**Radiology**

is a medical specialty that employs the use of imaging to both diagnose and treat disease visualized within the animal body. Radiologists use an array of imaging technologies.

**Types of radiology**

1. Diagnostic radiology is concerned with the use of various imaging modalities to aid in the diagnosis of disease.
2. Therapeutic radiology—or, as it is now called, radiation oncology uses radiation to treat diseases such as cancer using a form of treatment called radiation therapy.

**Techniques for diagnostic radiology includes**

1. Computed tomography (CT)
2. Magnetic resonance imaging (MRI)
3. Ultrasound
4. X-rays
5. Nuclear imaging techniques

**X-rays**

X-rays are basically electromagnetic radiations which are used to create images of inside body. The images show the parts of your body in different shades of black and white due to different level of absorption of x-rays by different tissues.

X‐rays were discovered by Wilhelm Conrad Roentgen in 1895. He discovered that the application of a high voltage to a cathode‐ray tube resulted in the fluorescence of phosphorescent material in the room and determined that this resulted from exposure to a previously unknown form of electromagnetic radiation which he termed ‘X’‐rays

**Generation of X‐rays**

X‐ray photons are produced as a result of electrons hitting metal while travelling at high speed. This is achieved through the application of an electric current to a cathode (negative electrode) via a high voltage power source (electricity) which enables electrons to be released from the cathode into the X‐ray tube. These electrons, being negatively charged, are attracted to the anode (positive electrode or target). When the

electrons strike the metallic target (anode) in the tube, X‐rays and heat are produced



**Degree of absorption**

 Calcium in bones absorbs x-rays the most, so bones look white. Fat and other soft tissues absorb less, and look gray. Air absorbs the least, so lungs look black.

## Radiographic exposure factors

The radiographic appearance of various body tissues is influenced by a number of factors which determine the character of X‐rays produced by the generator. These exposure factors are integral to image quality and should, therefore, be manipulated accordingly in order to achieve a diagnostic radiograph of optimal quality.

### Milliamperage (mA)

Milliamperage is the current that is applied to the cathode of the X‐ray tube to produce X‐rays. The higher the mA, the greater the number of X‐rays produced.

### Time (seconds)

The exposure time is the length of time that X‐rays are being produced during each exposure. The longer the exposure time, the greater the number of X‐rays produced.

### mAs

The milliamperage (mA) and time (s) are often combined on the generator settings as the mAs. Therefore, to achieve a given number of X‐rays per exposure, as mA is increased, exposure time is shortened, and vice versa.

### Kilovoltage (kV)

The voltage applied across the X‐ray generator at the time of X‐ray production is known as the kV. Increasing the kV results in increased energy of the X‐rays produced and, therefore, the ability of the X‐ray beam to penetrate the patient's tissues also increases.

### Focus‐film distance (FFD)

The focus‐film distance is the distance between the X‐ray source (generator) and the cassette or as it is commonly known, the ‘plate’. As this distance increases, the intensity of the X‐ray beam decreases.

**Radiographic positions**

Thoracic

1. Right lateral recumbency is preferred.
2. Forelimbs are extended cranially; hindlimbs caudally.
3. Place a foam pad under the sternum to avoid rotation and to maintain horizontal alignment of
4. the sternum and spine.
5. Neck is in natural position.

Abdomen

1. Right lateral recumbency.
2. Forelimbs are extended cranially; hindlimbs extended caudally.
3. Use foam pads to maintain horizontal alignment of sternum.
4. Use foam pads between stifles to maintain alignment.

Pelvic

1. Dorsal recumbency.
2. Forelimbs extended cranially and evenly with nose between forelimbs.
3. Hindlimbs extended caudally and evenly into full extension.
4. V-trough with foam pads on lateral aspect of body wall to superimpose sternum and spine.
5. Femurs rotated medially so they are parallel to one another and the x-ray table, and the patella is centered within the patellar groove over the stifle and taped in place.
6. Align tail with spine.

Forelimb Radiographs

* 1. Dorsal recumbency in a V-trough with affected limb down.
	2. Tape and extend both forelimbs cranially.
	3. Head is pushed laterally away from the dependent limb to avoid having the cervical spine superimposed over joint.

## Types of X-ray Machines

* Practically all X-ray equipment used in veterinary radiography was designed and constructed for animals use and suffers from various disadvantages when used for veterinary purposes.
* While there is a very wide variety of machines of different size, power and manufacture, they may be divided into three main groups.
	1. **Portable-X-ray Apparatus.**
* Commonly used in veterinary practice because of convenient transportation. The maximum output usually varies from 70-110 kv and 15-35 mA.
* In such machines the transformers are of small size and low weight and are located within the tube head immediately adjacent to the X-ray tube.
* The tube head itself is supported on a tube stand which may comprise either a small table top model or a considerably more substantial floor stand mounted on wheels.
* The apparatus also has a small control panel which is attached to the tube stand or the tube head or supported on a separate stand.
	1. **Dental X-ray Apparatus**
* Apparatus manufactured for dental use is sometimes advocated for veterinary use because of its low price.
* Such machines are of low output (in the region of 10 m A and 70 k V) and are designed to only cover a small area of the patient.
* The precise use which could be made of such machines would depend in part on the skill of the operator, but they are likely to be restricted to the examination of cats and the smallest dogs.
1. **Mobile X-ray Apparatus**

* These machines have higher output than portable machines by virtue of their larger transformers and are mounted on wheels with output of 90-125kv and 40 to 300mA. Most machines are movable on smooth surface within the radiology section.
* In machines of this type the transformers are larger to permit higher output and because of their increased weight are no longer located in the tube head but are mounted on wheels and form the best of the apparatus.
* These sets cannot be taken apart and the tube stand and control panel are built into the apparatus .
* These machines can be moved over level surfaces and, in most instances, operated from 13-15 A sockets.
1. **Fixed X-ray Apparatus**
* The machines which fall into this group are characterized by the fact that they require transformers of such size and output that they have to be built into the room and provided with special electrical connections to the mains.
* The X-ray tube is connected to the transformer by high-tension cables and is mounted on some form of gantry which allows only limited movement. Such machines are likely to be capable of an output of at least 300 m A and 120 k V and in some instances much higher ( 1000 m A and 200 l V ). The expense of such apparatus normally restricts its use to the teaching schools and research institutes .
* Large animals: The higher kilovoltage and milliamperge  provided by these machines should facilitate radiography of the trunk and spine of cattle and horses.
* Small animals: Apparatus of this type is very suitable for all small animal radiographic examinations and may incorporate facilities foe additional techniques such as rapid film changing, image intensification , or tomography.

**Contrast Media in Veterinary Radiology**

A contrast medium is a substance that is administered to the patient that is either more radiopaque or more radiolucent than the surrounding tissue. This allows assessment of the position, size, shape and internal architecture of the organ that was not apparent on the original radiograph. Sequential films or the use of image-intensified fluoroscopy may also show the function of an organ, e.g., the rate of stomach emptying or the presence of peristalsis. Properties required in an ideal contrast medium include:

 Different absorptive power from tissue, thereby producing effective radiographic contrast;

1- No irritant or toxic side effects

2-accurate delineation of the organ

3-Persistence for sufficient time to take radiographs

**TYPES OF CONTRAST MEDIA**

1-Negative contrast studies will show the location, size and wall thickness of the organ and will show marked wall thickening and large luminal filling defects such as masses or foreign bodies.

2-Positive contrast studies give little more information than negative contrast studies but are the best way of detecting a small defect in the wall of the organ, as minor contrast leakage is easily seen.

**POSITIVE CONTRAST MEDIA**

1.Barium sulphate preparations

2.Iodine preparations

a) Ionic, water-soluble iodine contrast media

b) Non-ionic, water-soluble iodine contrast media

**Radiation safety**

Radiation safety principles aim to limit exposure to ionising radiation for radiation therapy personnel, people affected by cancer and the general public. Wherever there is known risk of exposure to ionising radiation, health professionals must be guided by the ALARA (as low as reasonably achievable) principles of radiation safety for time, distance and shielding.

**Time**

The less time spent near a radiation source, the less radiation absorbed. This is especially important for personnel such as radiation therapists and physicists preparing radioactive sources, and for nursing staff when caring for individuals who have a radioactive source in a body tissue or cavity. For inpatients, the nurse should restrict direct contact to 30 minutes per eight-hour shift.

**Distance**

The inverse-square law states that radiation exposure and distance are inversely related. That means that as the distance from the source increases, the intensity of radiation decreases. To calculate exposure, the rule to use is that the amount of radiation exposure at one metre from the radioactive source equals the amount of radiation exposure at any distance from the source times the distance squared.

**Shielding**

The type of shielding device used depends on the range of emission of the radioactive source. Standard shielding devices include lead aprons, thyroid shields, and eye shields. Rooms that house x-ray generating equipment are shielded using specified materials. Radioactive sources need to be transported by licensed personnel in lead containers. Brachytherapy procedures are undertaken in a specialised unit or ward with appropriate facilities, and individuals are generally isolated in a single room.

Departments are designed with radiation protection and shielding at the forefront of planning. Radiation therapy workers are required to wear thermoluminescent dosimetry (TLD) badges, monitored by regulatory authorities to measure radiation exposure. Other radiation measurement devices such as Geiger counters are used to monitor areas where radioactive sources are used. Appropriate signage must be in place in the presence of any radioactive substance, and education and information provided to all individuals who may be impacted.

**Spill management**

In the event of a radiation incident, such as the loss of a source or a spill, appropriate procedures and notifications must be followed. These should be clearly outlined in the clinical environment as part of radiation safety and hospital policy.

After ingestion of a radioactive substance, 'spills' generally refer to the loss of body fluid, either urine or vomit, and can be classified as major or minor. A significant amount of fluid loss (vomit or urine) within the first 24 hours would be defined as a major spill.

**Modern Diagnosis**

**CT (Computed Tomography) Scan**

A computerized tomography scan (CT or CAT scan) uses computers and rotating X-ray machines to create cross-sectional images of the body. These images provide more detailed information than normal X-ray images. They can show the soft tissues, blood vessels, and bones in various parts of the body. A CT scan may be used to visualize the:

1. head
2. shoulders
3. spine
4. heart
5. abdomen
6. knee
7. chest

A CT scan has many uses, but it’s particularly well-suited for diagnosing diseases and evaluating injuries. The imaging technique can help your doctor:

1. diagnose infections, muscle disorders, and bone fractures
2. pinpoint the location of masses and tumors (including cancer)
3. study the blood vessels and other internal structures
4. assess the extent of internal injuries and internal bleeding
5. guide procedures, such as surgeries and biopsies
6. monitor the effectiveness of treatments for certain medical conditions, including cancer and heart disease

The test is minimally invasive and can be conducted quickly.

**Magnetic Resonance Imaging (MRI) scan**

MRI uses a strong magnetic field and radio waves to create detailed images of the organs and tissues within the body. Since its invention, doctors and researchers continue to refine MRI techniques to assist in medical procedures and research. The development of MRI revolutionized medicine.

### Functional magnetic resonance imaging (fMRI)

Functional magnetic resonance imaging or functional MRI (fMRI) uses MRI technology to measure cognitive activity by monitoring blood flow to certain areas of the brain.

The blood flow increases in areas where neurons are active. This gives an insight into the activity of neurons in the brain.

This technique has revolutionized brain mapping, by allowing researchers to assess the brain and spinal cord without the need for invasive procedures or drug injections.

**Ultrasound**

Ultrasound is a type of imaging. It uses high-frequency

sound waves to look at organs and structures inside

the body.

Health care professionals use it to view the heart,

blood vessels, kidneys, liver, and other organs.

During pregnancy, doctors use ultrasound to view the

fetus. Unlike x-rays, ultrasound does not expose you to radiation.

# Digital Radiography (DR)

Digital X-ray replaces the use of film or computed radiography (CR) plates with a direct digital transfer of X-ray images into the [PACS](https://www.itnonline.com/channel/pacs). Digital radiography (DR) is the direct conversion of transmitted X-ray photons into a digital image using an array of solid-state detectors such as amorphous selenium or silicon, with computer processing and display of the image. DR X-ray systems are used for both fixed base room installations and mobile DR, or portable DR, systems that are wheeled between room for imaging exams. Here is a link to the [portable DR systems product comparison chart](https://www.itnonline.com/chart/mobile-dr-systems)**.** Here is a link to the [DR Systems chart](https://www.itnonline.com/chart/digital-radiography-systems) that includes fixed room based systems and retrofit systems to replace film and CR.

**GAMMA CAMERA**

An electronic device that detects gamma rays emitted by radio pharmaceautical (e.g technetium 99m (Tc-99m) that have been introduced into the body as tracers. The position of the source of the

radioactivity can be plotted and displayed on a TV monitor or photographic film.