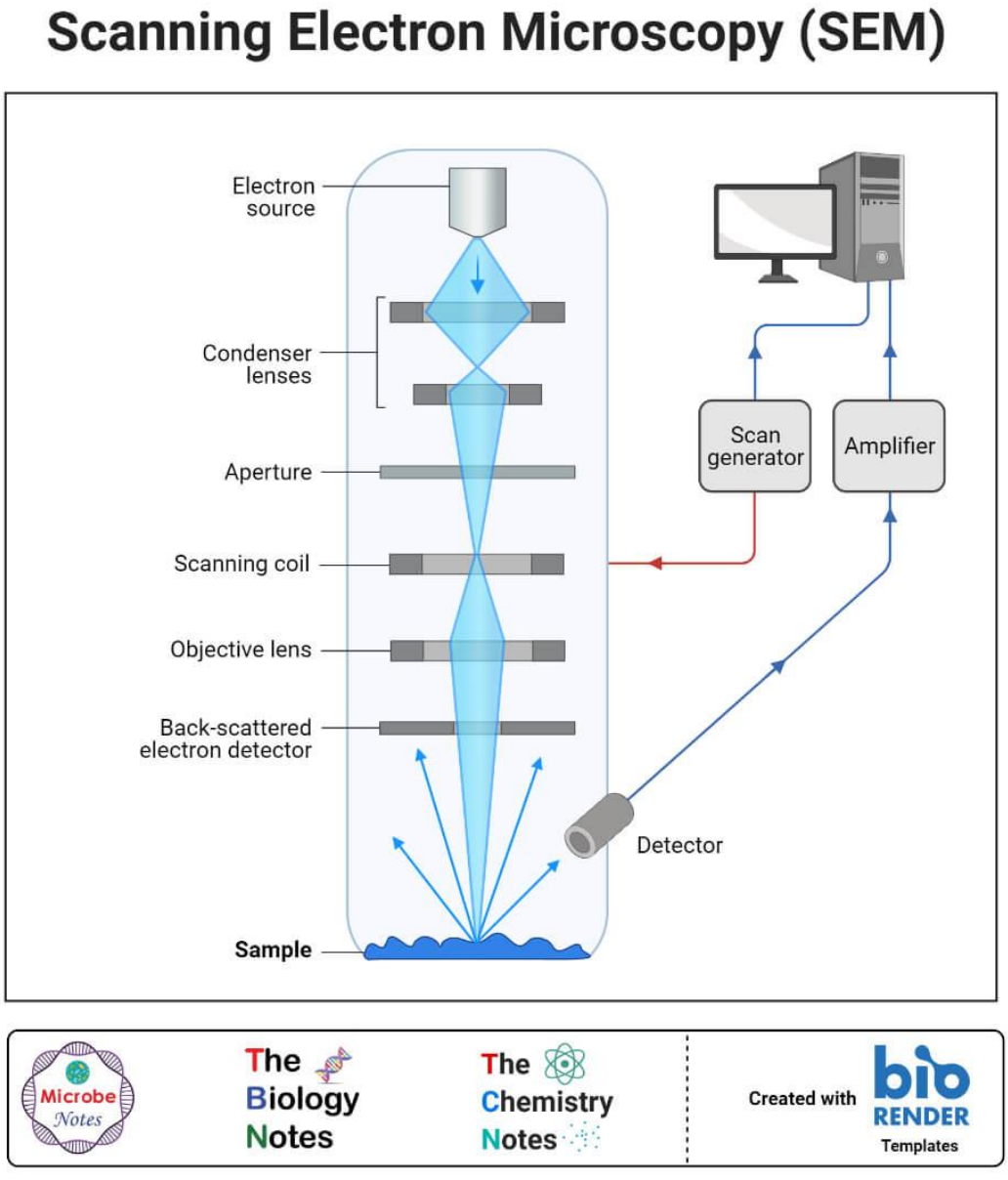
Scanning Electron Microscope (SEM) Definition

Scanning Electron Microscope (SEM) is a type of electron microscope that scans surfaces of microorganisms that uses a beam of electrons moving at low energy to focus and scan specimens. The development of electron microscopes was due to the inefficiency of the wavelength of light microscopes. electron microscopes have very short wavelengths in comparison to the light microscope which enables better resolution power.



- The source of the electrons and the electromagnetic lenses are from tungsten filament lamps that are placed at the top of the column and it is similar to those of the transmission electron Microscope.
- The electrons are emitted after thermal energy is applied to the electron source and allowed to move in a fast motion to the anode, which has a positive charge.
- The beam of electrons activates the emission of primary scattered (Primary) electrons at high energy levels and secondary electrons at low-energy levels from the specimen surface.
- The samples are mounted and coated with thin layer of heavy metal elements to allow spatial scattering of electric charges on the surface of the specimen allowing better image production, with high clarity.
- Scanning by this microscope is attained by tapering a beam of electrons back and forth over a thin section of the microscope. When the electrons reach the specimen, the surface releases a tiny staw of electrons known as secondary electrons which are then trapped by a special detector apparatus.
- When the secondary electrons reach and enter the detector, they strike a scintillator .This emits flashes of light which get converted into an electric current by a photomultiplier. This produces an image that looks like a television picture that can be viewed and photographed.
- The quantity of secondary electrons that enter the detector is highly defined by the nature of the specimen i.e raised surfaces to receive high quantities of electrons, entering the detector while depressed surfaces have fewer electrons reaching the surface and hence fewer electrons enter the detector.
- Therefore raised surfaces will appear brighter on the screen while depressed surfaces appear darker.

Applications of the Scanning Electron Microscope (SEM)

It is used in a variety of fields including Industrial uses, nanoscience studies, Biomedical studies, Microbiology

1. Used for spot chemical analysis in energy-Dispersive X-ray Spectroscopy.
2. Used in the analysis of cosmetic components which are very tiny in size.
3. Used to study the filament structures of microorganisms.

4. Used to study the topography of elements used in industries.

transmission electron microscope

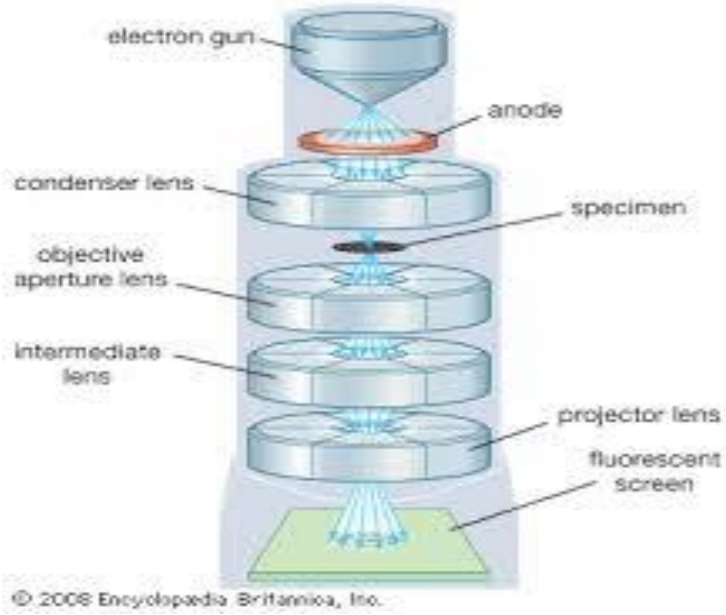
transmission electron microscope (TEM), type of electron microscope that has three essential systems:

(1) an electron gun, which produces the electron beam, and the condenser system, which focuses the beam onto the object.

(2) the image-producing system, consisting of the objective lens, movable specimen stage, and intermediate and projector lenses, which focus the electrons passing through the specimen to form a real, highly magnified image.

(3) the image-recording system, which converts the electron image into some form perceptible to the human eye.

(4) fluorescent screen, for viewing and focusing the image and a digital camera for permanent records. In addition, a vacuum system, consisting of pumps and their associated gauges and valves, and power supplies are required.



The source of electrons, the cathode, is a heated V-shaped tungsten filament or, in high-performance instruments, a sharply pointed rod of a material such as lanthanum hexaboride.

The filament is surrounded by a control grid, sometimes called a Wehnelt cylinder, with a central aperture arranged on the axis of the column; the apex of the cathode is arranged to lie at or just above or below this aperture.

The cathode and control grid are at a negative potential equal to the desired accelerating voltage and are insulated from the rest of the instrument.

The final electrode of the electron gun is the anode, which takes the form of a disk with an axial hole. Electrons leave the cathode and shield, accelerate toward the anode, and, if the stabilization of the high voltage is adequate, pass through the central aperture at a constant energy.

The specimen grid is carried in a small holder in a movable specimen stage. The objective lens is usually of short focal length (1–5 mm [0.04–0.2 inch]) and produces a real intermediate image that is further magnified by the projector lens or lenses.

A single projector lens may provide a range of magnification of 5:1, and by the use of interchangeable pole pieces in the projector a wider range of magnifications may be obtained.

The lenses require power supplies of a high degree of stability; for the highest standard of resolution, electronic stabilization to better than one part in a million is necessary. The control of a modern electron microscope is carried out by a computer, and dedicated software is readily available.

The identification of specific areas of an image, or pixels with specified characteristics, allows spurious colours to be added to a monochrome image. This can be an aid to visual interpretation and teaching and can create a visually attractive picture from the raw image.

APPLICATIONS:

- Biology: TEMs can be used to view the internal structure of cells, including the organization of molecules in viruses and cytoskeletal filaments.
- Material sciences: TEMs can be used to analyze materials at the atomic level, including determining the causes of failure in materials, and obtaining microstructural information.
- Drug discovery: TEMs can provide insights on the atomic interactions between a drug and its target.
- Nanotechnology: TEMs can be used to see nano-structures that are too small for an optical microscope to get a good look at.
- Electronics: TEMs can be used to identify minuscule cracks and flaws in chips.
- Forensics: TEMs can be used to analyze gunshot residue, blood found in clothing fibers, and other biological substances.
- Gemology and metallurgy: TEMs can be used to study crystals and metals