

WRAP Exams · wrapexams.com

Prelims PYQ, Mains model answers, and copy evaluation. Write to the desk for this paper, a doubt, or the AI waitlist.

ask@wrapexams.com · +91 85951 84903 · wrapexams.com

Q5

What do you understand by nanotechnology and how is it helping in health sector?

UPSC Civil Services Mains 2020 · GS III · 10 marks · Indian Economy

Indian Economy and issues relating to planning, mobilization of resources, growth, development and employment.

Core demand of the question

- What do you understand by nanotechnology and how is it helping in the health sector?
- Keep the explanation within a 10-mark length

Revision summary

Nanotechnology designs matter at 1-100 nanometres, where surfaces and optics change.

Health uses include targeted drug carriers, imaging agents, and antimicrobial coatings.

Lateral-flow tests and liposomal chemotherapies are working examples.

Lipid nanoparticles enabled mRNA COVID vaccines in 2020.

Toxicity, cost, and hype require regulation, not blanket enthusiasm.

Introduction

Nanotechnology is the design and use of materials and devices at the scale of roughly 1-100 nanometres, where surface chemistry and quantum behaviour differ from bulk matter. In health it is a set of tools for seeing, delivering, and killing at the scale of cells and proteins - not a single drug and not a magic powder.

Body

What it is

- A **nanometre** is one-billionth of a metre. At that size, gold, carbon, lipids, and polymers can be shaped as particles, tubes, shells, and films with new optical, catalytic, or barrier properties.
- **It sits across physics, chemistry, biology, and engineering: nanomedicine** is the health slice.
- India funds it through **Nano Mission** (DST) and related DBT/ICMR work, with the usual need for toxicity and ethics review.

Help in the health sector

- **Drug delivery:** liposomes and polymeric nanoparticles carry chemo or amphotericin to a target tissue, which can cut systemic toxicity (Doxil-type liposomal doxorubicin is the classic class).
- **Diagnostics and imaging:** **gold nanoparticles** and quantum dots improve assays and contrast; **lateral-flow** tests use gold conjugates - the same family as many rapid antigen strips.

- **Antimicrobials:** silver nanoparticles in coatings and some dressings; nano-enabled surfaces in hospitals. Stewardship still matters; nano is not a licence to skip hygiene.
- **Vaccines and biologics:** lipid nanoparticles became the delivery chassis for **mRNA COVID vaccines** in 2020 - a global health use of nano-formulation, even if India's first COVID shots were other platforms.
- **Implants and tissue:** nano-textured surfaces for better osseointegration; scaffolds for regenerative work still largely in trial.
- **Theranostics:** particles that both image and treat, especially in oncology research.

Cautions

- **ADME and toxicity** of persistent nanoparticles are not fully known; regulation must treat them as new entities, not as tiny versions of bulk powder.
- Cost and cold-chain for advanced nano-drugs can exclude public-hospital patients unless procurement is deliberate.
- Hype in cosmetics and 'nano-Ayurveda' claims should not be confused with peer-reviewed nanomedicine.

Flow diagram

Nanoscale 1-100 nm -> Drug delivery
Nanoscale 1-100 nm -> Diagnostics tests
Nanoscale 1-100 nm -> Lipid nanoparticle vaccines
Drug delivery -> Health sector
Diagnostics tests -> Health sector
Lipid nanoparticle vaccines -> Health sector

Conclusion

Nanotechnology is engineering at the billionth-of-a-metre scale. In health it already helps targeted drugs, rapid tests, coatings, and - globally in 2020 - lipid-nanoparticle vaccines. It helps as regulated medicine, not as a slogan on a bottle.

Facts & figures

Nano Mission

DST programme that funds Indian nanoscience and applications, including some health projects.

Liposomal drugs

Nano-scale lipid vesicles used to deliver difficult or toxic molecules with a better safety profile.

Gold nanoparticles

Common labels in rapid diagnostic strips because of strong colour at small size.

LNP mRNA vaccines

Lipid nanoparticles that packaged mRNA COVID vaccines in 2020; a landmark nano-formulation, not India's first indigenous COVID platform.

Silver nano coatings

Used in some medical devices and dressings for antimicrobial effect; resistance and toxicity still need watching.

WRAP Exams · Write. Read. Analyse. Practice. · <https://wrapexams.com/upsc/mains-answers/gs-3/2020/what-do-you-understand-by-nanotechnology-and-how-is-it-helping-in-health-sector/> · ask@wrapexams.com · wrapexams.com

WRAP Exams