1.4 Tools and Technology

Unit 1: The Science of Life

Student Objectives

1. List the function of each of the major parts of a compound light microscope.
2. Compare two kinds of electron microscopes.
3. Describe the importance of having the SI system of measurement.
4. State some examples of good laboratory practice.

Microscopes as Tools

- Introduction video

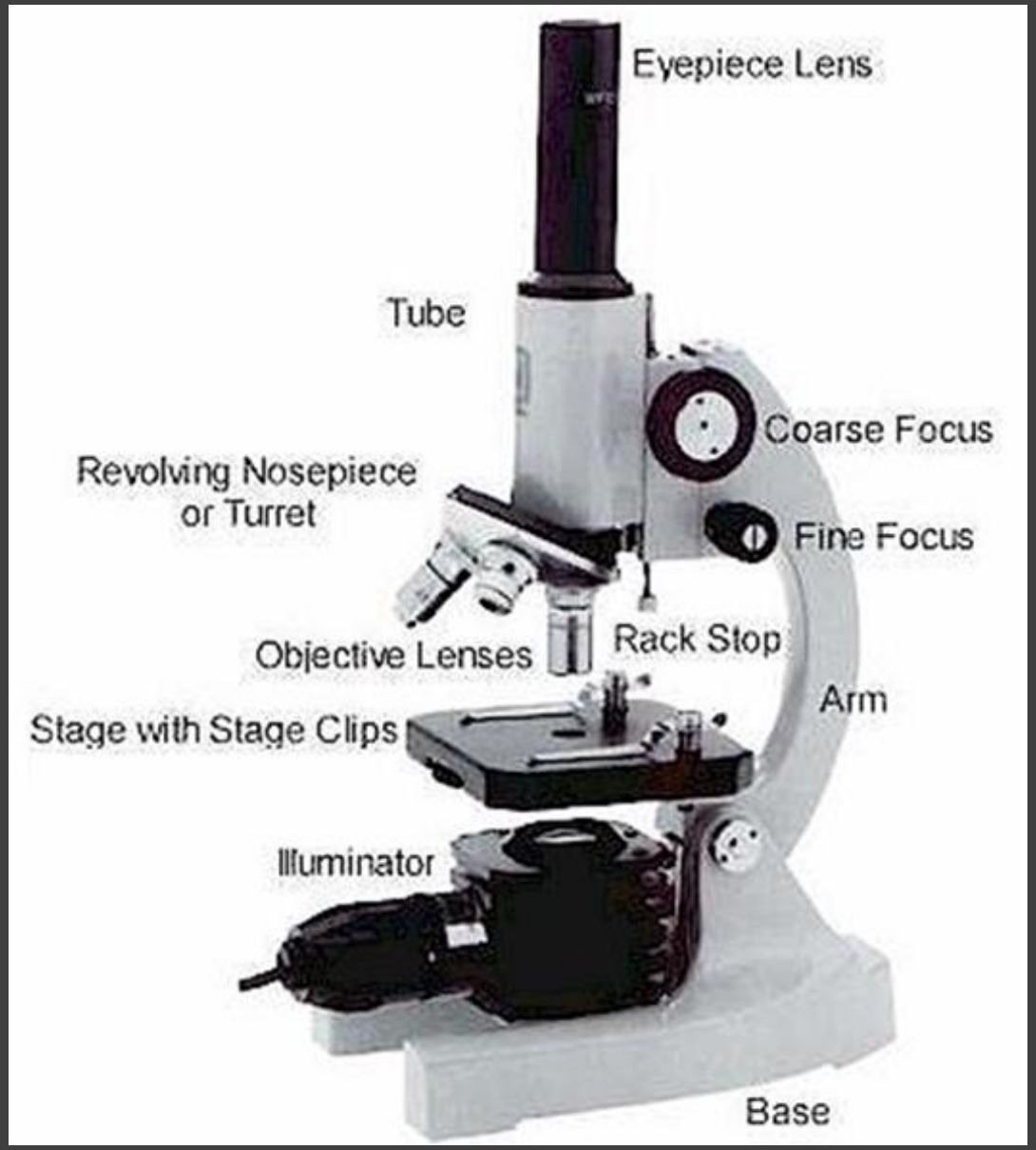
- Tools are objects to improve the performance of a task.
- **Microscopes** are tools that extend human vision by making enlarged images of objects. They are used to study organisms, cells, cell parts, and molecules.

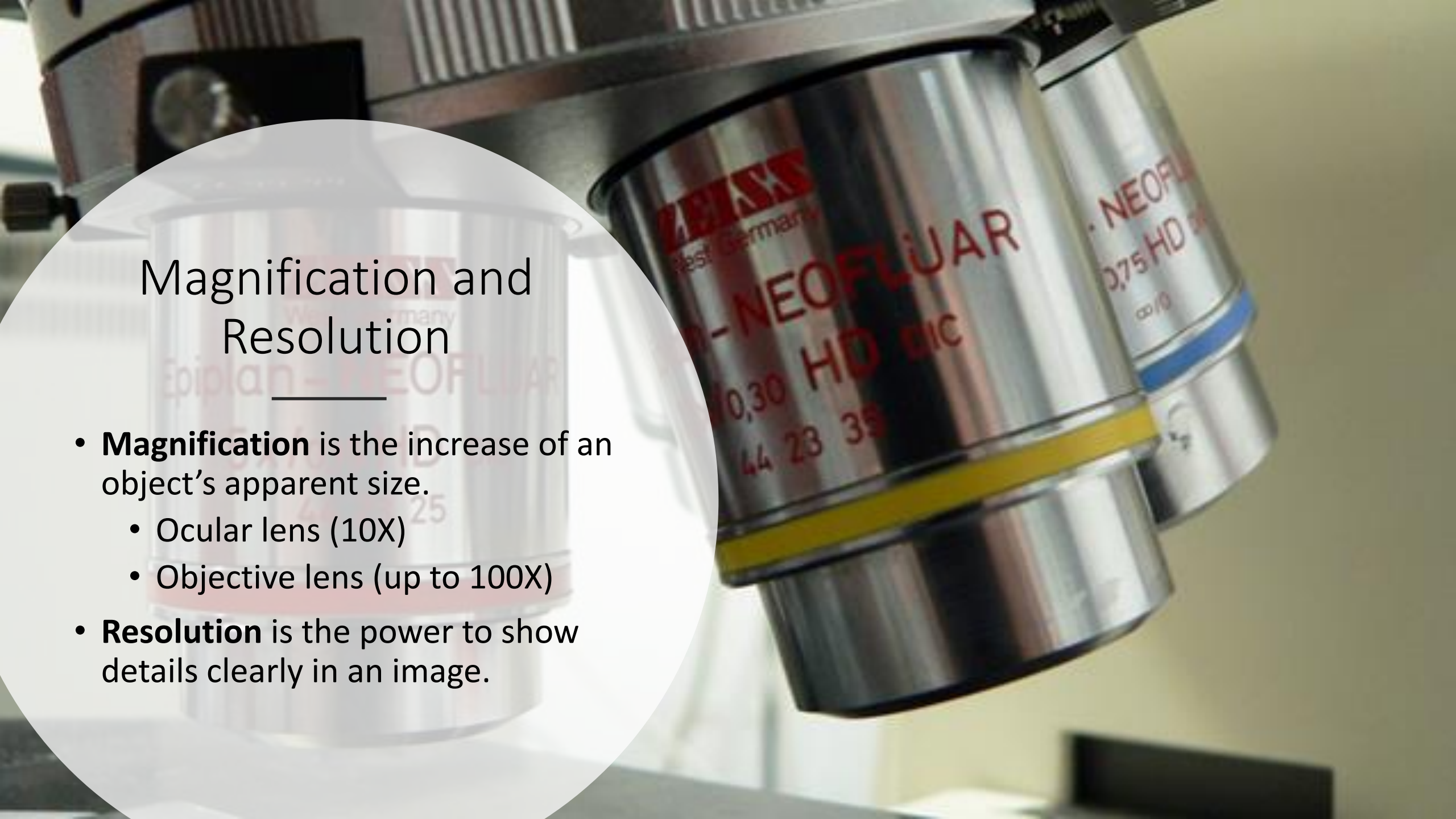
Light Microscope

- A **compound microscope** shines light through a specimen and has two lenses to magnify an image.
- The specimen must be thin enough for light to pass through it.

Parts of Microscope

1. The **Eyepiece** (ocular lens) magnifies the image usually 10 times.
2. The **Objective lens** is located right above the specimen. Light passes through the specimen and then through the objective lens.
3. The **Stage** is a platform that supports a slide holding the specimen.
4. The **Light Source** is a light bulb that provides light for viewing the image.





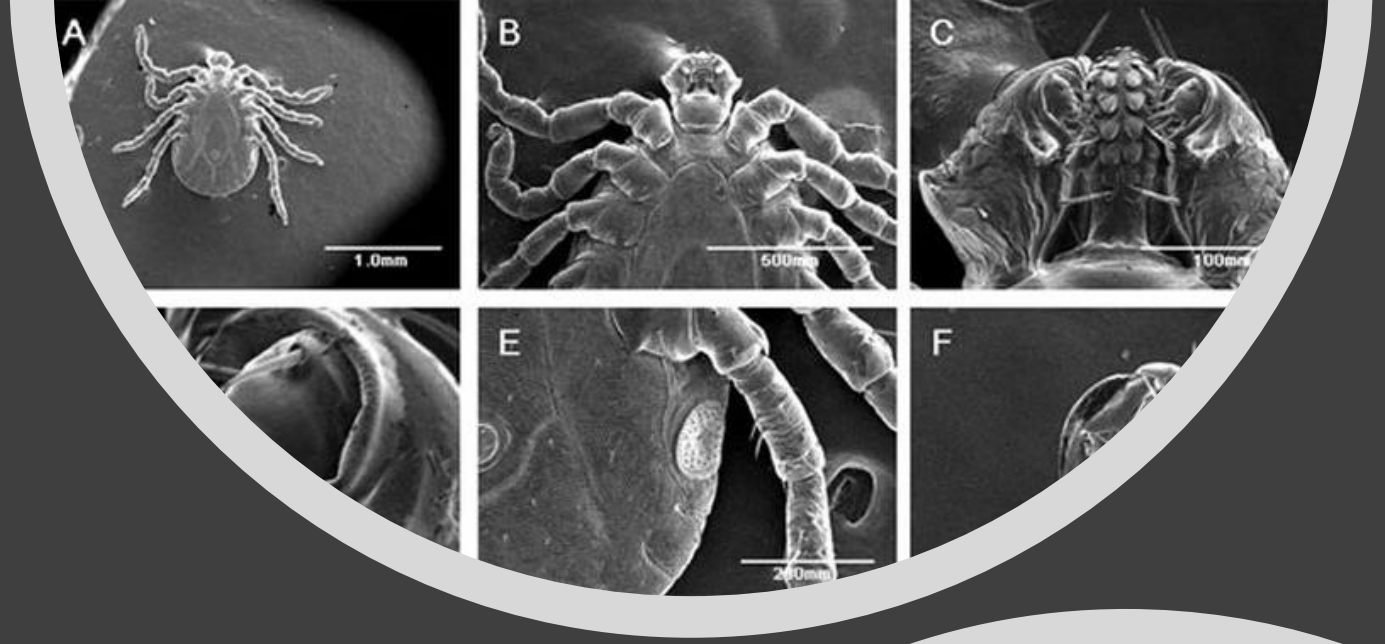
Magnification and Resolution

- **Magnification** is the increase of an object's apparent size.
  - Ocular lens (10X)
  - Objective lens (up to 100X)
- **Resolution** is the power to show details clearly in an image.

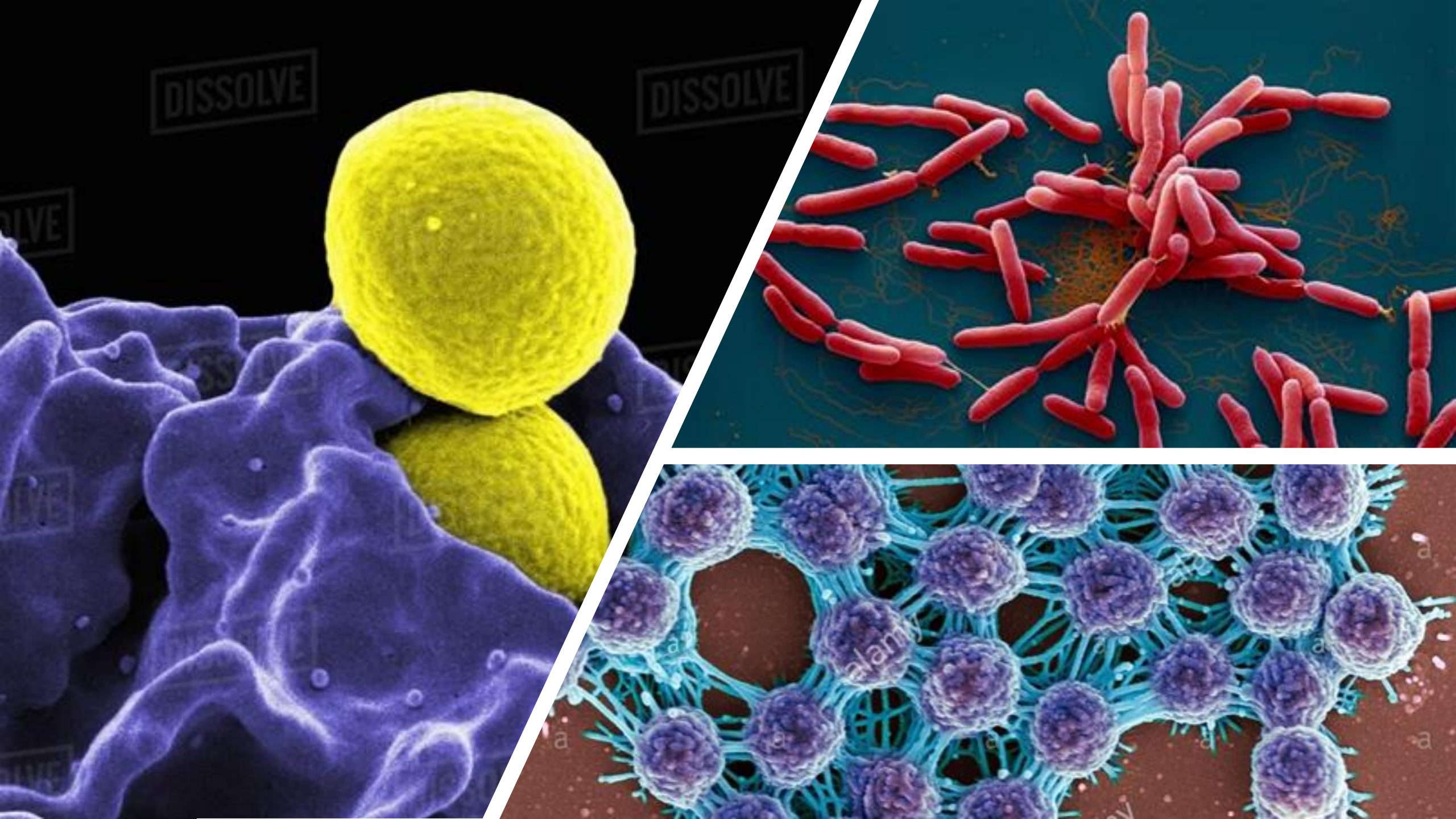
Electron Microscope

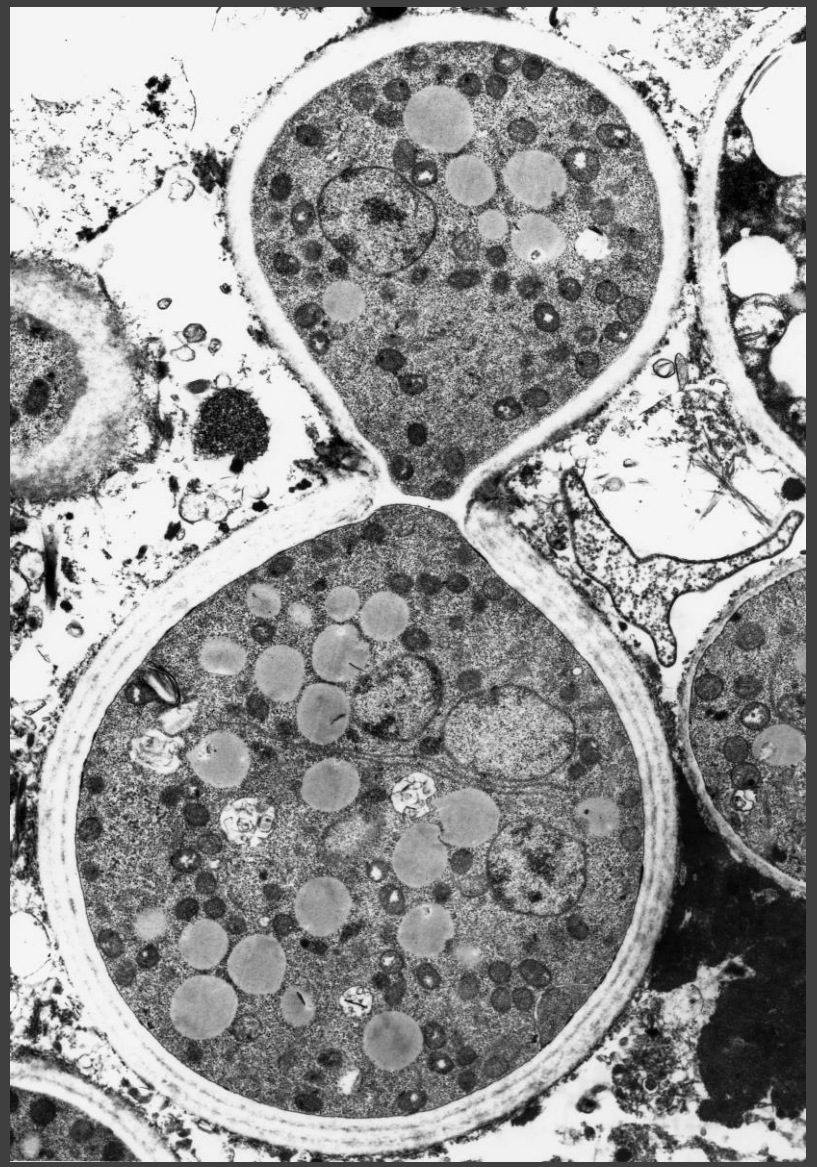
- In an **Electron Microscope**, a beam of electrons produces an enlarged image of the specimen.
    1. Scanning Electron Microscope
    2. Transmission Electron Microscope
- Images are in black and white, but computers can artificially color the images.
- Specimen is places in vacuum chamber, so living specimens cannot be viewed in Electron microscope.

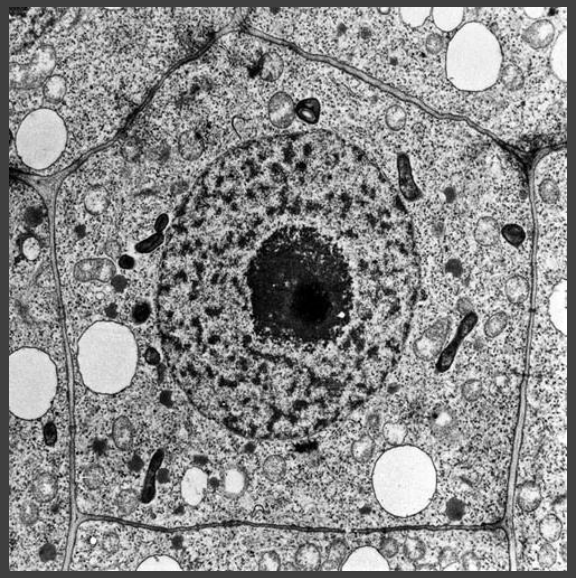
SEM: Scanning Electron Microscope



- The **SEM** passes a beam of electrons over the specimen’s surface.
- SEMs provide a three-dimensional image of the specimen's surface.
- The specimen is sprayed with a fine metal coating and a beam of electrons is aimed at it.
- SEMs can magnify up to 100,000 times.







TEM: Transmission Electron Microscope

- The **TEM** transmits a beam of electrons through a very thin slices specimen.
- Magnetic lenses enlarge the image and focus it on a screen.
- The TEM is great to view an internal structure.
- TEM can magnify objects up to 200,000 times.

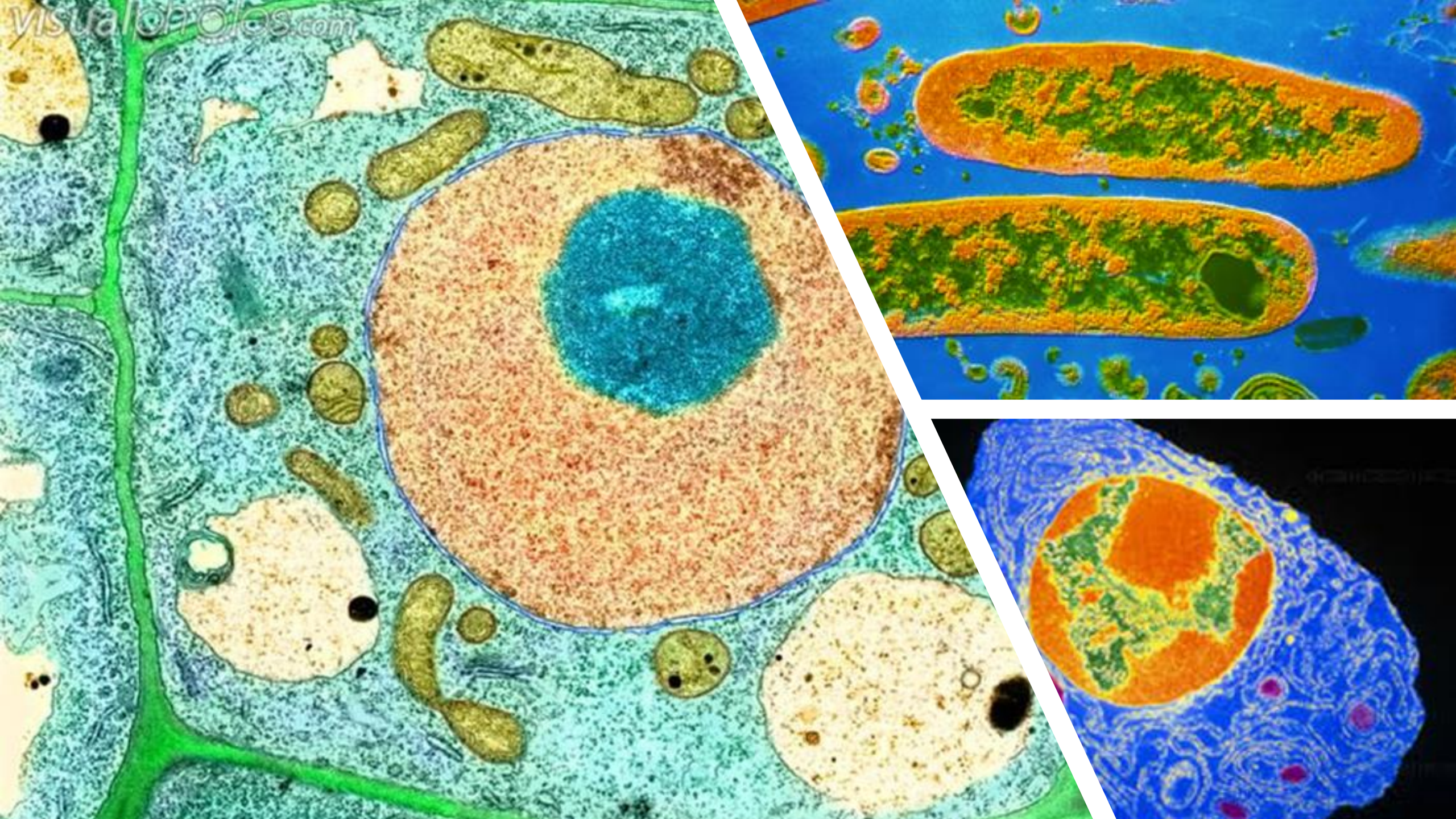

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TABLE 1-1 *SI Base Units*

Base quantity	Name	Abbreviation
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous (light) intensity	candela	cd

TABLE 1-2 *Some SI prefixes*

Prefix	Abbreviation	Factor of base unit
giga	G	1,000,000,000 (10^9)
mega	M	1,000,000 (10^6)
kilo	k	1,000 (10^3)
hecto	h	100 (10^2)
deka	da	10 (10^1)
base unit		1
deci	d	0.1 (10^{-1})
centi	c	0.01 (10^{-2})
milli	m	0.001 (10^{-3})
micro	μ	0.000001 (10^{-6})
nano	n	0.000000001 (10^{-9})
pico	p	0.000000000001 (10^{-12})

Units of Measurement

- Scientists use a common measurement system so that they can compare their results.
- The **Metric System** is a single, standard system of measurement.
- *System International d'Unites* (SI) is the International System of Units.
- Biologists use SI while making measurements in the laboratory.

TABLE 1-3 *Some Derived and Other Units*

Quantity	Name	Abbreviation
Area	square meter	m^2
Volume	cubic meter	m^3
Density	kilogram per cubic meter	kg/m^3
Specific volume	cubic meter per kilogram	m^3/kg
Celsius temperature	degree Celsius	°C
Time	minute	1 min = 60 s
Time	hour	1 h = 60 min
Time	day	1 d = 24 h
Volume	liter	1 L = 1,000 cm^3
Mass	kilogram metric ton	1,000 g = 1 kg 1 t = 1,000 kg

Base and Other Units

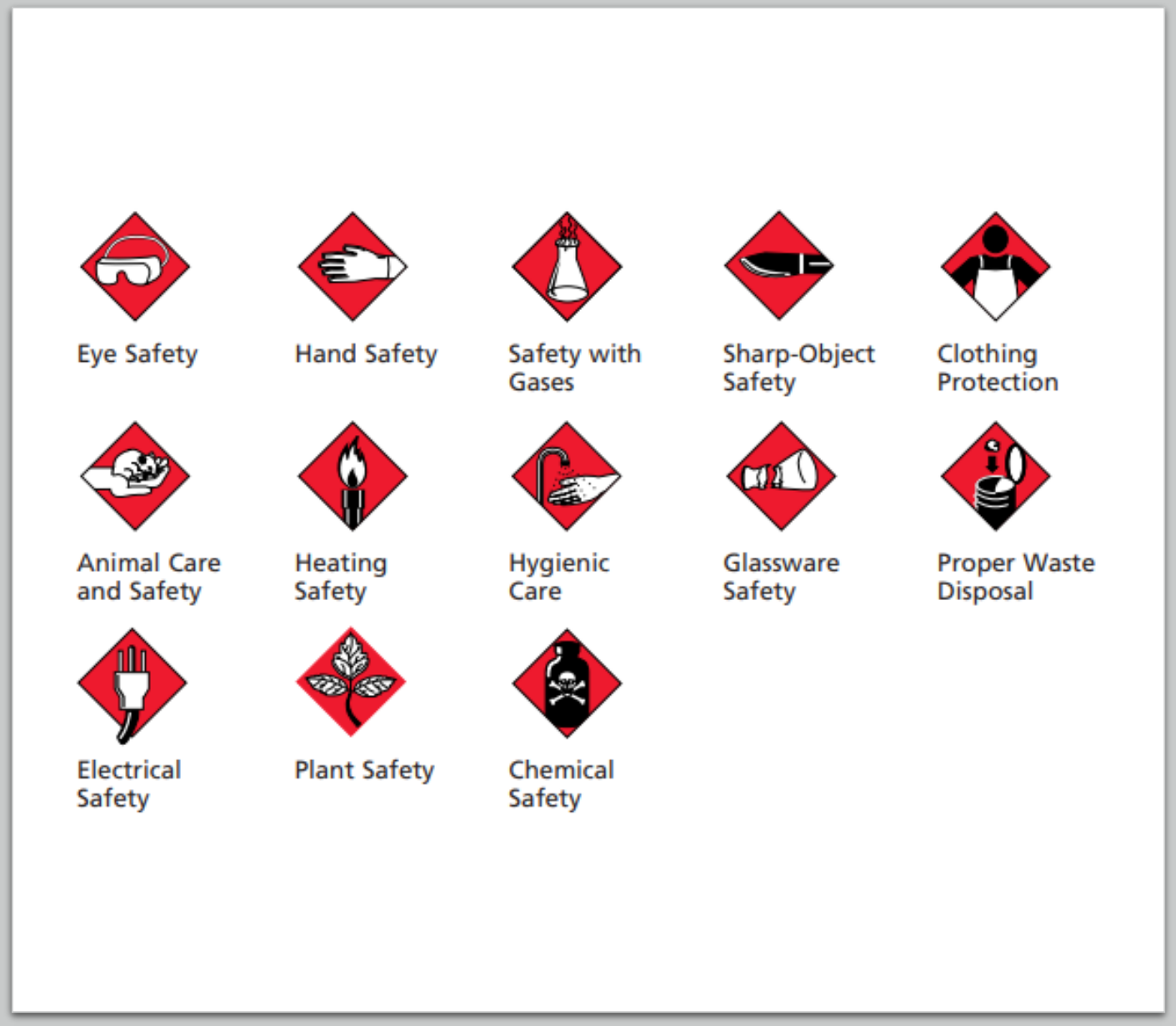
- The 7 **Base Units** describe length, mass, time, and other quantities.
- *Derived units* are produced by mathematical relationship between two base units or between derived units.
- Additional units of measurements can be used with SI units, such as units of time, volume, and mass.

Safety

- Hazards vary between the lab and the field:
- Chemical
- Physical
- Radiological
- Biological

Good Laboratory Practice

- Good laboratory practice arises from establishing safe, common-sense habits.
- Never work alone in the lab or without proper supervision.
- Always ask a supervisor before using any equipment.



Review Questions

1. List the four major parts of a compound microscope.
2. What is the difference between the magnification and resolution of an image under a microscope?
3. Compare the function of a transmission electron microscope with that of a scanning electron microscope.
4. What is the importance of using a common SI system of measurements?
5. How could you convert kilometers to millimeters?
6. Draw the safety symbol for ‘Hand Safety’.