

Young Scientist Program

Anatomy Teaching Team



“Radiology: What can we see on chest x-ray?”

Lesson Goals:

1. Understand what tissues x-rays can pass through and what things would block x-rays.
2. Be able to name some structures that would appear light or dark on x-ray.
3. Be able to identify the heart and lungs on a chest x-ray.
4. Understand what information a chest x-ray can provide about a diseased heart.

Supplies:

1. Chest x-ray films
2. Light box

Introduction

When people get sick or have various health related problems it is the doctor’s job to figure out what is causing the person’s illness or health condition. In many cases this diagnosis of the problem can be determined by recording the patient’s symptoms, talking to patients about how they feel, physically examining the patient, and analyzing lab samples. However, other more complex cases, especially involving the internal organs and anatomical structures sometimes require the doctor to get a picture of what is happening inside the body. Luckily there are many technologies that allow doctors to do just that, and the study and application of these imaging technologies is called **radiology**. Radiologic imaging is extremely important to medicine, and almost all doctors use them in their practice. Here we will talk about some of the basic type of imaging techniques used by doctors, and how they work to help doctors look into the body.

X- ray Imaging

X-rays are a type of **electromagnetic radiation**, which are waves (or particles) of energy that fly through space, similar to light or radio waves. X-rays are formed from the transition or collision of electrons, small negative particles that orbit the nucleus of atoms.

How to medical x-rays “see” into the body? In order to understand how x-rays work lets compare x-rays to light. X-rays and light are very similar in some ways, as both are types of electromagnetic radiation. They can both penetrate through certain materials (like light passes through glass) and can be blocked by certain materials (like light is blocked by a window shade). Yet x-rays and light are also very different, specifically in the types of materials that they can and cannot go through. X-rays have a smaller wavelength and higher energy and can therefore pass through more dense materials than light

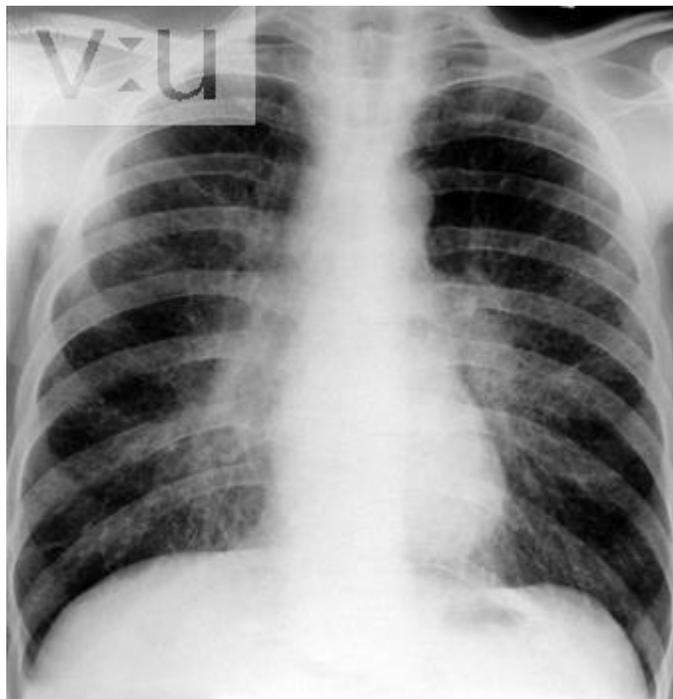
can. [Think of x-rays as “smaller” particles than light. For example, if light particles were the size of marbles, x-rays might be the size of BB’s.] So **x-rays can pass through tissues such as fat and skin**, (lower density materials) just like light passes through glass, while light cannot pass through fat and skin (as you can see by making a shadow with your hand). Just like a window shade can block light, there are **some materials that can block x-rays**. These are generally very dense materials such as bone or metal. Therefore, if you “shine”



x-rays onto the hand the x-rays will pass through the skin very easily, but will be blocked by bones and metal (as you can see by the dark parts of the x-ray above).

So we know that x-rays pass through the body, now how do you get an image or picture with them?

Getting an x-ray image, or a **radiograph**, is a lot like taking a normal photograph--just using x-rays instead of light and special film sensitive to x-rays. So, in order to take an x-ray picture of a person you first put the x-ray source on one side of the person and you place the x-ray film on the other side of the person away from the x-ray source. Next, you turn the x-ray source on for just a second. During this



time x-rays go from the source and pass into the body. Some x-rays make it all the way through the body (those that go through only skin, fat, or air), and other x-rays do not make it through (they blocked by dense materials such as bone). Parts of the body that let a lot of x-rays through will be very **black on the film**, while the parts of the body that do not let any x-rays through will be very **white on the film**.

The 3D to 2D problem

Just like normal photographs, x-rays are only flat images (two dimensional). Yet the “shadow” picture that is formed on the x-ray film is actually due to the x-rays passing through different tissues, organs, etc. (a three dimensional structure) as they make their way from the x-ray source to the x-ray film. Therefore, the image

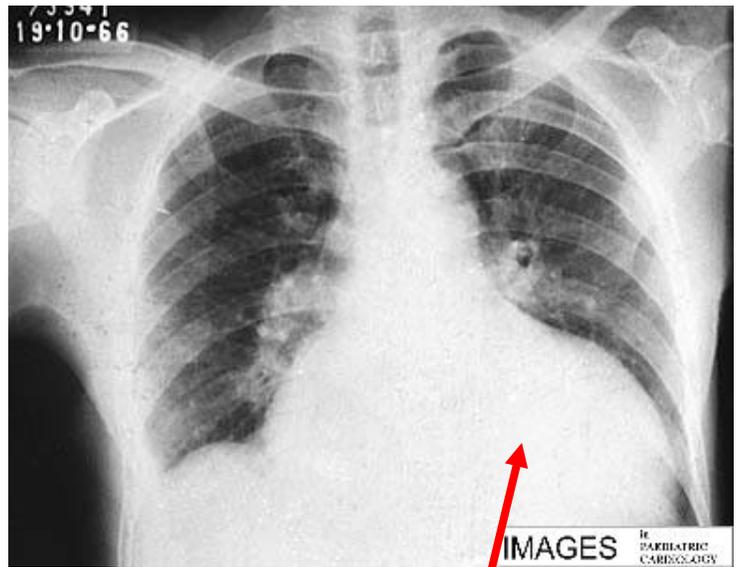
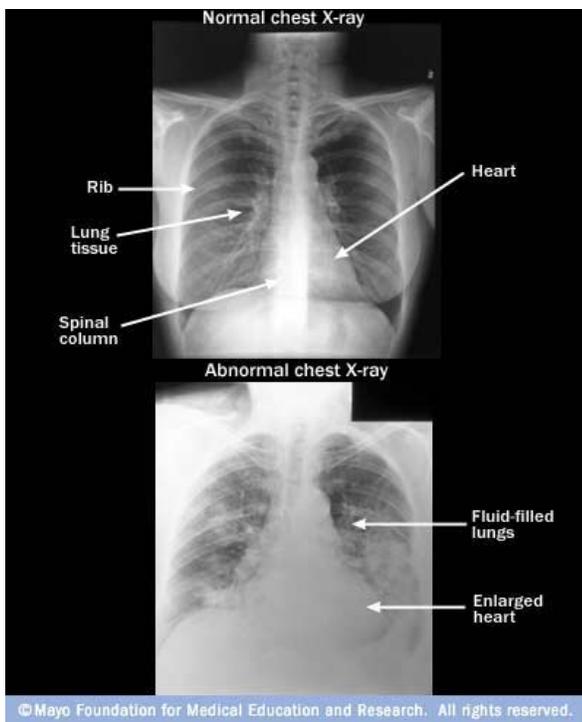
that results from taking an x-ray is actually an overlapped of all of the structures in the x-ray’s path. The best example of this concept is looking at a chest x-ray. In our chest we have multiple sets of bones called ribs and curve around a form our rib cage. When we look at a chest x-ray we can see the

outline of the rib-cage easily in the picture, but when we look inside the rib cage we just see a whole bunch of criss-crossing lines. These lines are actually just individual shadows of the ribs overlapping on the image (or superimposing on each other). Since the ribs are actually slightly tilted forward they will all overlap each other a bit in the front to back (anterior to posterior) direction. Therefore, their shadows overlap on the film causing this funny criss-crossing appearance.

What else we can see in a chest x-ray? Looking at a chest x-ray can tell you a lot about what is happening to some of the most important organs of the body, namely the lungs and the heart. In this x-ray we can identify the ribs, the clavicles, the spinal cord, the heart, the aorta, the diaphragm, and the airways in the lungs. **Point out basic anatomical structures on the x-ray.**

So based on what we talked about before why do you think the heart is so white? How is the heart different from the air in the lungs?

What can x-rays tell you about heart problems? As you have seen above, x-rays have the ability to show doctors the size, shape, and positioning of the heart inside the chest. In some specific cases this information can help doctors determine what is wrong with a patient's heart. For example, a patient suffering from congestive heart failure or severe hypertension may have a dramatically enlarged heart.



Enlarged Heart