

# Microscopes and the Metric System

BIO162  
Fall 2007

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## Metric Units and Their Magnitude

Prefix	Symbol	Decimal Equivalent	Exponential Equivalent
Tera-	T	1,000,000,000,000	$10^{12}$
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	$10^1$
(No Prefix)		1	$10^0$
Deci-	d	0.1	$10^{-1}$
Centi-	c	0.01	$10^{-2}$
Milli-	m	0.001	$10^{-3}$
Micro-	$\mu^*$	0.000001	$10^{-6}$
Nano-	n	0.000000001	$10^{-9}$
Pico-	p	0.000000000001	$10^{-12}$
Femto-	f	0.000000000000001	$10^{-15}$

The most commonly used symbols in chemistry are red.  
\*This symbol is the Greek letter "mu."

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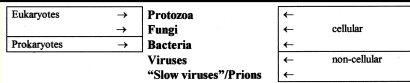
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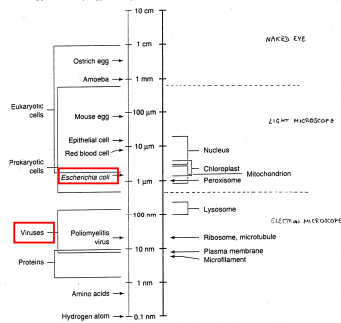
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Dimensions of typical cells, organelles, viruses and molecules:

- Sizes of Microorganisms:**
- Viruses: 0.01 – 0.3  $\mu\text{M}$
  - Bacteria: 1 – 3  $\mu\text{M}$
  - Fungi: 3 – 30  $\mu\text{M}$
  - Protozoa: 5 – 1000  $\mu\text{M}$




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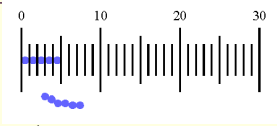
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## Measuring Microorganisms



### Ocular Micrometer

The ocular micrometers provided are calibrated so that when using 1000X oil immersion microscopy, the distance between any two lines on the scale represents a length of approximately one micrometer. Remember this does not hold true when using other magnifications.

The approximate size of a microorganism can be determined using an ocular micrometer, an eyepiece that contains a scale that will appear superimposed upon the focused specimen.

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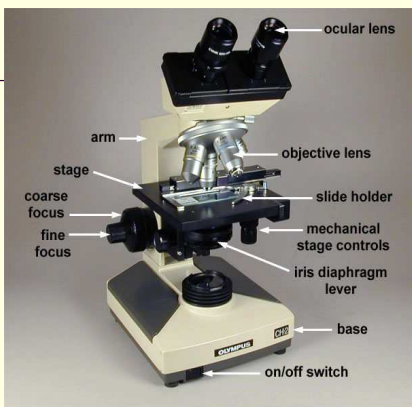
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## Microscopes

- **Resolving Power or Resolution** – ability to distinguish between 2 adjacent objects.
- **Magnification** – restricted to the type of light source.
  - Empty magnification – To increase magnification without increasing resolving power.

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## Types of Microscopes

- **Simple Microscope** – contains only 1 magnifying lens
  - Anton van Leeuwenhoek first developed
  - Limit of resolution is 300x
- **Compound Microscope** – contains more than 1 magnifying lens (also called compound light microscope)
  - Hans Jansen – first developed this microscope
  - Limit of resolution is 1000x
  - Photomicrographs – photographs taken through microscope.

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## Types of Microscopes

- **Brightfield** – Used to observe morphology of bacteria, protozoa, fungi and algae.
  - 0.2  $\mu$ m resolution limit, 1000x magnification limit

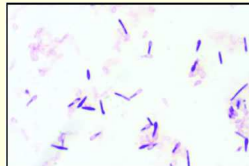


Figure 6. A gram stain of *Bacillus circulans* showing free endospores, terminal intracellular endospores and the classic gram positive (purple) reaction of the cells.

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## Types of Microscopes

- **Darkfield** – Used to observe organisms against a dark background.
  - 0.2  $\mu$ m resolution limit, 1000x magnification limit



Spirochetes – cause of Lyme's disease

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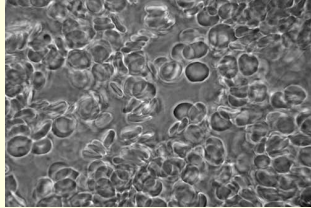
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## Types of Microscopes

- **Phase - contrast** – Used to observe unstained microorganisms.
  - 0.2  $\mu\text{M}$  resolution limit, 1000x magnification limit



Unstained RBCs

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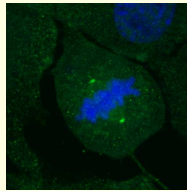
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## Types of Microscopes

- **Fluorescence** – Dyes attached to visualize organelles and proteins.
  - 0.2  $\mu\text{M}$  resolution limit, 1000x magnification limit



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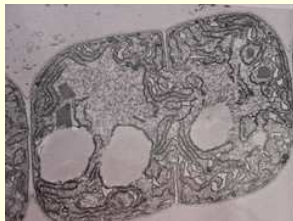
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## Types of Microscopes

- **Transmission Electron Microscope** –
  - 0.2  $\text{nM}$  resolution limit, 200,000x magnification limit



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## Types of Microscopes

- Scanning Electron Microscope –
  - 20 nM resolution limit, 10,000x magnification limit



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## Prokaryote vs. Eukaryote

- The cell is the basic unit of life. Based on the organization of their cellular structures, all living cells can be divided into two groups:
  - Prokaryotic – bacteria
    - Do not have organelles,
    - DNA is not surrounded by nuclear membrane
    - Usually smaller than eukaryotes
  - Eukaryotic – animal, plants, fungi, protozoan and algae
    - Have organelles (i.e. mitochondria, ER, golgi)
    - Have nuclear membrane

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## BACTERIAL SHAPES AND ARRANGEMENTS

- There are three common shapes of bacteria:
  - Coccus
  - Bacillus (rod)
  - Spiral
- Binary Fission – method in which bacteria divide.

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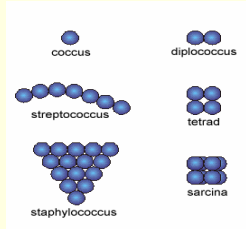
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## Coccus

- A coccus-shaped bacterium is usually spherical, although some appear oval, elongated, or flattened on one side.
- Most cocci are approximately **0.5 - 1.0 micrometer ( $\mu\text{m}$ )** in diameter.
- Have a tendency to remain attached after replication, in one of the following arrangements:



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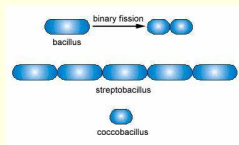
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## Bacillus (Rod)

- A bacillus or rod is a hotdog-shaped bacterium having one of the following arrangements:
- A single bacillus is typically **0.5-1.0  $\mu\text{m}$  wide** and from **1- 4  $\mu\text{m}$  long**.
- Small bacilli or bacilli that have just divided by binary fission may at first glance be confused for cocci.



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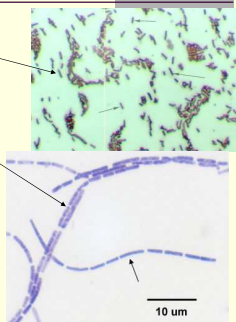
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## Example of Bacilli

- a. Bacillus: a single bacillus
- b. Streptobacillus: bacilli in chains
- c. Coccobacillus: oval and similar to a coccus



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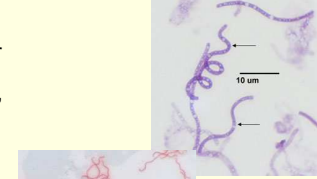
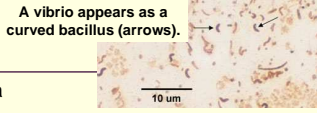
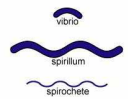
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## Spiral

- Spiral-shaped bacteria occur in one of three forms
  - a. Vibrio: an incomplete spiral or comma-shaped
  - b. Spirillum: a thick, rigid spiral
  - c. Spirochete: a thin, flexible spiral



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## Spiral

- The spirals range from **5-40 µm long** but some are over 100 µm in length.
- The spirochetes are the thinnest of the bacteria, often having a width of only 0.25-0.5 µm.

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## Yeast

- Yeasts, such as the common baker's yeast *Saccharomyces cerevisiae* are **unicellular fungi**.
- They usually appear spherical and have a diameter of **3 - 5 µm**.
- Yeasts commonly reproduce asexually by a process called **budding**.
- yeasts are **eukaryotic**.



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## How Big is a ... ?

- The head of a pin is about 2mm in diameter. Use this animation to compare the relative sizes of cells and organisms sitting on a pinhead. Nearly invisible without magnification, dust mites dwarf pollen grains and human cells. In turn, bacteria and viruses are even smaller.
- <http://www.cellsalive.com/howbig.htm>

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