Write a short passage explaining how X- rays, ultrasound and Radioisotopes are used in medical diagnosis and therapy.

Answer: X-rays have been used for medical imaging since Röntgen's discovery that X-rays can identify bone structures. Bones contain much calcium, which due to its relatively high atomic number absorbs X-rays efficiently. This reduces the amount of X-rays reaching the detector in the shadow of the bones, making them clearly visible on the radiograph. The lungs and trapped gas also show up clearly because of lower absorption compared to tissue, while differences between tissue types are harder to see. There are few methods of X-ray imaging:

a) Radiography – X-ray image obtained by placing a part of the patient in front of an X-ray detector and then illuminating it with a short X-ray pulse. Dental radiography is commonly used in the diagnoses of common oral problems, such as cavities;

b) Computed tomography (CT scanning) – medical imaging modality where tomographic images or slices of specific areas of the body are obtained from a large series of two-dimensional X-ray images taken in different directions. These cross-sectional images can be combined into a three-dimensional image of the inside of the body and used for diagnostic and therapeutic purposes in various medical disciplines.

c) Fluoroscopy – imaging technique commonly used by physicians to obtain real-time moving images of the internal structures of a patient through the use of a fluoroscope. In its simplest form, a fluoroscope consists of an X-ray source and fluorescent screen between which a patient is placed.

Also, usage of X-rays as a treatment is known as radiation therapy and is largely used for the management (including palliation) of cancer; it requires higher radiation energies than for imaging alone.

Ultrasound is widely used as a diagnostic tool to image the human body for at least 50 years. The creation of an image from sound is done in three steps – producing an ultrasound wave, receiving echoes from selected organ, and interpreting those echoes to form an image.

Medical sonography (ultrasonography) is an ultrasound-based diagnostic medical imaging technique used to visualize muscles, tendons, and many internal organs, to capture their size, structure and any pathological lesions with real time tomographic images. Obstetric sonography is commonly used during pregnancy and is widely recognized by the public.

Ultrasound also has therapeutic applications, which can be highly beneficial when used with dosage precautions. Relatively high power ultrasound can break up stony deposits, accelerate the effect of drugs in a targeted area etc.

Usage of radioisotopes for medical diagnosis and therapy is called the nuclear medicine.

Radioisotopes are used for brain, bone, liver, spleen, kidney, lung and thyroid imaging as well as for blood-flow studies. ^{131}I, with a half-life of 8 days, is used to diagnose and treat thyroid disorders.

A very effective role for radioisotopes in nuclear medicine is the use of short-lived positron emitters such as ^{11}C, ^{13}N, ^{15}O, or ^{18}F in a process known as Positron Emission Tomography (PET). Incorporated in chemical compounds that selectively migrate to specific organs in the body, diagnosis is effected by detecting annihilation gamma rays–two gamma rays of identical energy emitted when a positron and an electron annihilate each other. These gamma rays have the very useful property that they are emitted in exactly opposite directions. When both are detected, a computer system may be used to reconstruct where the annihilation occurred. By attaching a positron emitter to a protein or a glucose molecule, and allowing the body to metabolize it, we can study the functional aspect of an organ such as the human brain.

Radionuclide therapy (RNT) is based on such phenomena, that rapidly dividing cells are particularly sensitive to damage by radiation. For this reason, some cancerous growths can be controlled or eliminated by irradiating the area containing the growth with gamma-rays from the decaying certain isotope (e.g. ^{60}Co).