

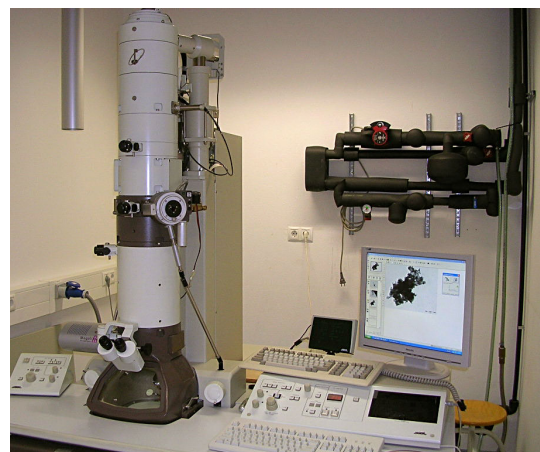
Electron Microscopy

Dr Manaf Abdulrahman Guma
University Of Anbar- College Of Applied Sciences-Hit(Heet)
Department Of Applied Chemistry

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Electron Microscopy (EM)

- There are two types of Electron Microscopy:
 1. Transmission Electron Microscopy (TEM)
 2. Scanning Electron Microscopy (SEM)



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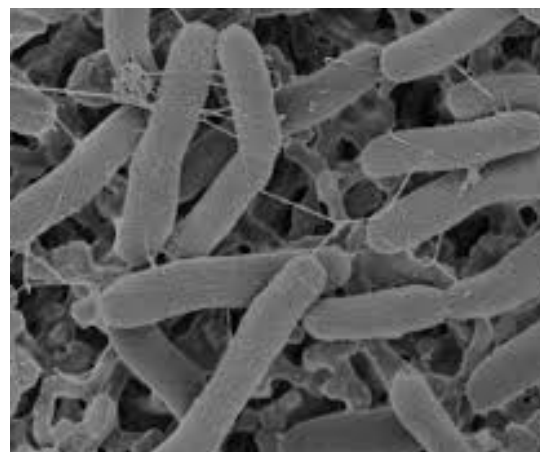
What is TEM?

- The transmission electron microscope is a very powerful tool for material science.
- TEM uses a high energy beam of electrons is shone through a very thin sample, and the interactions between the electrons and the atoms to observe features of a specimen.
- High resolution can be used to analyse the quality, shape, size and density of quantum wells, wires and dots of an image taken.

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What can TEM reveal ?

- TEMs can reveal the finest details of internal structure - in some cases as small as individual atoms.
- Examples: the crystal structure and features in the structure like dislocations. Etc.



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What does EM use instead of light? Why?

- The TEM operates on the same basic principles as the light microscope but uses electrons instead of light.
- Because the wavelength of electrons is much smaller than that of light.

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Describe the imaging?

1. The beam of electrons from the electron gun is focused into a small, thin, coherent beam by the use of the condenser lens.
2. This beam is restricted by the condenser aperture, which excludes high angle electrons.
3. The beam then strikes the specimen and parts of it are transmitted depending upon the thickness and electron transparency of the specimen.
4. This transmitted portion is focused by the objective lens into an image on phosphor screen or charge coupled device (CCD) camera.
5. Optional objective apertures can be used to enhance the contrast by blocking out high-angle diffracted electrons.
6. The image then passed down the column through the intermediate and projector lenses, is enlarged all the way.
7. The image strikes the phosphor screen and light is generated, allowing the user to see the image.

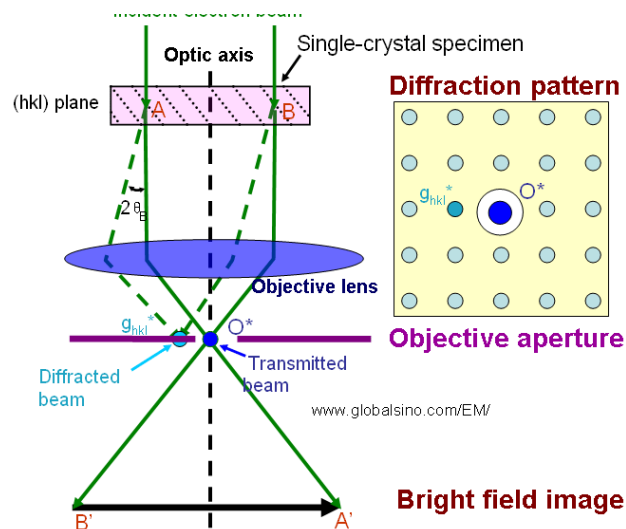
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Describe the diffraction in the TEM?

1. As the electrons pass through the sample, they are scattered by the electrostatic potential set up by the constituent elements in the specimen.
2. After passing through the specimen they pass through the electromagnetic objective lens which focuses all the electrons scattered from one point of the specimen into one point in the image plane.
3. Also, shown in the figure, a dotted line where the electrons scattered in the same direction by the sample are collected into a single point.
4. This is the back focal plane of the objective lens and is where the diffraction pattern is formed.

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Imaging and diffraction



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Describe the preparation techniques for TEM?

1. *Dimpling* is a preparation technique that produces a specimen with a thinned central area and an outer rim of sufficient thickness to permit ease of handling.
2. *Ion milling* is traditionally the final form of specimen preparation. In this process, charged argon ions are accelerated to the specimen surface by the application of high voltage. The ion impingement upon the specimen surface removes material as a result of momentum transfer

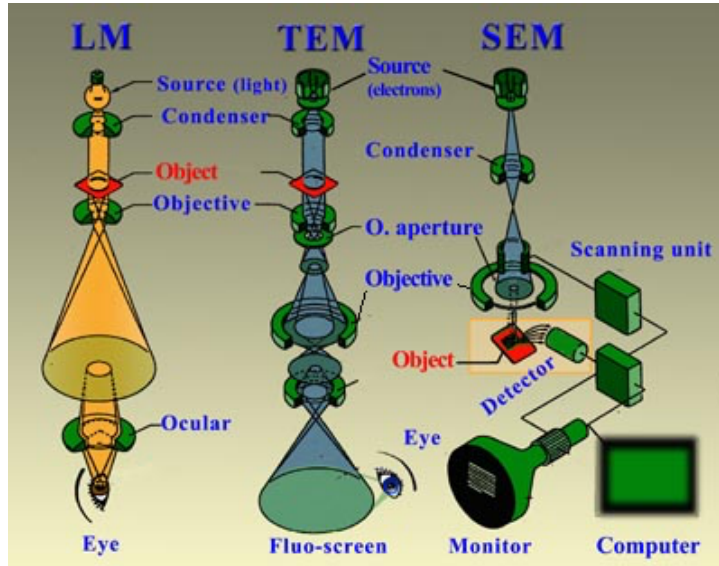
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What is SEM?

- SEM:
- SEM is used for inspecting topographies of specimens at very high magnifications.
- SEM magnifications can go to more than 300,000 X.

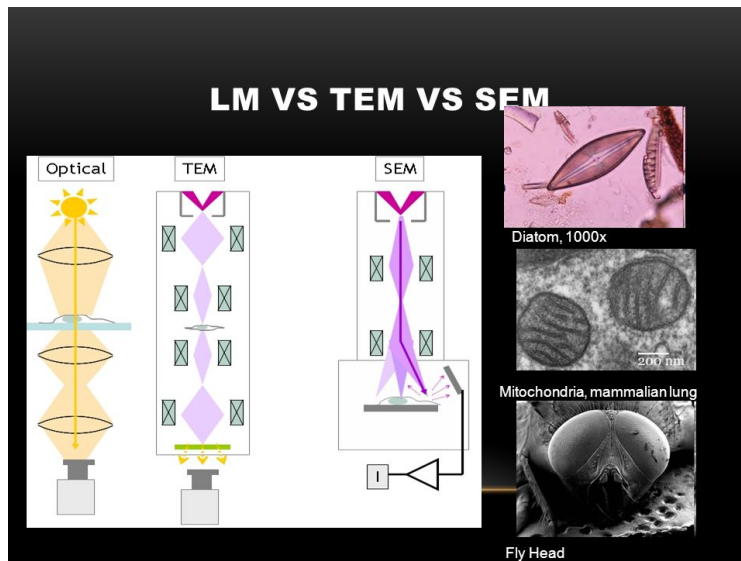
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The differences in tools of microcopies



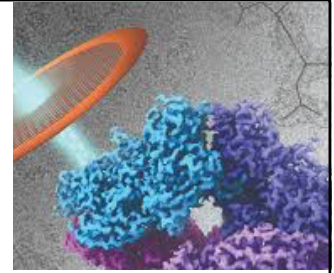
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The difference in an image resolutions



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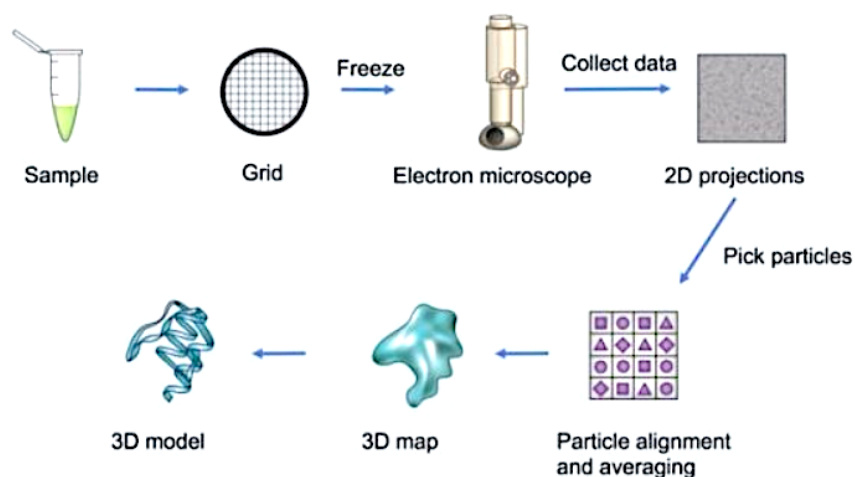
What is Cryo-EM?



- **Cryogenic electron microscopy (cryo-EM)** is an [electron microscopy](#) (EM) technique applied on samples cooled to [cryogenic](#) temperatures (means very low degree temperatures) and embedded in an environment of vitreous water.
- An aqueous sample solution is applied to a grid-mesh and plunge-frozen in liquid ethane.
- While development of the technique began in the 1970s, recent advances in detector technology and software algorithms have allowed for the determination of biomolecular structures at near-atomic resolution.
- This has attracted wide attention to the approach as an alternative to [X-ray crystallography](#) or [NMR spectroscopy](#) for macromolecular structure determination without the need for crystallization.

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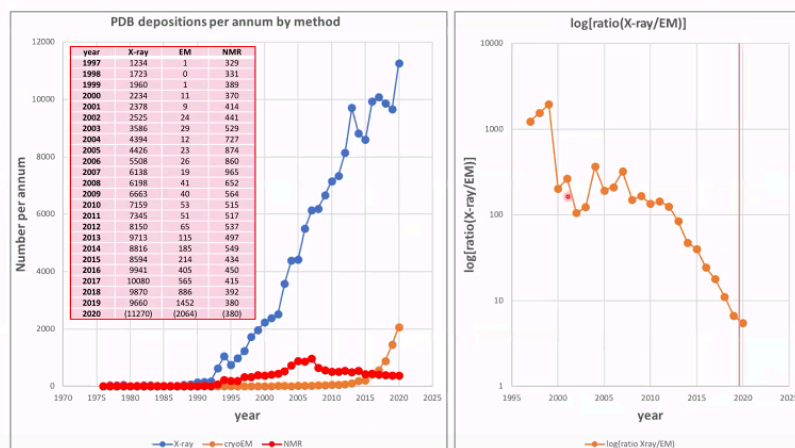
Cryo EM: from sample to structure ?



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Which technique is the most popular so far?

Statistics from Worldwide Protein Data Bank (wwPDB)
Total coordinates deposited 167,518



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