

Nanomicelles

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The applications of nano-technology are widening. Nanomicelles have emerged as a ray of hope for efficient drug delivery. In this context, one has to study its different applications from examination point of view.

In news: A team of scientists has created a nanomicelle that can be used for effective drug delivery to treat various cancers.

Placing it in syllabus: S&T

Dimensions

1. What are different generations of nanomaterials?
2. What are nanomicelles?
3. What are nanoshells?
4. How do all these make drug delivery efficient?

Content:

What are different generations of nanomaterials?

Generation 1: Passive Nanostructures

- It is the creation of materials where we control their structure on a molecular level, but the actual product doesn't "do" anything.
- It has material properties that are useful or even revolutionary, but that's as far as it goes.
- This includes the creation and addition of nano-scale particles that change the properties of existing materials.
- **Additive that turns paint into radio-blocking material** is an example.
- These types of nanotechnology are delivered suspended in liquids (colloids) or sprayed from an aerosol.

Generation 2: Active Nanostructures

- The second generation of nanotechnology is one into which we are now moving.
- They are active in some way and make changes to other objects or materials.
- **Nanomedicines** are a prime example.

Generation 3: Systems of Nanosystems

- The third-generation of nanotechnology is one that we have yet to reach.
- This is where we see various nanomachines working together.
- **Nanofactories assembling molecules or complex large-scale machines and materials** are examples.

Generation 4: Molecular Nanosystems

- Fourth-generation is the perfection of this technology.
- At this level we have complete control of the actual molecules that make up our nanomachines.
- A fourth-generation nanomachine is made from different molecules with specific structures, with each molecule having a specific structure and function.

What are nanomicelles?

- Nanomicelles are formed when **amphiphilic molecules assemble themselves to create a globular structure that is only around 5 to 100nm in diameter.**
- The particles may be **formed in aqueous or non-aqueous solutions** where the nonpolar region forms the interior and the polar region forms the exterior.
- Because of this, nanomicelles are **able to take on both hydrophilic and hydrophobic agents.**
- Nanomicelles are typically spherical, but can sometimes take other shapes, such as cylinders and ellipsoids.
- The small size and shape of nanomicelles is only

possible due to the molecular geometry of the particle.

- The shapes formed also depend on the ionic strength, surfactant concentration and pH strength of the solutions they are placed in.

Different agents are used to create nanomicelles, however, they are usually made through surfactant molecules that may be non-ionic, ionic, and cationic detergents. Some nanomicelles may also be developed from a mixture of lipids and detergents.

Uses of nanomicelles:

- Micelles are used primarily as solutions for membrane proteins.
- Research shows that nanomicelles are more effective in studying the capabilities of such proteins, than bilayer vesicles because of their relatively smaller size.
- Nanomicelles could be used as therapeutic interventions involving protein and peptide delivery.

Advantages of nanomicelles:

- The primary advantage of nanomicelles is its core-shell structure.
- The hydrophobic contents within the nanomicelle shell facilitates the solubilization of hydrophobic drugs in water. At the same time, the hydrophilic shell itself acts as a protection for the drug by eliminating the MPS that enables prolonged circulation.
- Another advantage of nanomicelles is their low toxicity, ability to minimize drug degradation, ability to permeate tissues easily for drug delivery, and lower adverse drug side effects.

Disadvantages:

- Inefficient drug-loading capabilities (smaller than liposomes)
- Poor physical stability in vivo.

- Insufficient cellular interactions with neutral micelles.

What are nanoshells?

- Nanoshell (NS) is defined as the **product of catalytic carbonization of polymer with transition metals**, it is a type of nanocarbon that has a characteristic shape of hollow sphere with a **diameter ranging from 10 to 50 nm**.
- There are **two types of nanoshells**: oxide nanoshells (e.g., hollow silica nanoshells) and metal nanoshells (e.g., gold and silver nanoshells).
- The most significant **applications of nanoshells** include

biomedical imaging,

Cancer and spectroscopic applications,

therapeutic applications,

fluorescence enhancement of weak molecular emitters,

surface-enhanced Raman spectroscopy,

surface-enhanced infrared absorption spectroscopy,

protective waterproof coatings for wood, metal, and stone,

ion-selective films,

gold nanoshells for blood immuno assay and cancer detection and therapy

How do these make drug delivery efficient?

- Nanomicelles are colloidal constructs composed of amphiphilic monomers and have two parts, a small hydrophobic head and a long hydrophilic tail.
- The hydrophobic core interacts with hydrophobic drugs/agents, whereas the hydrophilic tail helps surrounding with water and enhances solubility.

- Therefore nanomicelles can encapsulate hydrophobic drugs as well as imaging agents to improve the sensitivity of imaging and diagnosis.
- They have high structural stability, less toxicity, ability to entrap large amounts of hydrophobic drugs/contrast agent and solubilize in water.
- The current form of drug delivery through intravitreal injections are not patient-compliant and therefore poses a challenge on patient care and treatment.
- Researches on bioengineering have found the use of nanomicelles as a smart and efficient drug-delivery system.

Mould your thought:

1. Explain the generations of nanomaterials. What are the applications of nanomicelles?

Approach to the answer:

- Write about the generation of nano materials.
- Write about nanomicelles
- Write its applications
- Explain its application in drug delivery and give conclusion.