrane receptors.

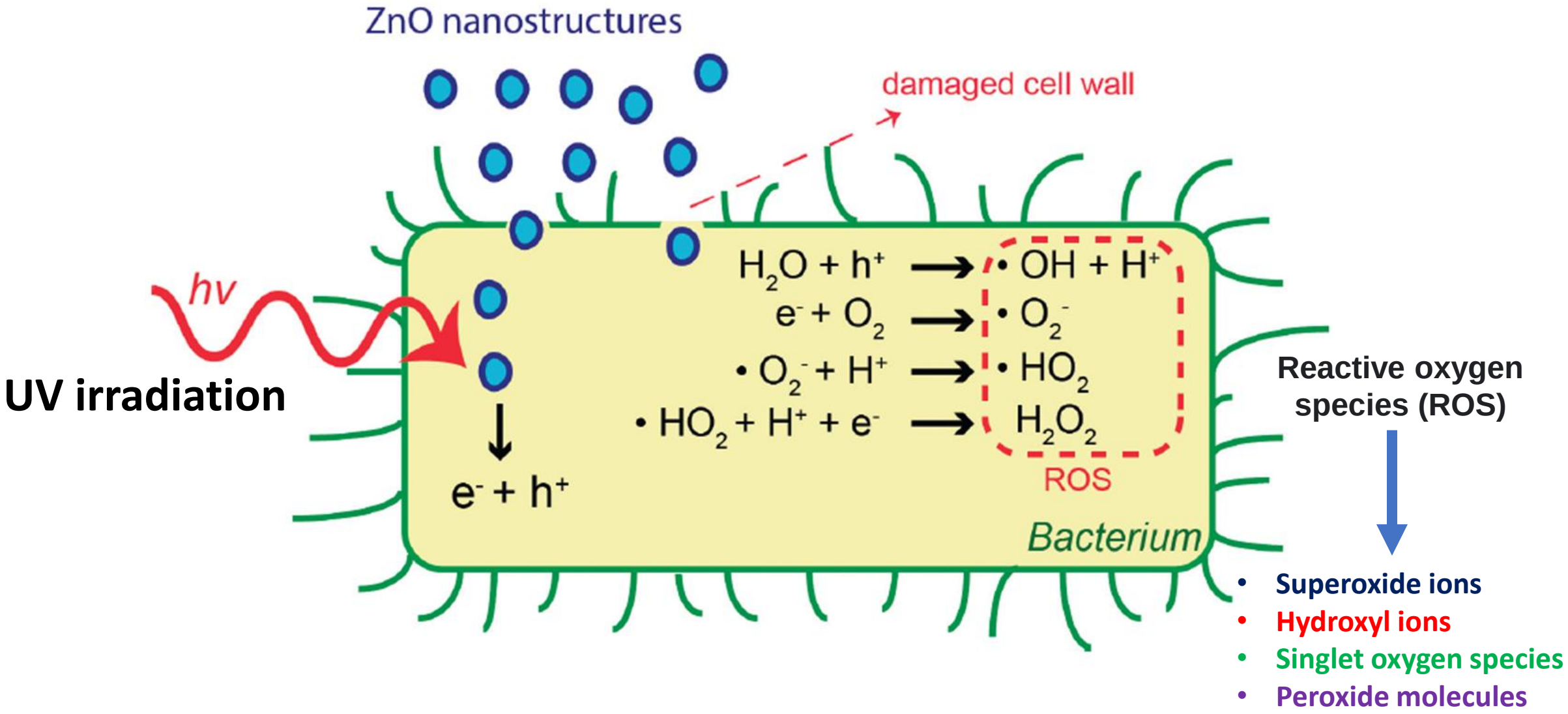
These compounds might be flavones, aldehydes, amides, polysaccharides, or others, and green generated nanoparticles have **higher** biological activity than chemically manufactured nanoparticles.

The ZnO nanoparticles show antibacterial activity against a broad spectrum of pathogenic bacteria, and these nanoparticles adopt various mechanisms such as:

1. Reactive oxygen species (ROS) generation,
2. Cell membrane integrity disruption,
3. Biofilm formation, or
4. Enzyme inhibition

Reactive Oxygen Species (ROS) is a phrase used to describe several reactive molecules and free radicals derived from molecular oxygen.

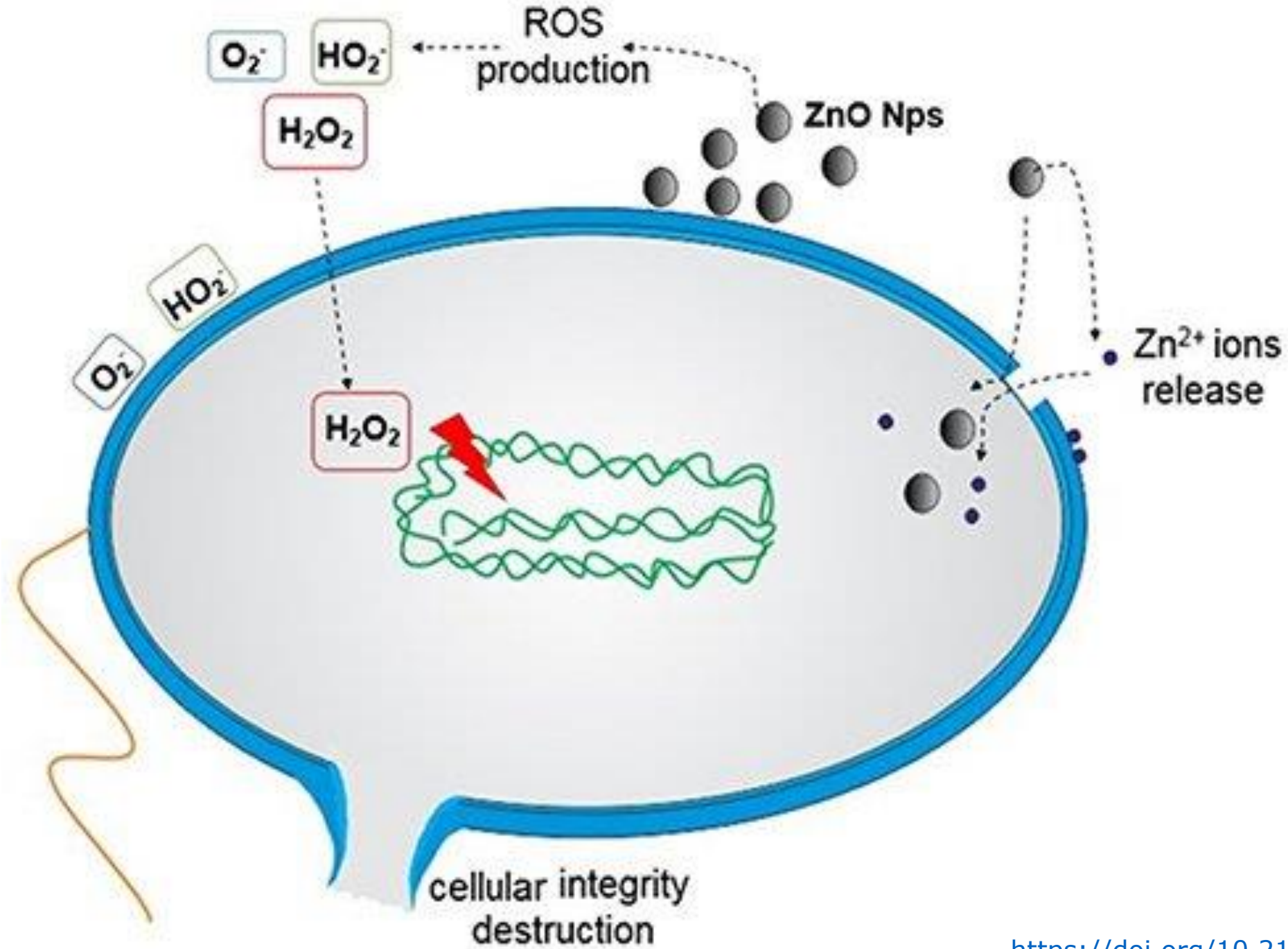
1. ZnO nanoparticles' ROS mechanism



2. Cell membrane integrity disruption

is another significant mechanism for the antibacterial effect of ZnO nanoparticles.

Penetration of ZnO nanoparticles results in cell death by the loss of phospholipid bilayer integrity and leakage of intracellular components of the cell.



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Synthesis of ZnO nanostructures processes

1. Hydrothermal synthesis of ZnO nanostructures
2. Microwave-assisted synthesis of ZnO nanostructures
3. Sonochemical synthesis of ZnO nanostructures
4. Low temperature synthesis of ZnO nanostructures

Synthesis of ZnO nanoparticles

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Synthesis of ZnO nanoparticles by precipitation technique

Materials

Synthesis of ZnO nanoparticles

Green Synthesis of Sliver nanoparticles

Chemical synthesis of Sliver nanoparticles

Synthesis of Gold Nanoparticles

Green Iron Nanoparticle Synthesis using Green Tea Extract

Thank you