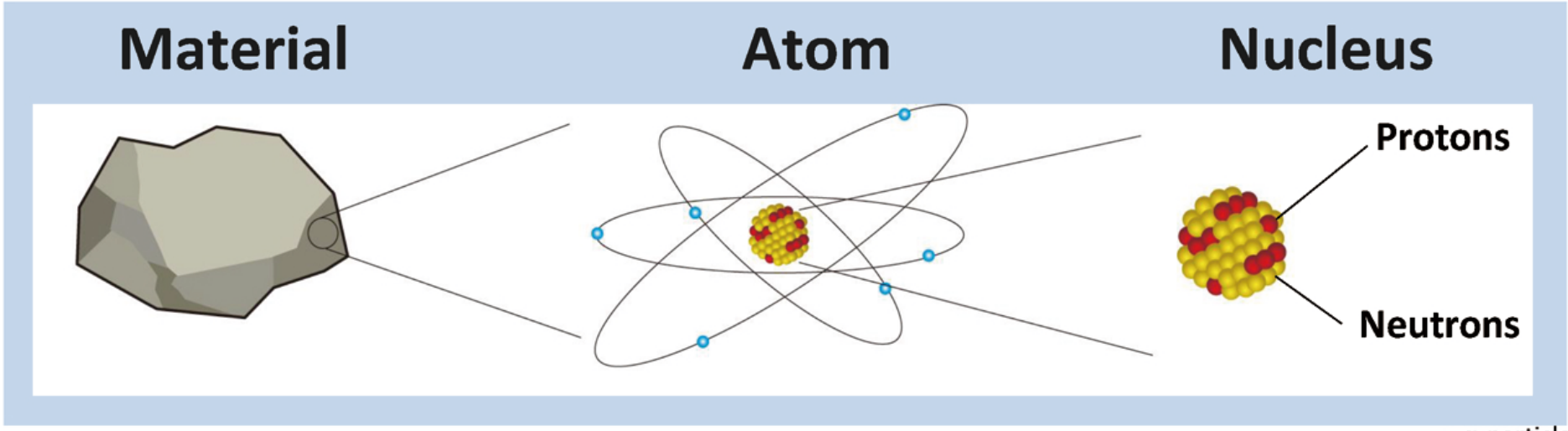
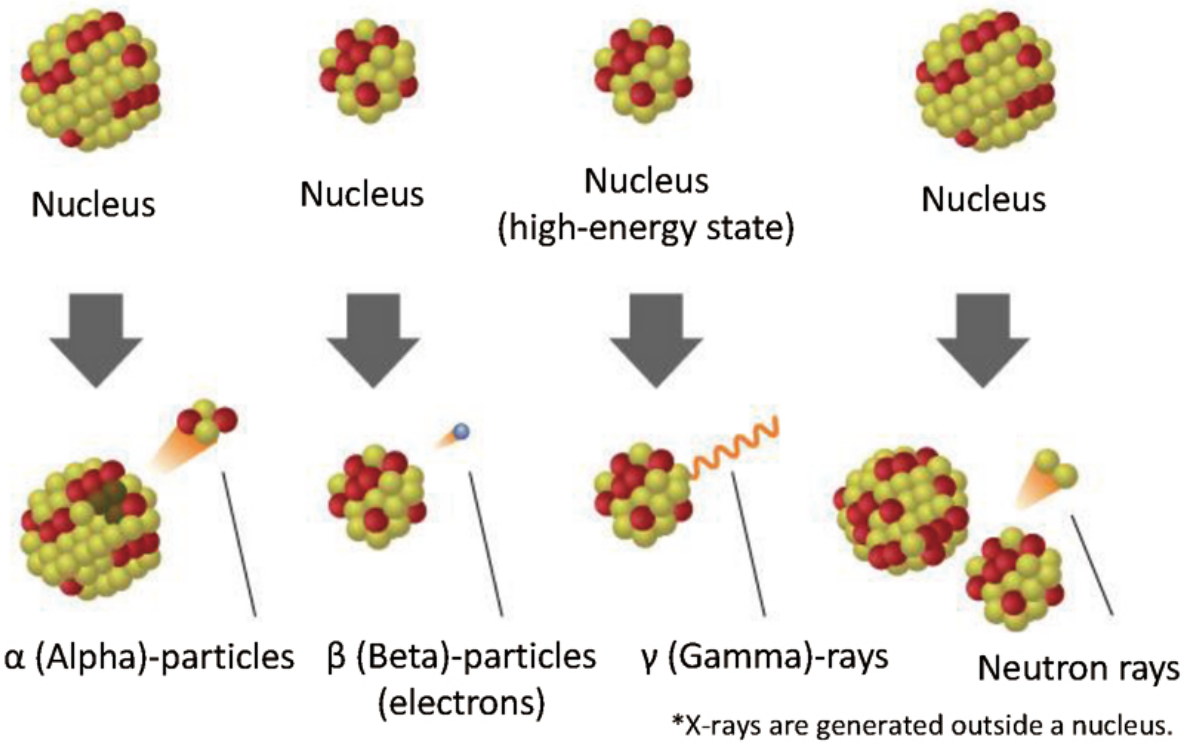
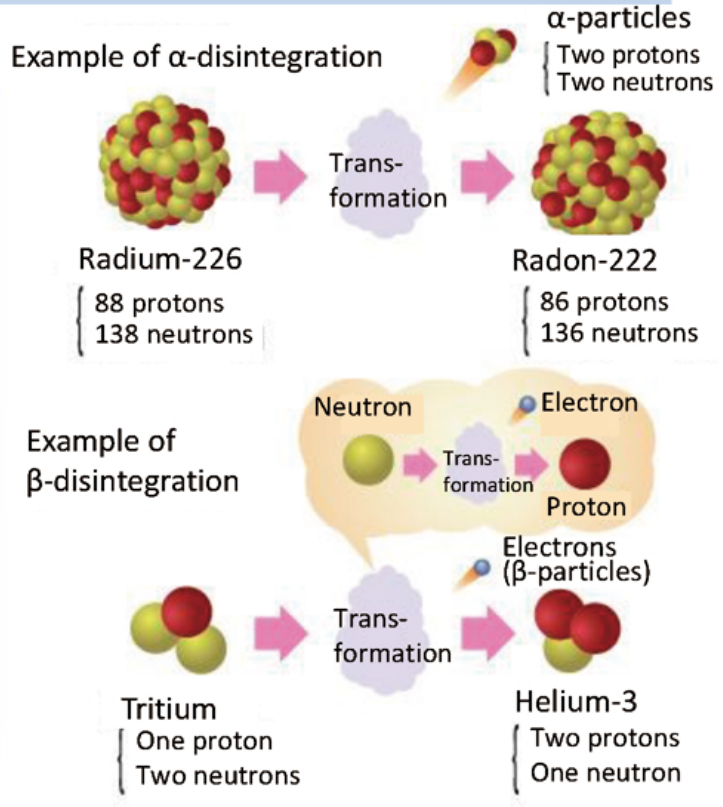
Radiation

Where does Radiation Come from?

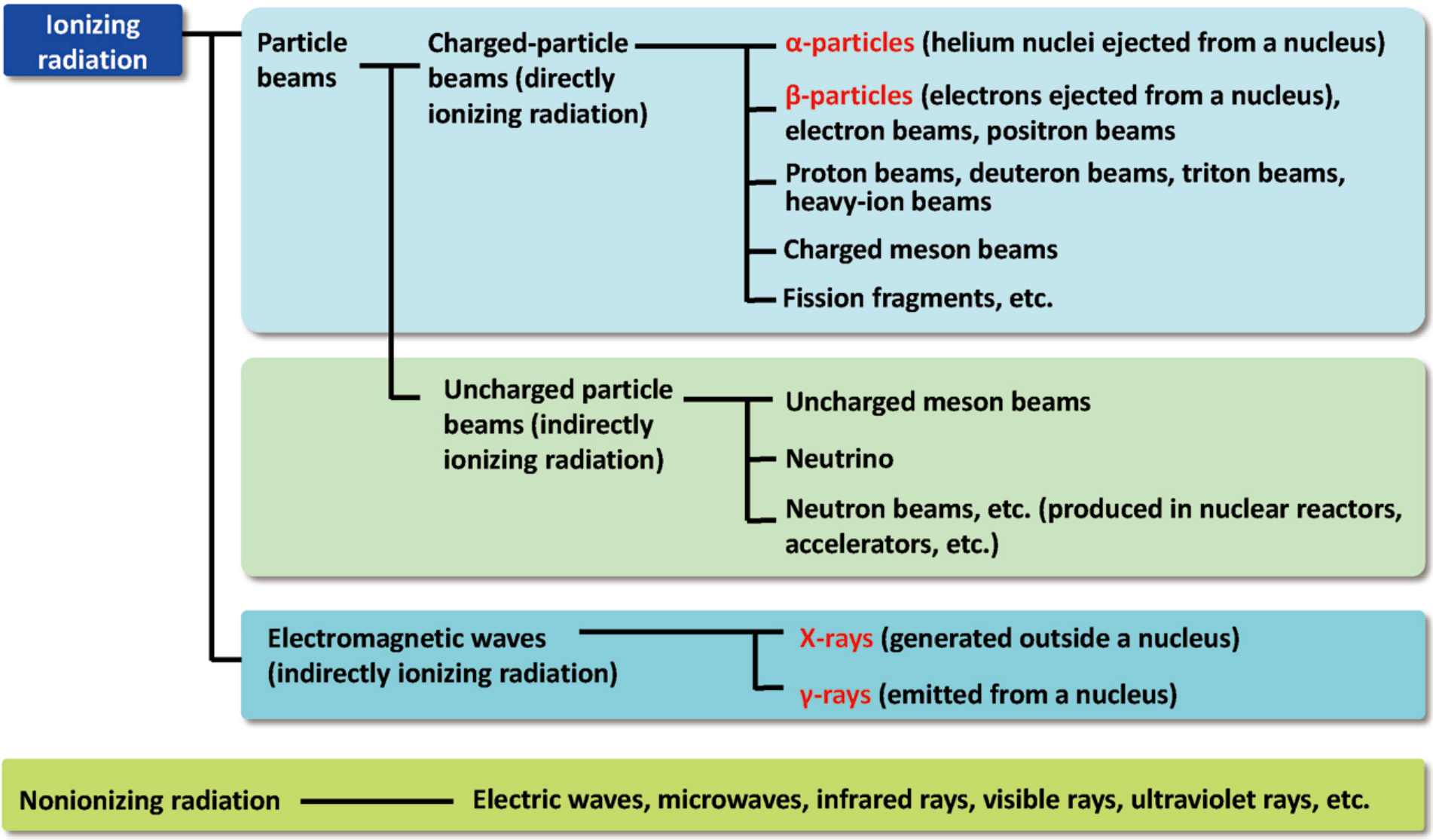






Radiation

Types of Radiation



While radiation includes ionizing radiation and nonionizing radiation, radiation usually means ionizing radiation.

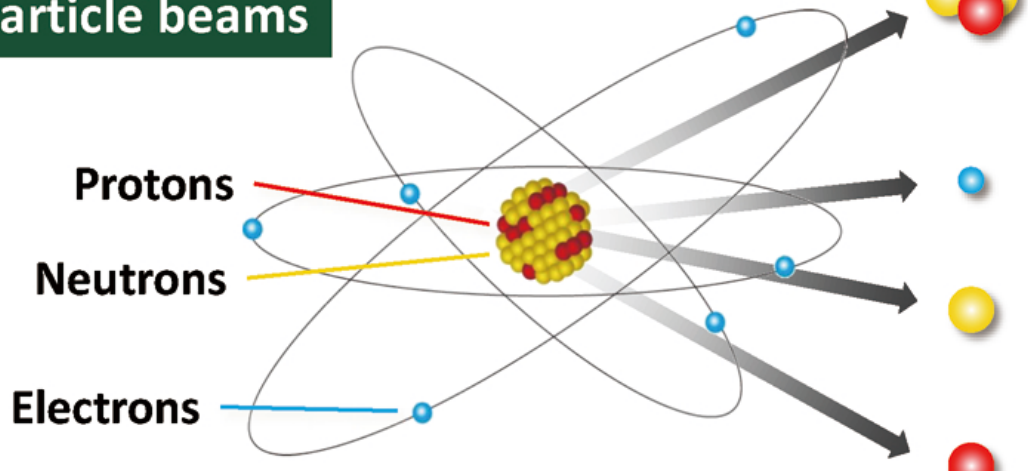
Source: Partially revised "Ionizing Radiation" in the Encyclopedia for Public Acceptance of Atomic Energy Accessible on the Internet, ATOMICA

Radiation

Types of Ionizing Radiation

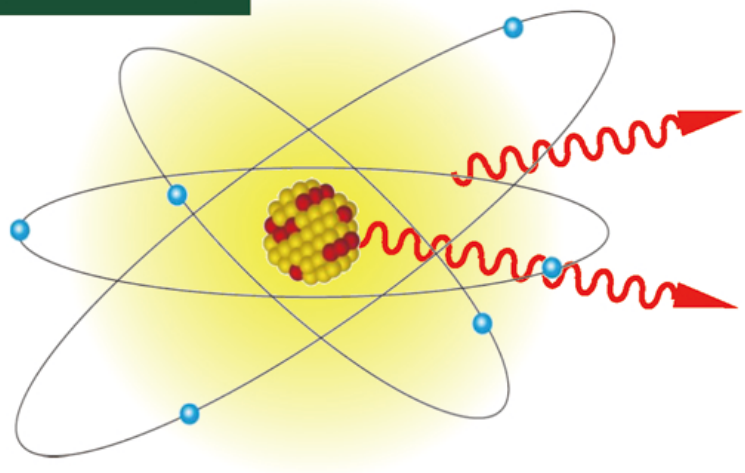
Ionizing radiation — Radiation that causes ionization

Particle beams



- **α-particles** (helium nuclei ejected from a nucleus)
- **β-particles** (electrons ejected from a nucleus)
- **Neutron beams** (produced in nuclear reactors, accelerators, etc.)
- **Proton beams** (produced in accelerators, etc.)

Electromagnetic waves

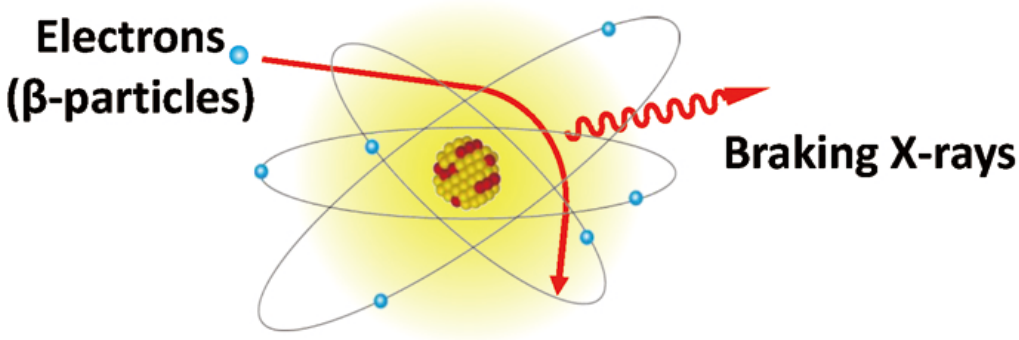


- **X-rays** (generated outside a nucleus)
- **γ-rays** (emitted from a nucleus)

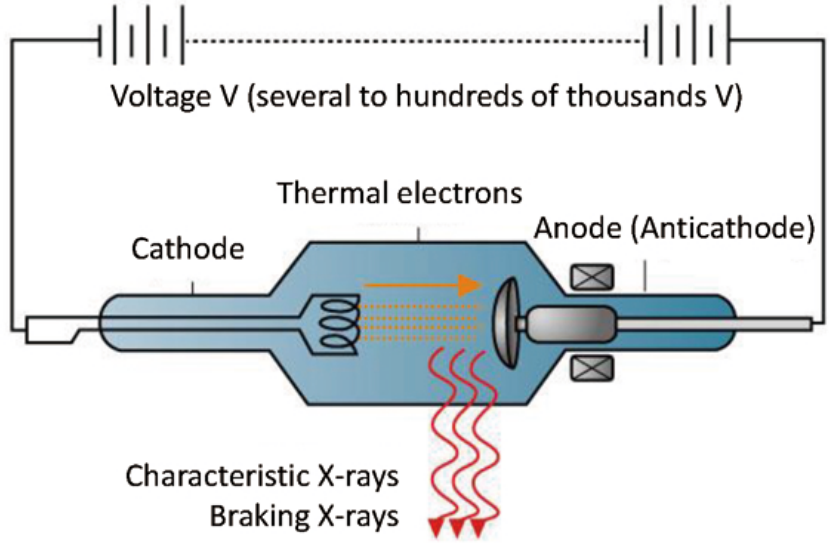
Radiation

X-rays for Medical Use and Generators

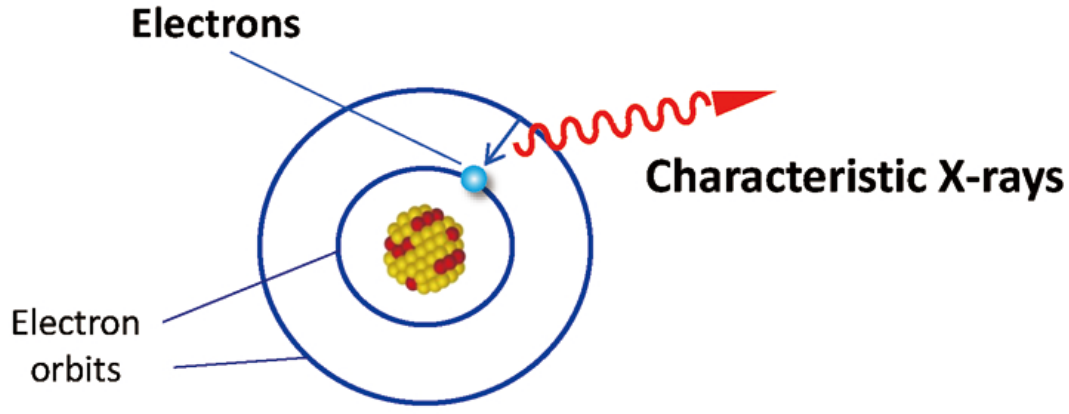
Braking X-rays



Structural drawing of an X-ray generator

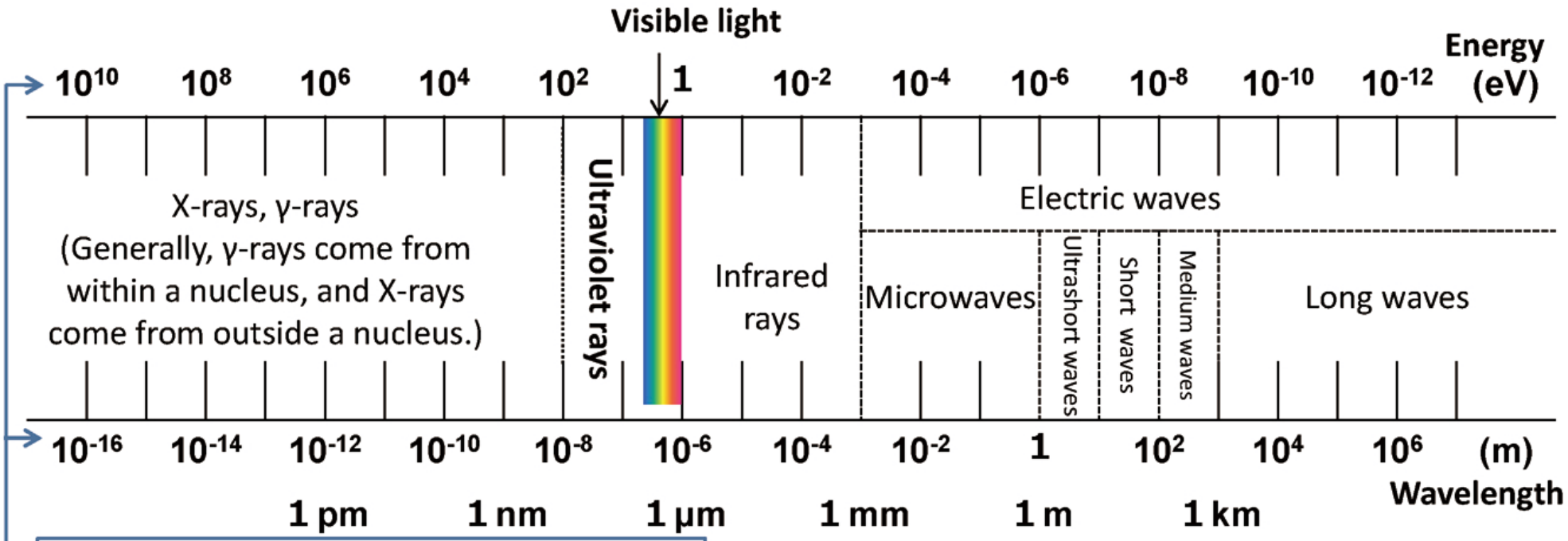


Characteristic X-rays



Radiation

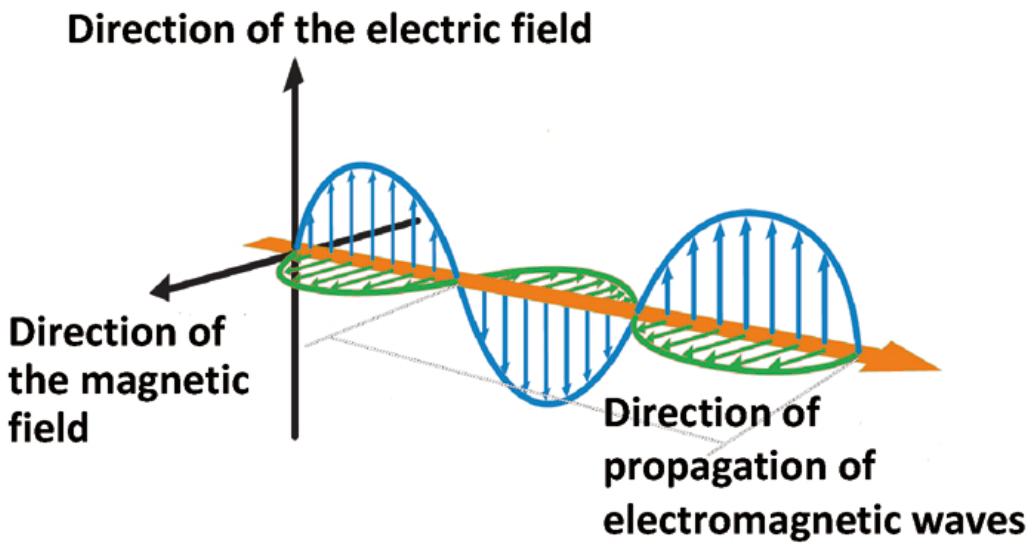
Types of Electromagnetic Waves



- Light has particle properties in addition to wave properties.
- Electromagnetic waves are called "photons" when they are considered as particles.

The values indicated above show photons' energy (eV) and those indicated below show their wavelengths (m) as wave motions.

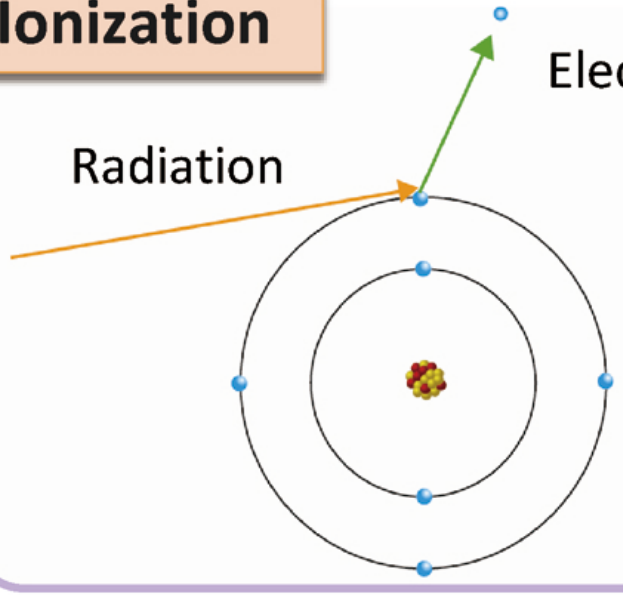
pm: picometers
nm: nanometers
μm: micrometers
eV: electron volts



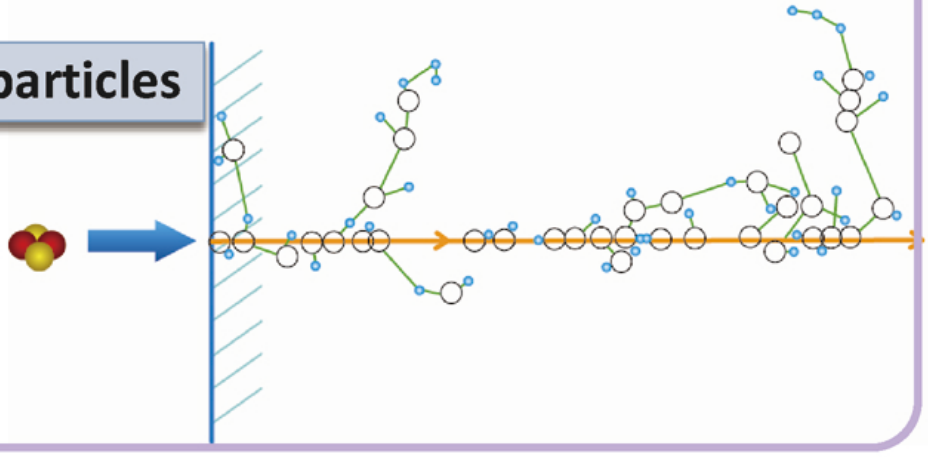
Radiation

Ionization of Radiation - Property of Ionizing Radiation

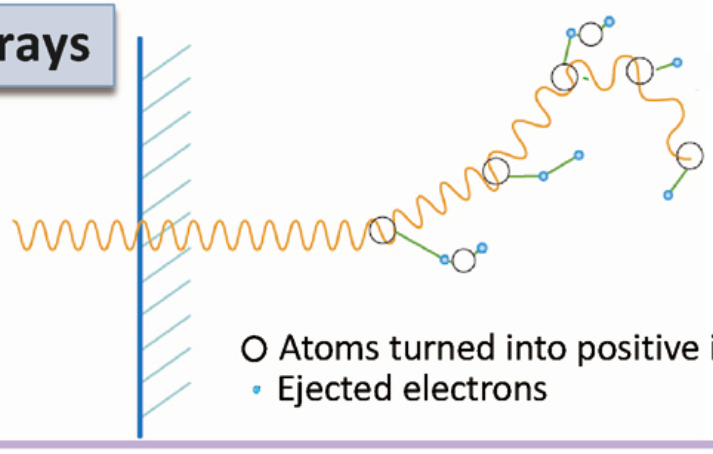
Ionization



α-particles



γ-rays



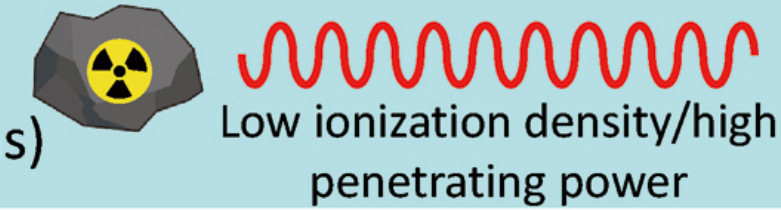
Radiation

Types of Radiation and Biological Effects

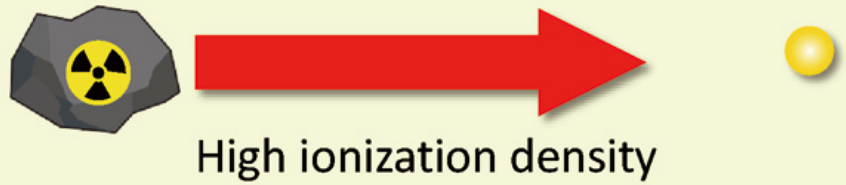
- **α-particles**
  - Two protons plus two neutrons
  - Helium (He) nuclei
  - Charged particles (2+)

- **β-particles**
  - Electrons (or positrons)
  - Charged particles (- or +)

- **γ-rays and X-rays**
  - Electromagnetic waves (photons)



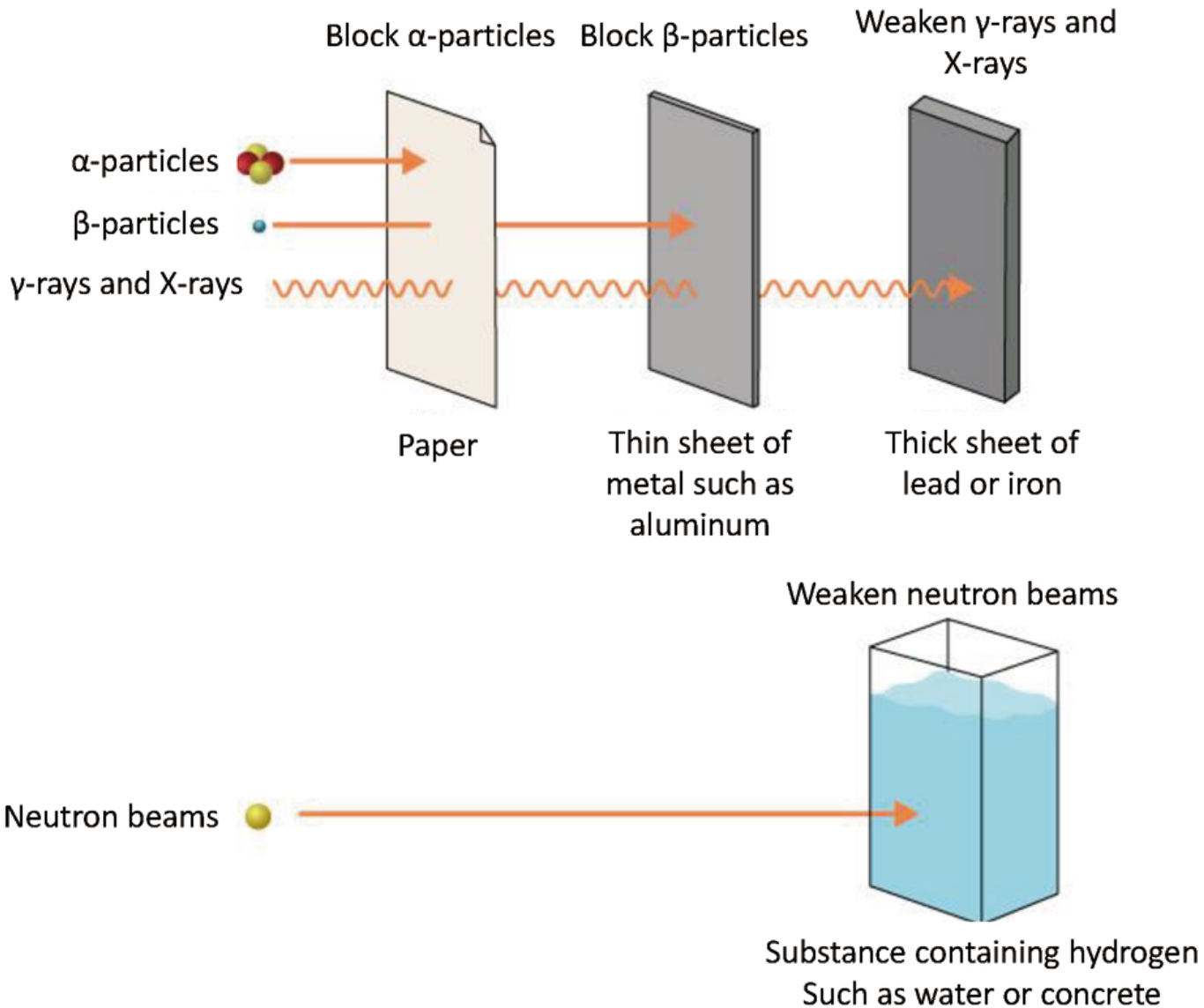
- **Neutron beams**
  - Neutrons
  - Uncharged particles



When the ionization number is the same, the higher the ionization density is, the larger the biological effects are.

Penetrating Power of Radiation

Radiation can be blocked by various substances.



Radiation

Penetrating Power of Radiation within the Body

Distance traveling in the air

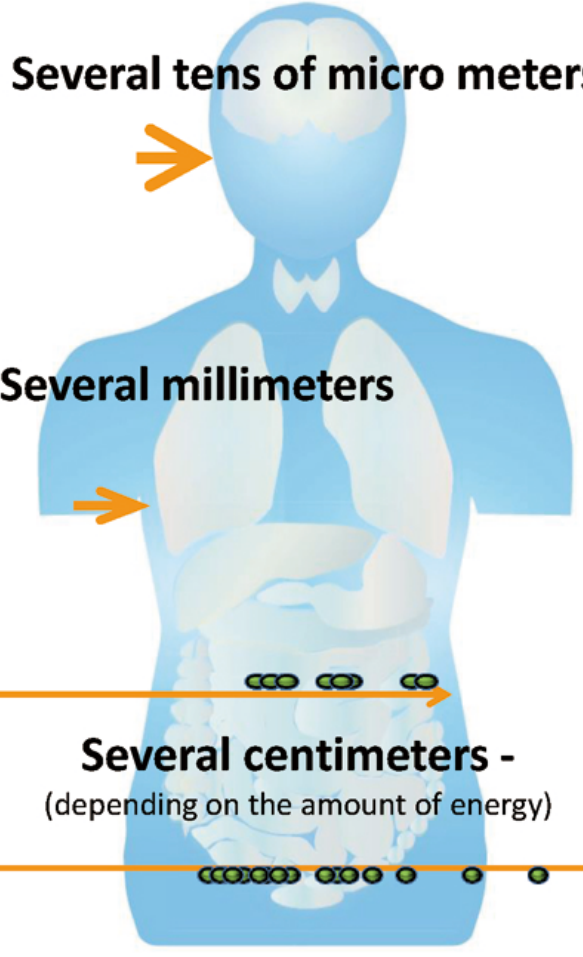
Upon collision with the body

α-particles

Particles (Helium nucleus)
(One-trillionth of a centimeter)

Several centimeters

Several tens of micro meters



Several millimeters

β-particles

Particles (electrons)

Several meters
(depending on the amount of energy)

γ-rays
X-rays

Several tens of meters
(depending on the amount of energy)

Several centimeters -
(depending on the amount of energy)

Radiation

Penetrating Power and Range of Effects on the Human Body

When radioactive materials are located outside the body

When radioactive materials are located within the body