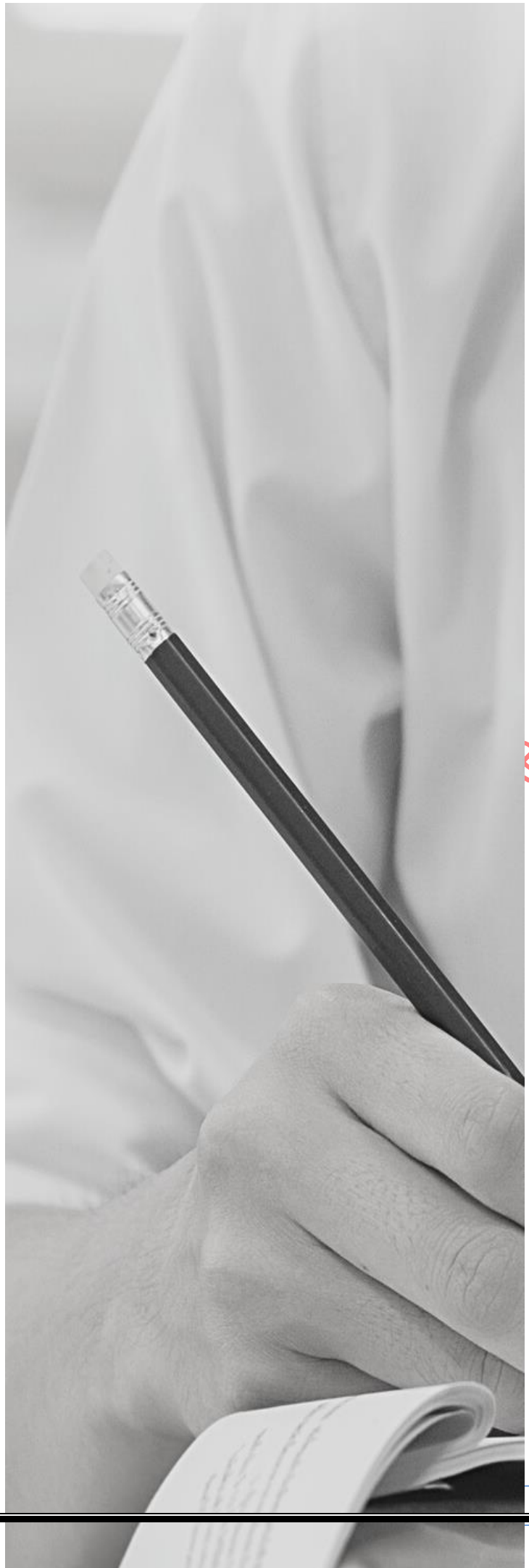

**Tikrit University**
**College of Veterinary Medicine.**



**Subject name: Special Material(Nano).**

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**Lect.6.**

## The effects of nanomaterials on laboratory animals and their toxicity

**Nanoparticles, due to their small size and unique physicochemical properties, can interact with biological systems in ways that larger particles cannot. When laboratory animals are exposed to nanoparticles, various disorders and toxicological effects can occur, depending on the type of nanoparticle, route of exposure, dose, and duration.**

**Below are some of the key disorders and effects observed in laboratory animals exposed to nanoparticles:**

**1- Respiratory Disorders:**

**Inhalation Exposure: Nanoparticles can deposit in the lungs and cause inflammation, fibrosis, and oxidative stress.**

**Examples: Carbon -**
**nanotubes (CNTs) and metal oxide nanoparticles (e.g., titanium dioxide, $TiO_2$) have been shown to cause pulmonary inflammation, granuloma formation, and even lung cancer in rodents.**

**Mechanism: Nanoparticles can penetrate deep into the alveoli, evade clearance mechanisms, and induce oxidative stress and cytokine release.**

**2-Cardiovascular Disorders.**

**Systemic Inflammation: Nanoparticles can enter the bloodstream and cause systemic inflammation, leading to endothelial dysfunction and atherosclerosis.**

**Thrombosis Some nanoparticles (e.g., carbon-based nanoparticles) have been shown to promote blood clot formation.**

**Mechanism Nanoparticles can induce oxidative stress and activate inflammatory pathways, damaging vascular tissues.**

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**3-Neurological Disorders**

**Neurotoxicity Nanoparticles can cross the blood-brain barrier (BBB) and accumulate in the brain, leading to neuroinflammation, oxidative stress, and neurodegeneration.**

**Examples Studies have shown that silver nanoparticles (AgNPs) and manganese oxide nanoparticles can cause neuronal damage and behavioral changes in rodents.**

**Mechanism Nanoparticles can disrupt mitochondrial function, increase reactive oxygen species (ROS), and activate microglia, leading to neuronal damage.**

**4-Hepatic and Renal Toxicity.**

**Liver Damage Nanoparticles can accumulate in the liver, causing hepatotoxicity, inflammation, and fibrosisExamples Gold nanoparticles (AuNPs) and quantum dots have been associated with liver damage in animal studies.**

**Kidney Damage Nanoparticles can accumulate in the kidneys, leading to renal inflammation, oxidative stress, and impaired function.**

**Examples Silica nanoparticles ($SiO_2$) and cadmium-based nanoparticles have been shown to cause renal toxicity in rodents.**

**Mechanism Nanoparticles can induce oxidative stress, disrupt cellular membranes, and interfere with organ function.**

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### 5-Immune System Disorders .

Immunotoxicity: Nanoparticles can modulate immune responses, leading to either immunosuppression or hyperactivation.

Examples: Titanium dioxide ($TiO_2$) and zinc oxide (ZnO) nanoparticles have been shown to alter immune cell function and cytokine production.

Autoimmunity: Some nanoparticles can trigger autoimmune responses by modifying self-proteins.

Mechanism: Nanoparticles can interact with immune cells, alter antigen presentation, and induce inflammatory cytokine release.

### 6- Reproductive and Developmental Toxicity

Reproductive Toxicity: Nanoparticles can accumulate in reproductive organs, affecting fertility and hormonal balance.

Examples: Studies have shown that titanium dioxide and silver nanoparticles can reduce sperm quality and disrupt ovarian function in rodents.

Developmental Toxicity Prenatal exposure to nanoparticles can lead to developmental abnormalities in offspring.

Examples: Exposure to carbon-based nanoparticles during pregnancy has been linked to fetal growth restriction and developmental delays.

Mechanism Nanoparticles can cross the placental barrier, induce oxidative stress, and interfere with developmental processes.

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**7-Genotoxicity and Carcinogenicity**

DNA Damage: Nanoparticles can cause direct or indirect DNA damage, leading to mutations and chromosomal aberrations.

Examples: Metal nanoparticles (e.g., nickel, cobalt) and carbon nanotubes have been shown to induce genotoxicity in animal models.

Carcinogenesis Chronic exposure to certain nanoparticles can increase the risk of cancer.

Examples Long-term exposure to multi-walled carbon nanotubes (MWCNTs) has been associated with mesothelioma in rodents.

Mechanism Nanoparticles can generate ROS, interfere with DNA repair mechanisms, and promote tumorigenesis.

8-Gastrointestinal Disorders

Oral Exposure: Ingested nanoparticles can cause gastrointestinal inflammation, oxidative stress, and altered gut microbiota.

Examples Zinc oxide and silver nanoparticles have been shown to damage intestinal epithelial cells in animal studies.

Mechanism: Nanoparticles can disrupt the intestinal barrier, induce inflammation, and alter microbial balance.

9-ermal Toxicity .

Skin Exposure**: Nanoparticles can penetrate the skin and cause local .inflammation, oxidative stress, and allergic reactions.

Examples: Titanium dioxide and silver nanoparticles have been associated with .skin irritation and sensitization in animal models.

Mechanism: Nanoparticles can interact with skin cells, induce ROS production, and trigger immune responses.

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## Factors Influencing Nanoparticle Toxicity

**Size and Surface Area: Smaller nanoparticles tend to be more toxic due to their higher surface area-to-volume ratio.**

**Shape and Surface Chemistry: The shape and surface modifications of nanoparticles can influence their interaction with biological systems.**

**Dose and Duration: Higher doses and prolonged exposure increase the likelihood of adverse effects.**

**Route of Exposure Inhalation, ingestion, dermal contact, and injection can lead to different toxicological outcomes.**

## Lect.6

## SEM

**They are images produced by scanning it with a focused beam of electrons.**

**Electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition.**

**The electron beam is generally scanned using raster scanning and the location of the beam is combined with the signal to produce an image.**

**The most common scanning electron microscope technique is to detect secondary electrons emitted by atoms excited by an electron beam.**

**The number of secondary electrons that can be detected depends, among other things, on the topography of the sample.**

**By scanning the sample and collecting the secondary electrons that are emitted using a special detector, an image is created that displays the surface topography.**

Featured home page SEM

.Use a packageA narrow electronic beam to scan the biological model

This beam moves forward and backward as it crosses the examined body, which will .emit secondary electrons that are used to form the image

That is, the sample causes the secondary electrons to reflect and can be used to .produce the image

When using a scanning electron microscope, the image appears in three dimensions, .where the outer surface of the cells can be examined

The electron microscope contains the tools that produce electrons and are used to .scan the sample to be examined

These electrons are represented by the released electron cannon and pass through the .column completely emptied of air so as not to impede the passage of the electrons

When the beam arrives, it collides with the sample to be examined, producing several .radiations, including secondary electrons responsible for producing the image

The image, and any difference in the density of the secondary electrons emitted by the .sample, shows us a difference in the sparkle on the screen