

# THE WORLD OF MICROSCOPY

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SCOPE

Scientists Changing Our Pre-college Education



# THE MAGNIFYING POWER OF LENSES

- Magnifying glass: 2–6 times
- Camera lens: up to 83 times (digital camera), up to 300 times (professional television camera)
- Light microscope: up to 2,000 times



[https://upload.wikimedia.org/wikipedia/commons/thumb/5/50/Magnifying\\_glass2.jpg/1200px-Magnifying\\_glass2.jpg](https://upload.wikimedia.org/wikipedia/commons/thumb/5/50/Magnifying_glass2.jpg/1200px-Magnifying_glass2.jpg)



<https://images.8tracks.com/cover/i/000/674/156/3CjBFIN-1772.jpg?rect=355,0,1225,1225&q=98&fm=jpg&fit=max&w=320&h=320>

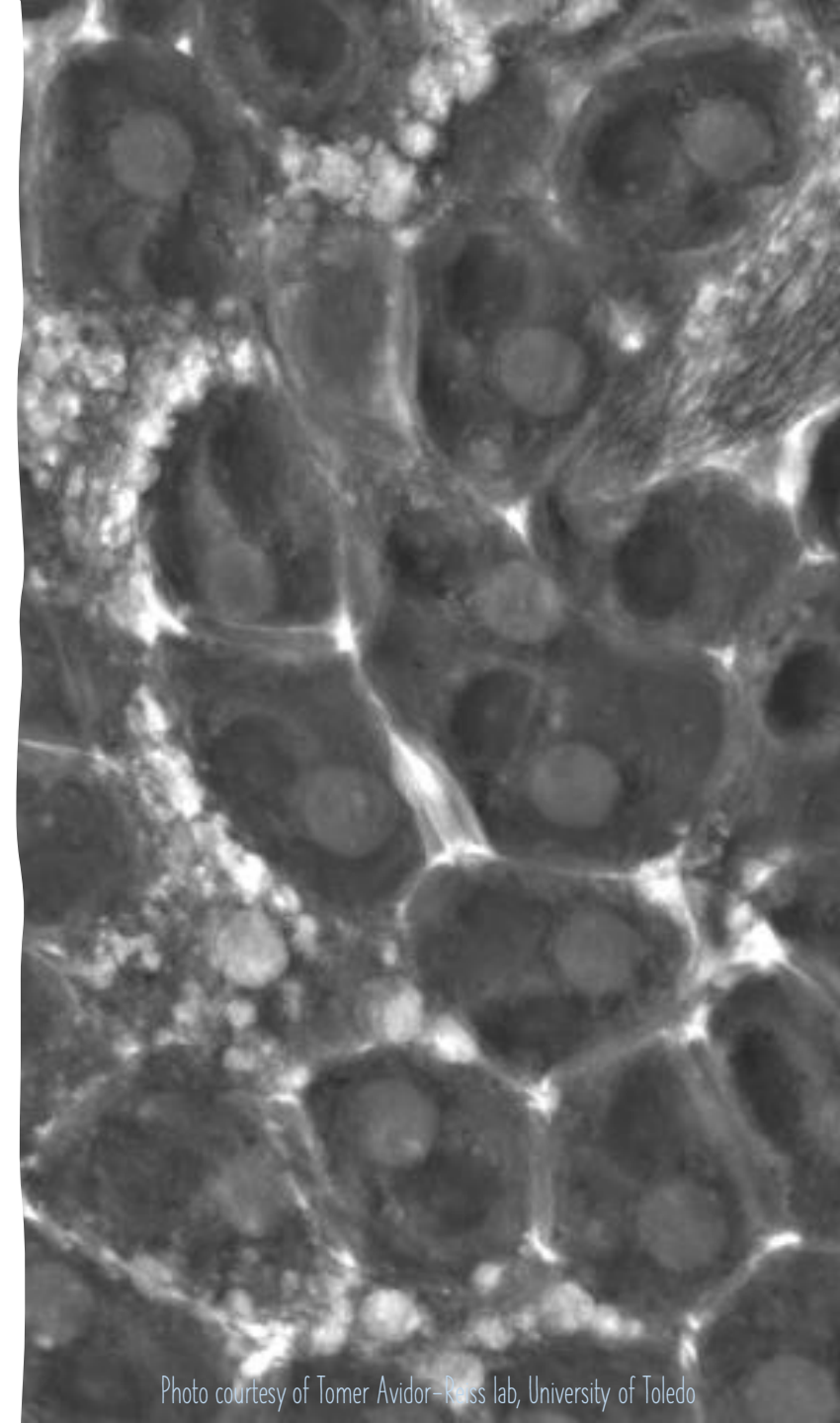
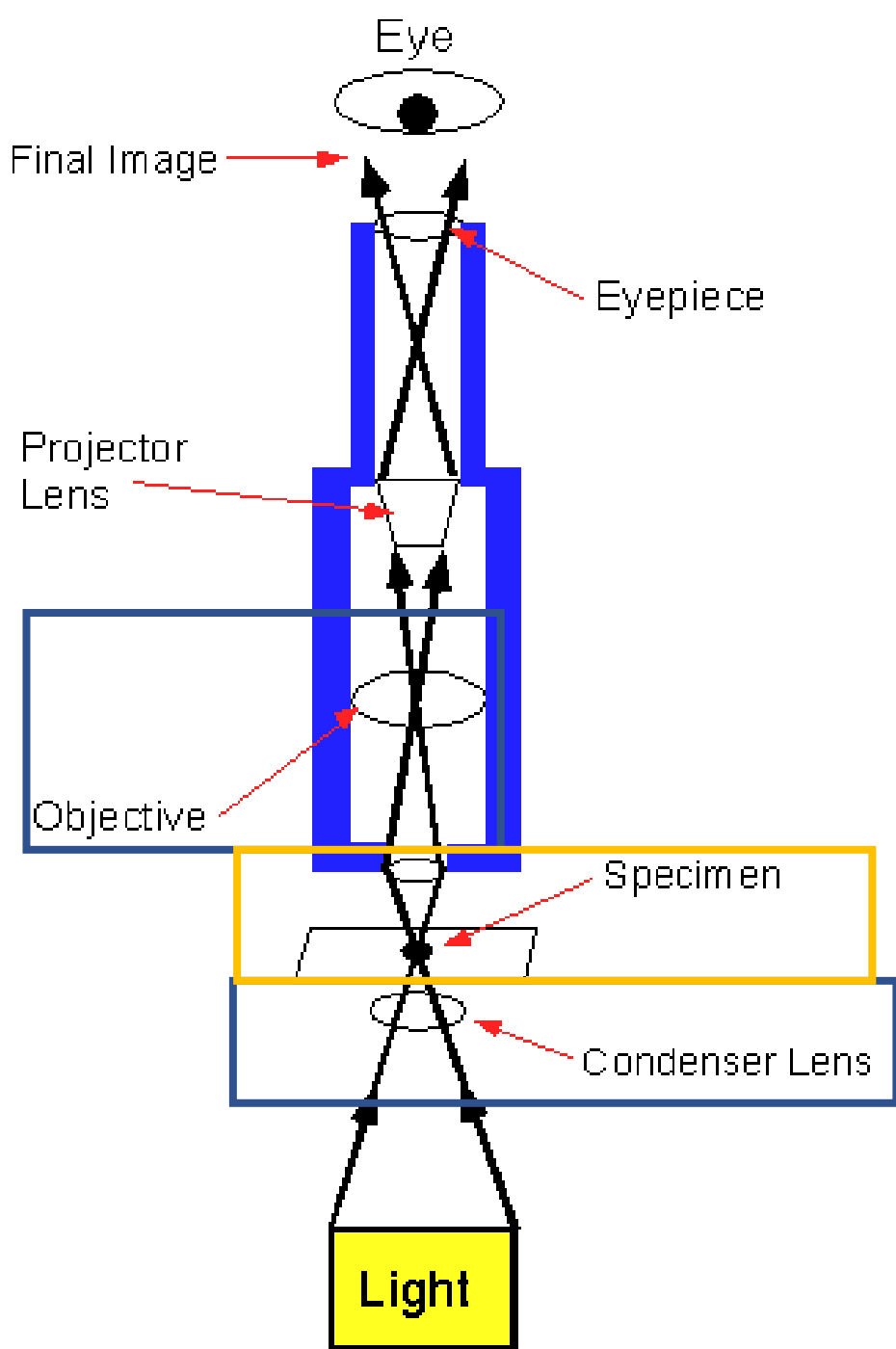


Photo courtesy of Tomer Avidor-Russ lab, University of Toledo



# LIGHT MICROSCOPES

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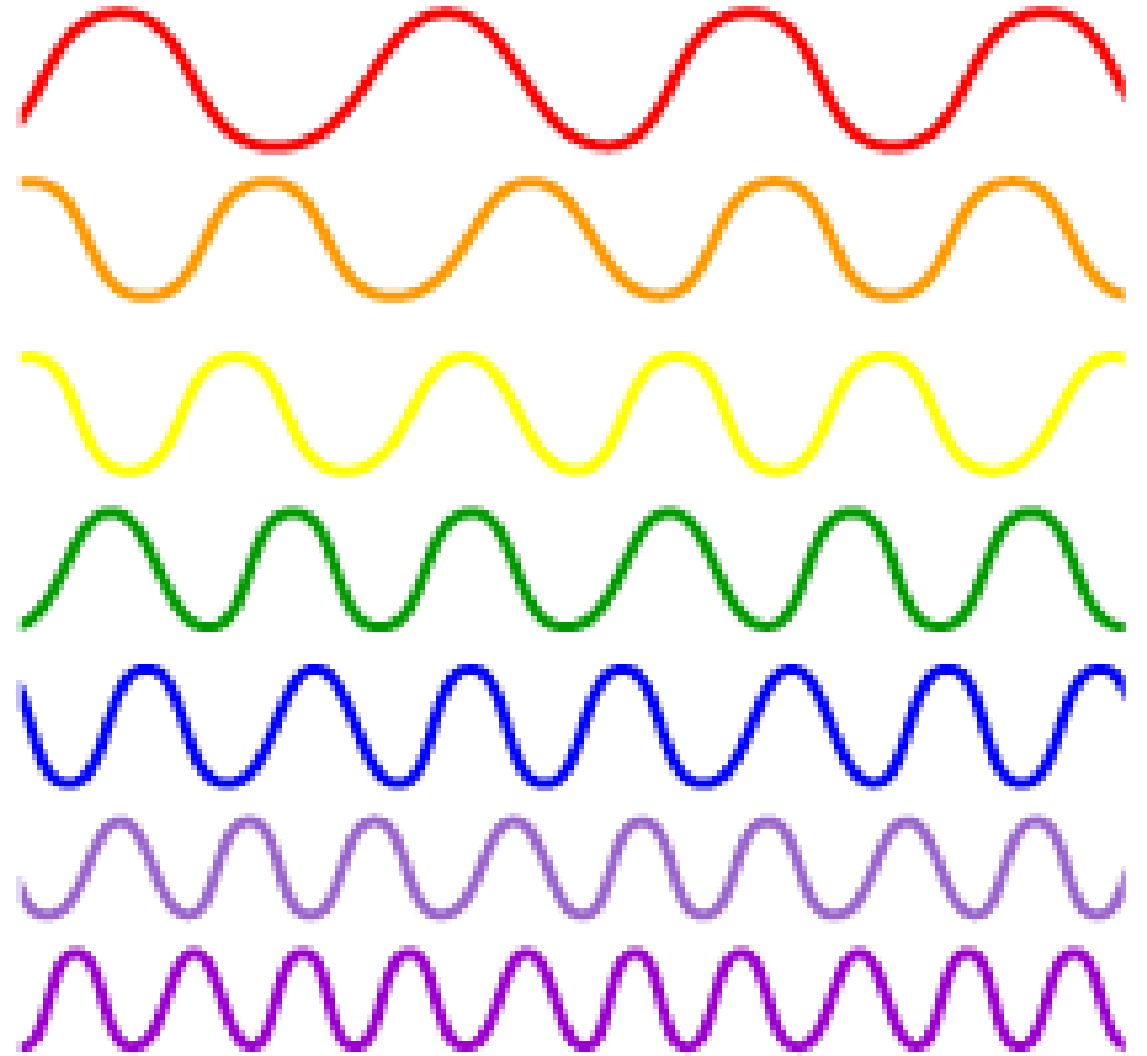
- Use visible light to view image
- Lenses focus the light
- Light passes through the sample
- Can zoom in to ~2,000 times



# THE LIMITATION OF LIGHT

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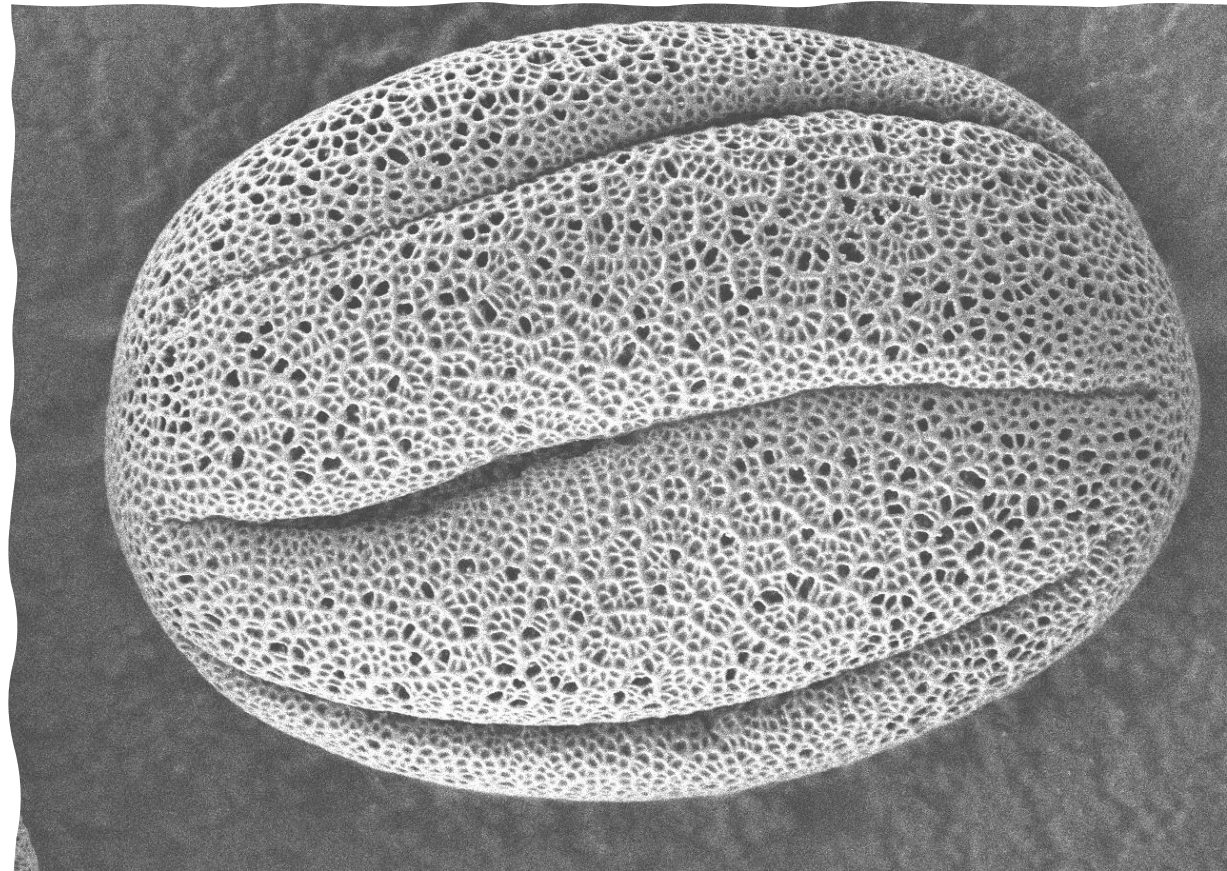
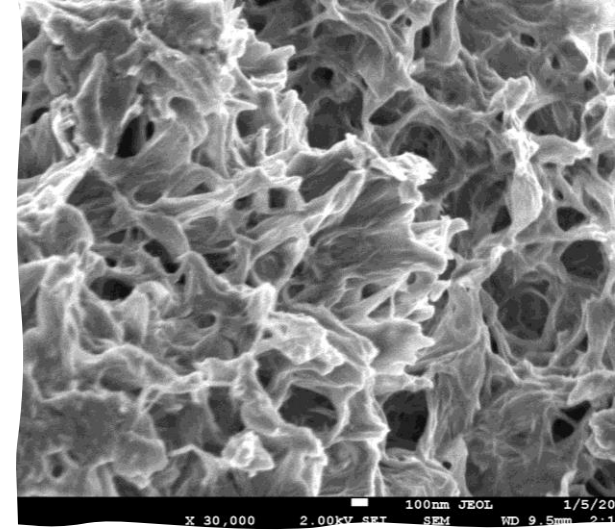
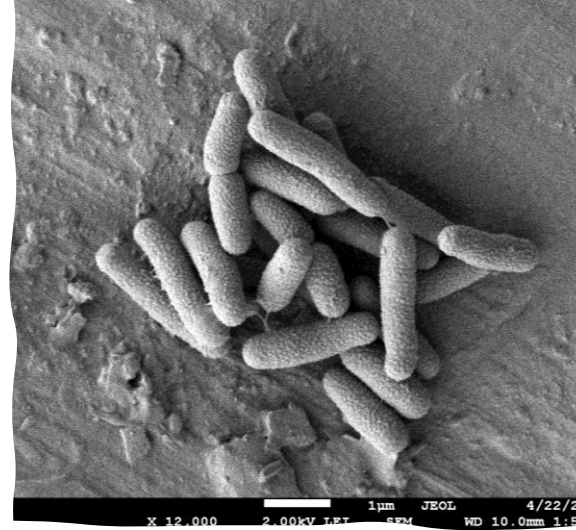
- Light behaves like a wave
  - Humans can only see certain wavelengths, called the visible spectrum
  - Different colors have different wavelengths
  - Anything smaller than the smallest wavelength of visible light (400 nm) cannot be seen using a light microscope

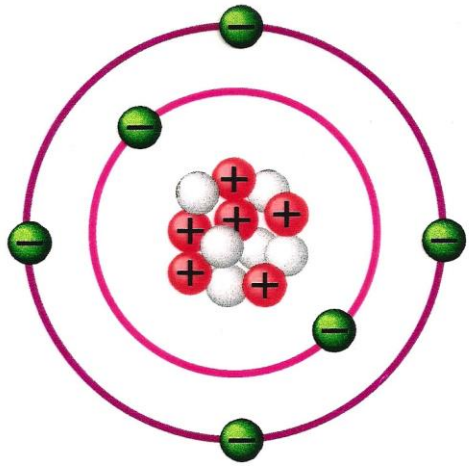


# WHAT IF WE WANT TO SEE SOMETHING SMALLER?

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- Although a light microscope can zoom in a lot, sometimes we need to zoom in further
  - Bacteria
  - Pollen
  - Nanoparticles





● - Electron

●+ - Proton

● - Neutron

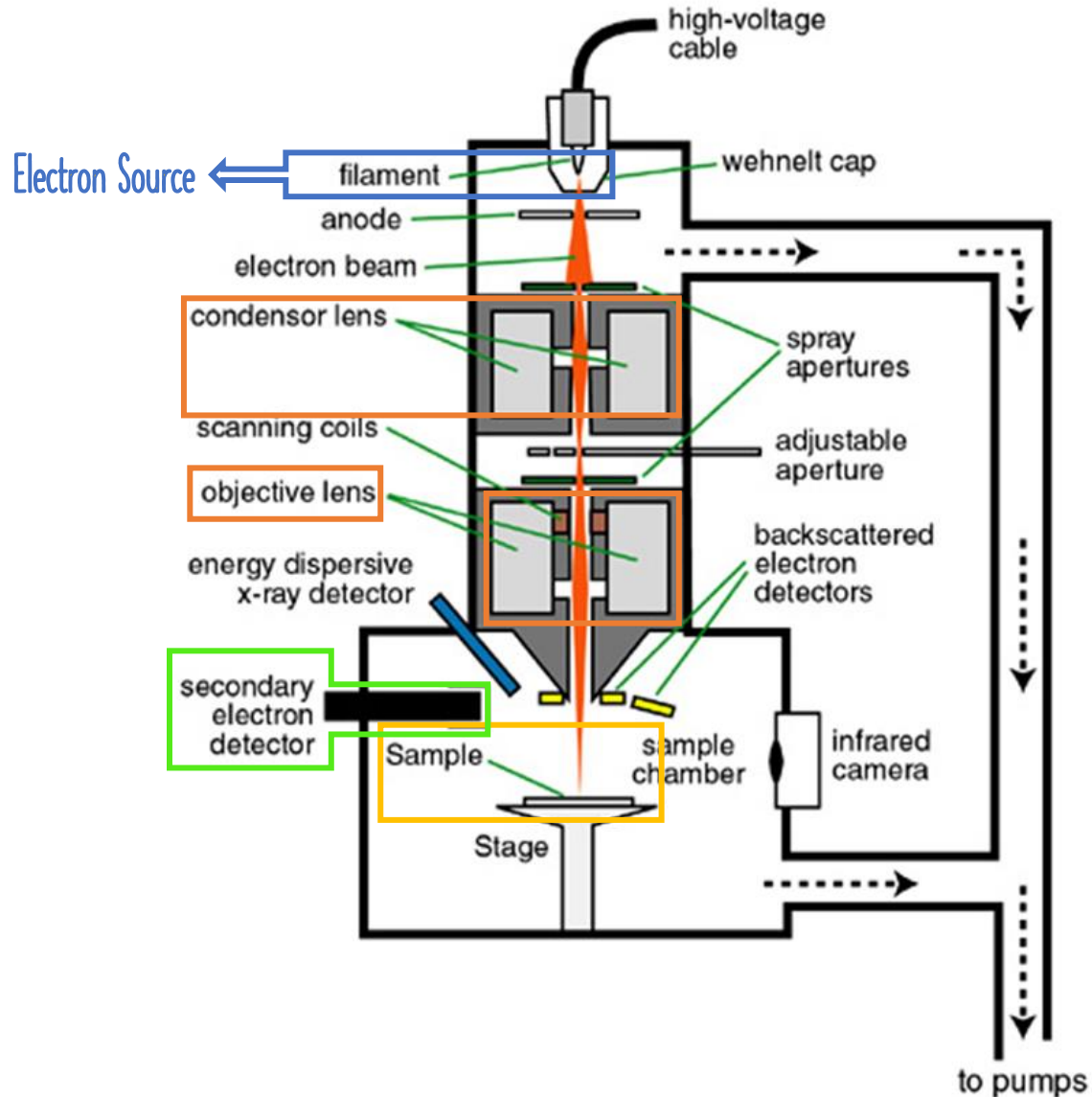
<https://sciencepediablog.files.wordpress.com/2016/06/carbon.jpg?w=882>



# ELECTRONS!

- Part of an atom
- Have a much smaller wavelength than light (~0.01 nanometers)
  - Only one wavelength (only one type of electron)
- Can easily be removed from an atom
  - Static electricity
  - Electric current

# SCANNING ELECTRON MICROSCOPE



- High electric current "frees" the electrons from a tungsten wire
- Magnets instead of lenses are used to focus the beam
- Scans the surface of the sample
- Can zoom in to 1,000,000 times
- Image is never in color!
  - Only one type of electron (no such thing as purple, green, blue electrons)

# REMOTELY CONTROLLING THE SEM

The screenshot displays the JEOL SEM control software interface. At the top, there is a menu bar with options: File (F), Edit (E), Function (O), Image Processing (I), Tools (T), Setup (S), Maintenance (M), and Help (H). Below the menu bar, there are several control panels. The 'Observation' panel shows 'Accel. Voltage' set to 2.00kV and 'Emission current' set to 9.0μA. The 'Stage Map' panel contains a table with columns for No., memo, X, Y, R, Z, and T. The 'SEM Monitor' panel shows 'Vacuum' at 9.6E-5 Pa and 'Spec. Surface Offset' at 0.0 mm. The 'Recipe' panel lists various observation conditions. The 'SEM Monitor' panel also includes a diagram of the SEM head with labels for Gun, LABE, and TED. A status bar at the bottom displays parameters: X 25, 2.00kV, LEI, LM, WD 38.0mm, 10:24:57, and JEOL 5/21/2020. The main display area shows a dark image of the specimen with a yellow circle highlighting a specific region.

No.	memo	X	Y	R	Z	T
P		0.000	0.000	0.0	8.0	0.0
Q		0.000	0.000	0.0	8.0	0.0
1	1	12.3...	-8.117	0.0	10.0	0.0
2	2	12.7...	1.467	0.0	10.0	0.0
3	3	12.8...	8.170	0.0	10.0	0.0
4	4	-0.570	-15....	0.0	10.0	0.0
5	5	-0.170	-7.191	0.0	10.0	0.0

SEM Monitor  
Vacuum 9.6E-5 Pa  
Spec. Surface Offset 0.0 mm  
Exchange Position  
Home Position  
VENT EVAC  
The specimen holder is on the specimen stage.