Who Invented the first microscope?

- Credit for the first microscope is usually given to Zacharias Jansen, in Middleburg, Holland, around the year 1595.

Magnification ~ 9x (barely qualifies as a microscope)

Robert Hooke

~1670

Discovered the cell (looking at cork)

Anton von Leeuwenhoek

Dutch tradesman 1632-1723

-no higher education

Discovered: bacteria, sperm cells, blood cells...
Anton von Leeuwenhoek

• Single tiny lens

“These little animals were, to my eye, more than ten thousand times smaller than the animalcule which Swammerdam has portrayed, and called by the name of Water-flea, or Water-louse, which you can see alive and moving in water with the bare eyes.”
- letter to Royal Society 1678

Magnification ~ 270X

Anton von Leeuwenhoek

an unbelievably great company of living animalcules, a-swimming more nimbly than any I had ever seen up to this time. The biggest sort... bent their body into curves in going forwards... Moreover, the other animalcules were in such enormous numbers, that all the water... seemed to be alive.

Discovery of bacteria -
In the mouth of old man who had never brushed his teeth!

Magnification ~ 270X

Compound Microscope

• Structure: Made of two lenses, Objective and eyepiece
  – Objective: The object being viewed is placed just outside the focal length of the objective lens. The intermediate image thus formed is real, inverted, and enlarged.

An example

• Suppose the focal length of the objective is 12mm, and the object is placed at 13mm. The image is then 156mm away from the lens and the magnification is

\[ \frac{156}{13} = 12 \times \]

\[ \frac{1}{b_i} = \frac{1}{f} - \frac{1}{b_o} \]
- **Eyepiece**: Work as a magnifying glass, used to view the real intermediate image formed by the objective lens.
  - To view the image with a relaxed eye (so the light rays entering the eye are parallel), the image must be located at the focal point of the eyepiece.
  - Shorter the focal length, larger the magnification.

**Microscope eyepiece**

Same principle as magnifying glass

- No lens
  - Magnification = $250/f$ (in mm)

- With lens

**Compound microscope**

Total magnification $= M_{\text{obj}} \times M_{\text{eyepiece}}$

$= s_{\text{obj}} \times 250/f_{\text{eyepiece}}$

$S_i = 160$ mm for standard microscopes

Example - $f_{\text{obj}} = 1.6$ mm, $f_{\text{eyepiece}} = 25$ mm

$M = 100 \times 10 = 1000$
Oil immersion objective
- high magnification -> short focal length - big angles

Oil with $n = 1.5$
Optical limitation

- Light cannot be focused to less than $\sim \lambda$.
  - due to diffraction (coming up later in course)

Solutions - use short wavelength (e.g. x-rays)
- use something other than light

Scanning Tunneling Microscope

Electrical current depends sensitively on distance
Scanning tunneling microscopy (STM)