Unit 10: Medical Nanotechnology and Nanodevices

I. Pre-reading

A. New Vocabulary

Word / Term	Form	Definition / Synonym	Persian Translation
nanotechnology	n	science of manipulating matter at the nanoscale	نانوفناوری
nanoparticle	n	ultra-small particle measured in nanometers	نانوذره
nanocarrier	n	nanoscale system for transporting drugs	نانوحامل
targeted drug delivery	n	directing drugs to specific tissues or cells	رسانش هدفمند دارو
biocompatibility	n	ability to coexist with living tissue without harm	زیست‌سازگاری
biosensor	n	device detecting biological signals	زیست‌حسگر
quantum dot	n	nanoscale semiconductor used for imaging	نقطهٔ کوانتومی
surface modification	n	altering the outer layer of a material	اصلاح سطحی
encapsulation	n	enclosing a substance within a protective shell	کپسوله‌سازی
cytotoxicity	n	toxicity to cells	سمیت سلولی
nanorobot	n	nanoscale robot used in medical applications	نانوروبات
imaging contrast agent	n	substance improving visibility in medical imaging	مادهٔ حاجب تصویربرداری

B. Pre-reading Questions

1. What advantages do nanoscale materials offer in medicine?
2. How can nanoparticles improve drug delivery?
3. What safety concerns exist for using nanomaterials inside the human body?
4. How might nanodevices change the future of medical diagnostics?

II. Reading

Medical Nanotechnology and Nanodevices

Medical **nanotechnology** focuses on designing and using materials at the **nanoscale**, typically less than 100 nanometers, to solve clinical problems. At this small size, materials show unique **physical**, **chemical**, and **biological** properties that can improve diagnosis, treatment, and monitoring of diseases.

One of the most important applications is **targeted drug delivery**. Traditional medications spread throughout the body, which can reduce their effectiveness and increase side effects. **Nanoparticles** and **nanocarriers** can transport drugs directly to diseased tissues such as tumors. These nanosystems often include **surface modifications** that help them recognize specific cells. As a result, the drug is released precisely where it is needed, improving treatment outcomes and minimizing damage to healthy tissue.

Nanotechnology is also transforming **medical imaging**. Structures like **quantum dots** and specialized contrast agents provide brighter, clearer images in MRI, CT, and fluorescence imaging. Their small size allows them to circulate easily in the bloodstream and attach to biological targets, enabling earlier and more accurate diagnosis.

Another rapidly developing area is **biosensing**. **Nanodevices** can detect extremely small amounts of biomarkers in blood or saliva, allowing for early detection of diseases such as cancer or infections. These sensors are highly sensitive because nanomaterials interact strongly with biological molecules.

Researchers are even exploring **nanorobots** that could one day repair tissues, remove blood clots, or deliver drugs inside individual cells. Biomedical engineers design these systems by combining **biocompatible materials**, computational modeling, and advanced manufacturing techniques.

Despite their promise, nanomaterials require careful testing. Potential risks include **cytotoxicity**, accumulation in organs, and long-term effects that are not yet fully understood. However, ongoing innovation and regulation continue to move medical nanotechnology toward safe and widespread clinical use.

III. Post-reading

A. True (T), False (F), or Not Given (NG)

1. Nanotechnology works with materials smaller than 100 nanometers.
2. Nanoparticles reduce side effects by delivering drugs to specific tissues.
3. Quantum dots are used only for cancer therapy, not imaging.
4. Nanodevices can detect very small quantities of biological markers.
5. Nanorobots are already widely used in hospitals today.

B. Multiple Choice

1. What is the main advantage of targeted drug delivery?
   a) Faster manufacturing b) Reduced side effects and improved accuracy
   c) Lower cost d) Better taste of medications
2. Quantum dots are mostly used for:
   a) Mechanical ventilation b) Medical imaging
   d) Bone fixation c) Blood pressure monitoring

3. Nanobiosensors are effective because nanomaterials:
   a) Are heavier than biological molecules
   b) Interact strongly with biological targets
   c) Have no electrical properties
   d) Are only used on the skin

C. Fill in the blanks

1. Nanotechnology involves manipulating materials at the _____ scale.
2. Nanoparticles can deliver drugs to _____ tissues, reducing side effects.
3. Quantum dots provide brighter images for medical _____.
4. Nanodevices can measure very small amounts of _____ in biological samples.
5. Surface _____ helps nanocarriers recognize specific cells.
6. Engineers must consider _____ to ensure nanomaterials are safe for the body.
7. One future application of nanotechnology may include medical _____ that operate inside the body.
8. Some nanomaterials require further study to understand their long-term _____.