

# Unit 6: Medical Imaging Systems in Biomedical Engineering

## I. Pre-reading

### A. New Vocabulary

Word / Term	Form	Definition / Synonym	Persian Translation
imaging	n	creating visual representations of internal body structures	تصویربرداری
modality	n	specific method or type of imaging	روش/نوع تصویربرداری
tomography	n	technique for imaging by sections	توموگرافی / برش‌نگاری
attenuation	n	reduction in signal or intensity	تضعیف
detector	n	device that senses radiation or signals	آشکارساز
reconstruction	n	creating images from raw data	بازسازی
radiation	n	energy transmitted as waves or particles	تابش
ultrasound	n	imaging using high-frequency sound waves	سونوگرافی / فراصوت
radiograph	n	process of producing images using X-rays	رادیوگرافی / تصویربرداری با اشعه ایکس
computed tomography	n	X-ray-based imaging technique (CT)	سی‌تی‌اسکن
magnetic resonance	n	phenomenon used in MRI imaging	تشدید مغناطیسی
noninvasive	adj	not involving entry into the body	غیرتهاجمی

### B. Pre-reading Questions

1. What are the main types of medical imaging systems?
2. How do CT and MRI differ in principle?
3. What are the advantages of noninvasive imaging methods?
4. How do biomedical engineers contribute to imaging technologies?

## **II. Reading**

### **Medical Imaging Systems**

Medical imaging systems allow physicians to visualize internal body structures without surgery. These **noninvasive** technologies have transformed diagnosis and treatment, offering clear and detailed insights into anatomy and function. The main **modalities** include **X-ray radiography**, **computed tomography (CT)**, **magnetic resonance imaging (MRI)**, **ultrasound**, and **positron emission tomography (PET)**.

**X-ray imaging** uses controlled radiation that passes through the body, creating a **radiograph** based on tissue density differences. It is fast, inexpensive, and widely used for bones and chest examinations. However, excessive radiation exposure must be minimized.

**Computed tomography (CT)** extends X-ray imaging by rotating the source around the body to create multiple cross-sectional images. These are **reconstructed** by computer into 3D models, providing detailed information about internal organs and blood vessels.

**Magnetic resonance imaging (MRI)** does not use ionizing radiation. Instead, it relies on **magnetic fields** and **radio waves** to produce high-resolution images of soft tissues like the brain, muscles, and joints. MRI is particularly useful for neurological and musculoskeletal studies.

**Ultrasound imaging** employs **high-frequency sound waves** transmitted into the body. The reflected echoes are converted into images, making this method safe for fetal monitoring and organ assessment. It is portable, low-cost, and real-time.

**PET imaging** involves the detection of radioactive tracers injected into the body. It provides functional information about metabolism and is commonly combined with CT for detailed anatomical and physiological mapping.

Biomedical engineers contribute to imaging through system design, **signal processing**, **artifact reduction**, **image reconstruction**, and the development of **contrast agents**. They also ensure **safety standards** and optimize **image quality** for accurate **diagnosis**.

In summary, medical imaging systems merge physics, biology, and engineering to create technologies that save lives. Continuous innovation in digital imaging and computer analysis makes diagnosis faster, more accurate, and less invasive.

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## **III. Post-reading**

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

1. MRI uses ionizing radiation.
  2. CT provides three-dimensional views of the body.
  3. Ultrasound imaging is unsafe during pregnancy.
  4. Biomedical engineers improve image quality and safety.
  5. PET provides structural but not functional information.
  6. X-ray imaging is used mainly for bones and lungs.
  7. Image reconstruction is done using software algorithms.
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## B. Multiple Choice

1. Which imaging technique uses magnetic fields?  
a) CT      b) X-ray      c) MRI      d) PET
  2. What is the main advantage of ultrasound?  
a) Uses radiation      b) Real-time and safe  
c) Expensive equipment      d) Slow data collection
  3. Which imaging type provides metabolic data?  
a) CT      b) PET      c) MRI      d) X-ray
  4. What is the function of image reconstruction?  
a) Build 3D images from raw data      b) Store patient records  
c) Reduce radiation exposure      d) Create artifacts
  5. Biomedical engineers in imaging focus on:  
a) Anatomy study      b) Equipment calibration and signal processing  
c) Drug formulation      d) Cell culture
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## C. Fill in the blanks

1. MRI uses \_\_\_\_\_ and radio waves to create images.
  2. \_\_\_\_\_ imaging is commonly used in pregnancy.
  3. Engineers work to reduce image \_\_\_\_\_ and noise.
  4. PET provides \_\_\_\_\_ information about body metabolism.
  5. CT images are reconstructed into \_\_\_\_\_ models.
  6. Biomedical engineers design \_\_\_\_\_ to improve safety and resolution.
  7. X-ray is a \_\_\_\_\_ imaging technique.
  8. Modern imaging systems are \_\_\_\_\_ and computer-controlled.
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