**X-rays Pre-Lecture Investigation**

**The concept of photoelectric effect:**

The Photoelectric effect was discovered by Albert Einstein in 1905, it is a phenomenon in which electrically charged particles are released from or within a material when it absorbs [electromagnetic radiation](https://www.britannica.com/science/electromagnetic-radiation). The effect is often defined as the ejection of [electrons](https://www.britannica.com/science/electron) from a [metal](https://www.britannica.com/science/metal-chemistry) plate when [light](https://www.britannica.com/science/light)falls on it. In a broader definition, the [radiant](https://www.britannica.com/technology/radiation-measurement) [energy](https://www.britannica.com/science/energy) may be [infrared](https://www.britannica.com/science/infrared-radiation), visible, or [ultraviolet](https://www.britannica.com/science/ultraviolet-radiation) light, [X rays](https://www.britannica.com/science/X-ray), or [gamma rays](https://www.britannica.com/science/gamma-ray), the material may be a solid, liquid, or gas, and the released particles may be [ions](https://www.britannica.com/science/ion-physics) (electrically charged atoms or molecules) as well as electrons.

**Photoelectric effect in the X-ray production:**

Photoelectric effect**,** or photoelectric absorption (PEA) is a form of interaction of X-ray or gamma photon with the matter. A low energy [photon](https://radiopaedia.org/articles/photon) interacts with the electron in the atom and removes it from its shell. The electron that is removed is then called a photoelectron. The incident photon is completely absorbed in the process. Hence it forms one of the reasons for attenuation of X-ray beam as it passes through the matter.

**The concept of Bremsstrahlung Radiation:**

Bremsstrahlung is a German term that means "braking rays." It is an important phenomenon in the generation of X-rays. In the Bremsstrahlung process, a high speed electron traveling in a material is slowed or completely stopped by the forces of any atom it encounters. As a high speed electron approaches an atom, it will interact with the negative force from the electrons of the atom, and it may be slowed or completely stopped. If the electron is slowed down, it will exit the material with less energy. The law of conservation of energy tells us that this energy cannot be lost and must be absorbed by the atom or converted to another form of energy. The energy used to slow the electron is excessive to the atom and the energy will be radiated as x-radiation of equal energy.

If the electron is completely stopped by the strong positive force of the nucleus, the radiated x-ray energy will have an energy equal to the total kinetic energy of the electron. This type of action occurs with very large and heavy nuclei materials. The new x-rays and liberated electrons will interact with matter in a similar fashion to produce more radiation at lower energy levels until finally all that is left is a mass of long wavelength electromagnetic wave forms that fall outside the x-ray spectrum.

**Difference between Proton Bombardment and Bremsstrahlung Radiation:**

Proton bombardment just means hitting atoms with protons (a hydrogen nucleus).

Example: A hydrogen nuclei collides with another hydrogen nuclei and it loses a positron, in this process it's charge becomes neutral and becomes a neutron. So that's how Deuterium, an isotope of hydrogen is formed. So, the proton here is split to a neutron while it releases a positron.

**Difference between X-rays and Gamma-rays:**

1) Main difference is where the rays originate. A nucleus in an excited state (has "extra" energy) may release energy via gamma emission. Electrons transitioning into a lower atomic orbital may emit an x-ray. Electrons propagating through a material may be accelerated (slowed down) by the electric field of a nucleus and will emit an x-ray. Bottom line - gammas come from the nucleus, x-rays come from electrons.

2) We can machine produce x-rays directly by accelerating a beam of electrons into a high atomic number metal, typically tungsten. The electrons are accelerated either by potential difference in a x-ray tube, or via microwave guidance in a clinical accelerator. In either case, we can control the maximum energy of the resulting x-ray spectrum, and we can control, like an on-off switch, when the x-rays are produced. Since gammas come from the nuclei of a radioactive atoms, we can't turn the gamma radiation on or off. We can only shield the radiation. In addition, beyond selecting which radioactive materials we use, we can't control the energies of the gamma radiations.

3) Machine produced x-rays consist of a spectrum of energies, whereas gammas from a particular radionuclide have discrete energies.

**Difference between Soft X-rays and Hard X-rays:**

Hard X-rays:

1) Their penetration power is high.

2) Their wavelength is less (0.1**Å** - 10 **Å**).

3) Their Frequency is high 10^18 Hz.

4) Their energy is high 10^4 eV.

Soft X-rays:

1) Their penetration power is low.

2) Their wavelength is more (10 **Å** - 100 **Å**).

3) Their Frequency is low 10^16 Hz.

4) Their energy is low 10^2 eV.

Soft X-rays are more harmful than Hard X-rays as soft x-rays can't easily penetrate through a patient's body and add needless risk of radiation damage.

If the normal human skin be exposed to soft x-rays, a pastille dose (1B) is sufficient to produce erythema, and twice this quantity causes a painful blistering, which may be the beginning of a dermatitis. **So exposure to soft x-rays of dose greater than or equal to 1B may be harmful to humans**.

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