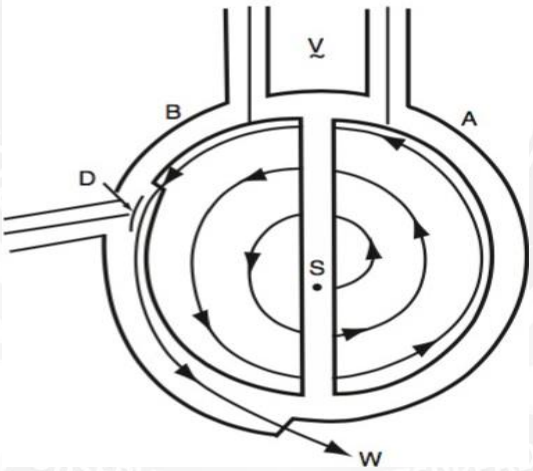
BM-3252 MEDICAL PHYSICS

UNIT II

PRODUCTION OF RADIONUCLIDES

Cyclotron Produced Radionuclide

- Cyclotrons and other charged-particle accelerators produce radio nuclides bybombarding stable nuclei with high-energy charged particles.
- Protons, deuterons (^{2}H nuclei), tritons (^{3}H nuclei), and alpha particles (^{4}He nuclei) are commonly used to produce radio nuclides used in medicine.
- Heavy charged particles must be accelerated to high kinetic energies to overcome andpenetrate the repulsive coulombic barrier of the target atoms' nuclei.
- The large potentials generated were used to produce artificial radioactivity by accelerating particles to high energies and bombarding stable nuclei.



- Positive ions injected into the center of the cyclotron are attracted to and accelerated toward a negatively charged, hollow, semicircular electrode shaped like and called a "dee."
- There are two dees separated by a small gap and kept under an extremely high vacuum.
- Constrained by a static magnetic field, the ions travel in a circular path, where the radius of the circle increases as the ions are accelerated.
- Half way around the circle, the ions approach the other dee and, at the same instant, the polarity of the electrical field between the two dees is reversed, causing the ions to continue their acceleration toward the negative potential.
- This alternating potential between the dees is repeated again and again as the particles

continue to acquire kinetic energy, sweeping out larger and larger circles.

- As the length of the pathway between successive accelerations increases, the speed of the particle also increases; hence, the time interval between accelerations remains constant. The cyclic nature of these events led to the name "cyclotron."
- The final energy achieved by the accelerated particles depends on the diameter of the dees and on the strength of the static magnetic field.
- Finally, as the ions reach the periphery of the dees, they are removed from their circular path by a negatively charged deflector plate, emerge through the window, and strike the target.
- Depending on the design of the cyclotron, particle energies can range from a few million electron volts (MeV) to several billion electron volts (BeV).The accelerated ions collide with the target nuclei, causing nuclear reactions. An incident particle may leave the target nucleus after interacting, transferring some of its energy to it, or it may be completely absorbed.
- The specific reaction depends on the type and energy of the bombarding particle as well as the composition of the target.
- Target nuclei are left in excited states, and this excitation energy is disposed of by the emission of particulate (protons and neutrons) and electromagnetic (gamma rays) radiations. Gallium-67 (Ga-67) is an example of a widely used cyclotron-produced radionuclide.