Radiation is energy traveling through space in the form of waves or particles.Nuclear substances (radioactive materials) Ionizing Radiation It has sufficient energy to ionize (remove electrons from) atoms or molecules Examples: x-ray, gamma rays, alpha particles, beta particles, and neutrons Non-ionizing Radiation It does not have sufficient energy to ionize atoms or molecules.Some early observations of the effects of ionizing radiation: 1897 -> First cases of skin damage reported 1902 -> First report of x-ray induced cancer 1911 -> First report of leukemia in humans and lung cancer from occupational exposure 1911 -> 94 cases of tumor reported in Germany (50 being radiologists) 1920s -> Bone cancer among radium dial painters was linked with ingestion of radium ?Ionizing Radiation Effects ???????3Sv o produce nothing other than blood changes o cause illness but will rarely be fatal o will likely cause serious illness with poor outlook at the upper end of the range o are almost invariably fatal o causes nausea o causes epilation or hair loss, hemorrhage and will cause death in many cases o will lead to LD50/30 or death in 50% of cases within 30 days o survival is unlikely * Acute dose -> received in a relatively short time, up to about one hour ?Examples: Charged Particles Electromagnetic Waves Uncharged Particles Alpha particles (?+) Beta particles (?+ , ?- ) X-rays Gamma rays Neutrons (n) Ionizing Radiation ?It consists of subatomic particles or electromagnetic waves that are energetic enough to detach electrons from atoms or molecules, ionizing them.6Sv Acute Dose Ionizing Radiation Effects Amount of Exposure Rate of Exposure Area of Exposure Type of Radiation (WR) Sensitivity of Tissue (WT) Biological Effect Radiation Protection ?Direct Ionization Charged particles (e.g. alpha and beta) interact strongly with matter and produce negatively-charged electrons and positively-charged ions along their path.Equivalent ?????????Absorbed W Dose R or rem 1 Sv = 100 rem 1 rem = 0.01 Sv Weighting Factor Dose H= D = x x Radiation ?????Unit -> Sievert (Sv) (SI unit) ????Roughly speaking, particles or photons with energies above few electron volts (eV) are ionizing.Radioactivity = decays/second = disintegrations/second Unit -> Becquerel (Bq) or Curie (Ci) (SI unit) 1 Bq = 1 decay/s = s-1 1 Ci = 3.7 x 1010 Bq (decay/s) 1Bq = 2.7x10-11 Ci ???Effective dose = Equivalent dose x Tissue Weighting Factor ????E= H or rem 1 Sv = 100 rem 1 rem = 0.01 Sv x W T ??Unit -> Sievert (Sv) (SI unit) ????The occurrence of ionization depends on the energy of the impinging individual particles or waves, and not on their number (intensity).It is invisible and not directly detectable by human senses, so instruments such as Geiger counters or scintillation detectors are used to detect its presence.Gamma rays need thicker shielding than X-ray because they have greater penetrating power ?Radiation Measurement Units ??????Exposure to ionizing radiation can be: External -> The source of radiation is outside the body (e.g. X-ray machine) Internal -> The source is taken into the body through ingestion, inhalation, or skin contact (e.g. I-131 taken orally by the patient) ?Instead, the energy is converted to heat Examples: Light, laser, heat, microwaves, and radar Radiation Ionizing Radiation ?X-rays can travel long distances through air and most other materials like gamma rays, but they differ in their origin.Indirect Ionization Photons and neutrons (have no charge) release charged particles in matter which are themselves directly ionizing.It is the spontaneous emission of radiation from unstable atomic nuclei.It is defined as the electric charges freed by such radiation in a specified volume of air divided by the mass of that air.It is applied to all radiation exposures, all types of ionizing radiation, any absorbing medium.Exposure to ionizing radiation can cause damage to living tissues: High Doses -> Skin burns,

radiation sickness, and death Low Doses –> Cancer, tumors, and genetic damage ?Minimum risks and maximum benefits should be achieved in a practice which included ionizing radiation.Radioactive materials decay (unstable nucleus).Severity increases with dose above threshold ?Dose falls exponentially with increasing thickness.X–rays
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