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Nanotechnology

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MSc. Nano-biotechnology

Lab. 6: The biological effects of nanoparticles

A) Nanomaterials applications and some Current Products

1- Carbon nanoparticles: Fabrics, Cosmetics, Electronics, Sports Equipment, Building Materials, Food Supplements, Food Flavorings.

2- Silver: Antibacterial, Antifungal, Self-Cleaning Glass, Food Storage Containers, Hygiene Products, Bandages.

3- Silica: Electronics, Paints/Pigments, Cosmetics, Food Supplements.

4- Zinc Oxide and **Titanium Oxide:** sunscreens, Cosmetics, Self-Cleaning Coatings.

5- Gold: Chemical Detection, Home Pregnancy Tests, Wrinkle Reducing Skin Cream.

Nano-Bandage (Silver Bandages) (المثال للاطلاع)

Use silver in the wound pad as a natural antibacterial. Laboratory testing showed that silver reduced bacterial growth

(Staph. aureus, *E. coli* and *Pseudomonas aeruginosa)*

B) Toxicity Concerns of Nanomaterials

Sources of nanoparticles

1. Natural sources of nanoparticles

Nanoparticles are abundant in nature; as they are produced in many natural processes, including photochemical reactions, volcanic eruptions, forest fires, and simple erosion, and by plants and animals.

2. Anthropogenic nanomaterial

Humans have created nanomaterial's, as they are byproducts of simple combustion (with sizes down to several nm) and more recently, chemical manufacturing. combustion in vehicle and airplane engines, combustion of treated pulverized sewage sludge, and combustion of coal and fuel oil for power generation.

• Nanoparticles might enter the body by

1- Inhalation 2- Ingestion 3- Through the skin 4- Following introduction of material in foods 5- In some medical procedure, for example implantation of a prosthetic joint.

► **The factors** which are thought to make **nanoparticles toxic** are:

a) **Large surface area**, adsorbed organic molecules and metals

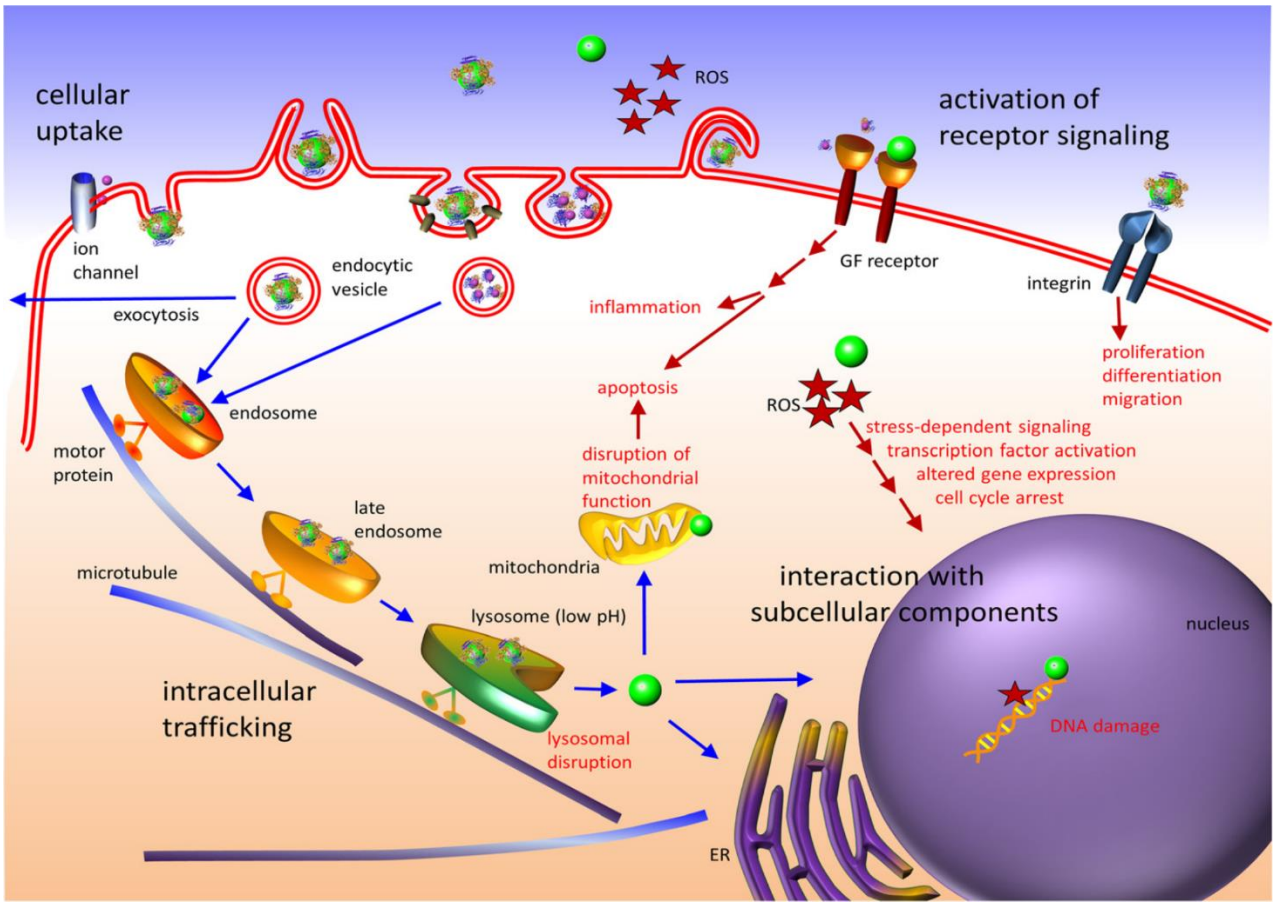
b) **Solubility**

Effect on human health

Oxidative stress and Cytotoxicity

Nanomaterials are known to cause oxidative stress as a mechanism of toxicity. This increase in **Reactive Oxygen Species (ROS)** can be irreversibly harmful

to cells causing membrane damage, protein oxidation, DNA damage, mitochondria dysfunction, apoptosis, and genotoxicity.



In vitro and in vivo characterization

- For **in vitro** characterization, NPs may be assayed in biological matrices such as blood, plasma, cells, or primary culture.

Some in vitro tests that may be performed include:

1- **Sterility** check (e.g., testing for the presence of **bacteria, virus or mycoplasma**)

2- **Blood contact** properties (e.g., **plasma protein binding**, **hemolysis**, **coagulation, complement activation**, **cytotoxic activity** of NK cells)

3- **Cell uptake** and distribution (e.g., cell **binding**, NP **internalization**)

4- **Toxicity** (enzyme **induction or suppression** testing, **oxidative stress**, **apoptosis** testing, **necrosis** testing).

► The amount of information obtained by **in vitro testing is limited**.

- In addition to in vitro testing, **NPs that will be used for biomedical/clinical applications** (e.g., **therapeutics**, **in vivo diagnostics**) **have to be tested in animal models.**
- **In vivo assays** can provide **essential information** regarding what may happen when the **NPs are inside the body**.

Some in vivo tests that may be performed include

1- Dose-response

2- Bio- distribution;

3- Acute and multi dose efficacy

4- Safety

5- Administration route determination

6- Absorption, Distribution, Metabolism, and Excretion (ADME).

- The **ultimate goal** of **in vitro and in vivo testing is to match the physicochemical** parameters of the NPs to its biological function.