

Bacterial Cell Organization: Cell Size, Shape and Arrangement

By-

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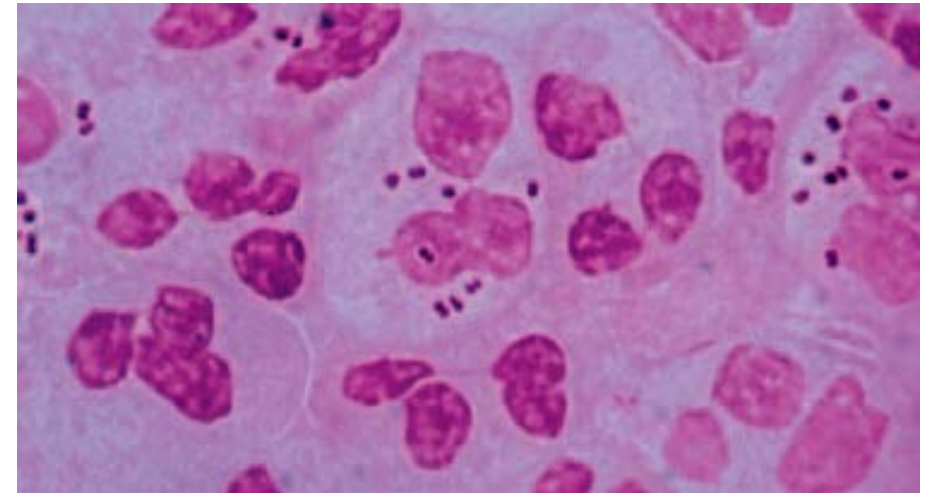
Procaryotes

Which are procaryotes?

- Prokaryotes are organisms whose cells lack a nucleus and other organelles.
- Much of our understanding of phenomena in biochemistry and molecular biology comes from research on bacteria.
- There are two quite different groups of procaryotes: Bacteria and Archaea.

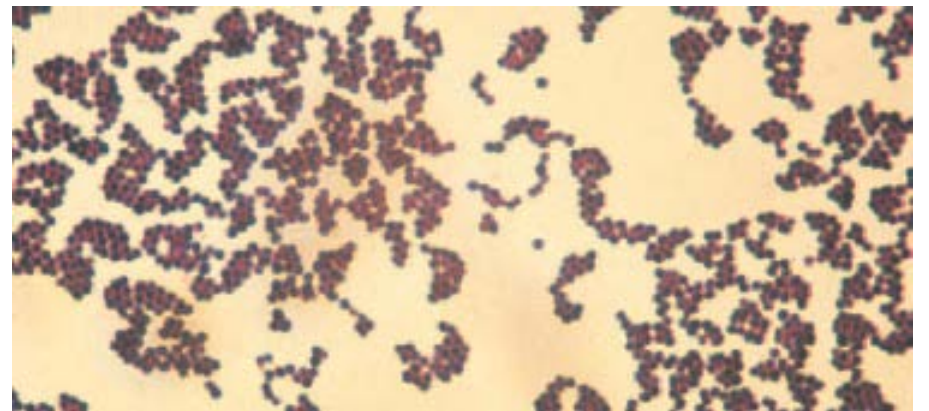
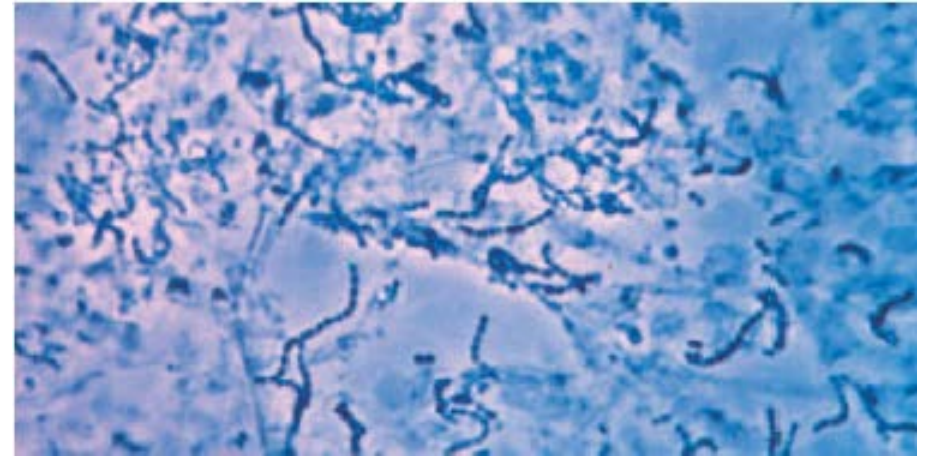
Size, Shape, and Arrangement

- Although it is true that many procaryotes are similar in morphology, there is a remarkable amount of variation due to differences in genetics and ecology.
- Major morphological patterns are described here, and interesting variants are mentioned in the procaryotic survey.
- Most commonly encountered bacteria have one of two shapes.
- **Cocci (s., coccus) are roughly spherical cells:** They exist as individual cells, but also are associated in characteristic arrangements that are frequently useful in bacterial identification.
 - **Diplococci (s., diplococcus) arise when cocci divide and remain together to form pairs (*Neisseria*)**



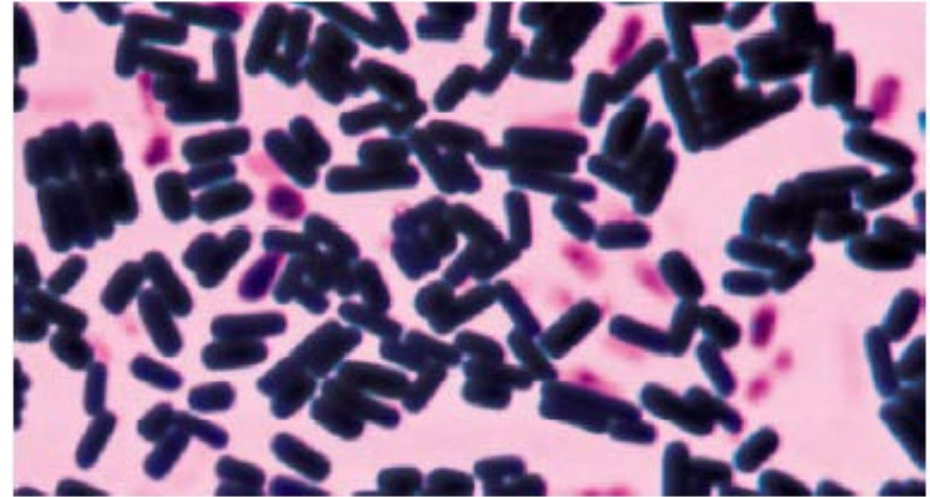
... Size, Shape, and Arrangement

- Long chains of cocci result when cells adhere after repeated divisions in one plane; this pattern is seen in the genera *Streptococcus*, *Enterococcus*, and *Lactococcus*.
- *Staphylococcus* divides in random planes to generate irregular grapelike clumps. Divisions in two or three planes can produce symmetrical clusters of cocci.
- Members of the genus *Micrococcus* often divide in two planes to form square groups of four cells called tetrads.
- In the genus *Sarcina*, cocci divide in three planes producing cubical packets of eight cells.

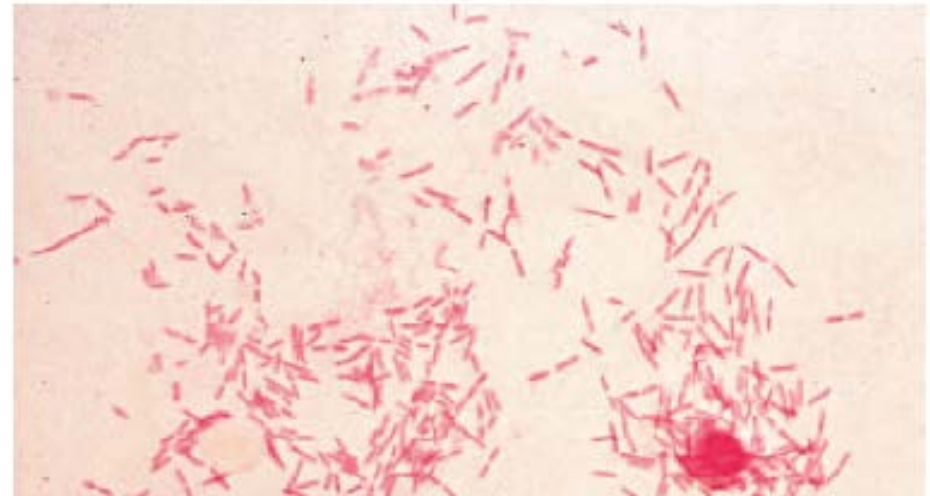


Rod, often called a bacillus (pl., bacilli)

- *Bacillus megaterium* is a typical example of a bacterium with a rod shape.
- Bacilli differ considerably in their length-to width ratio, the coccobacilli being so short and wide that they resemble cocci.
- The shape of the rod's end often varies between species and may be:
 - flat,
 - rounded,
 - cigar-shaped,
 - bifurcated.

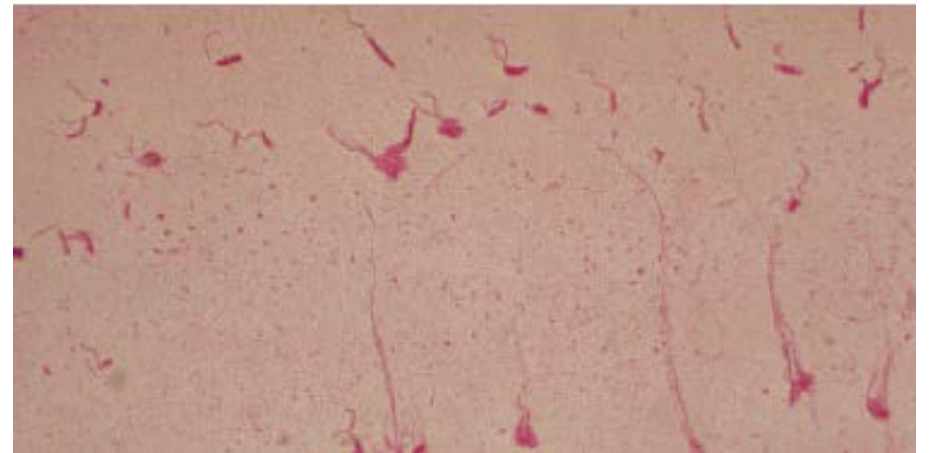


(a)



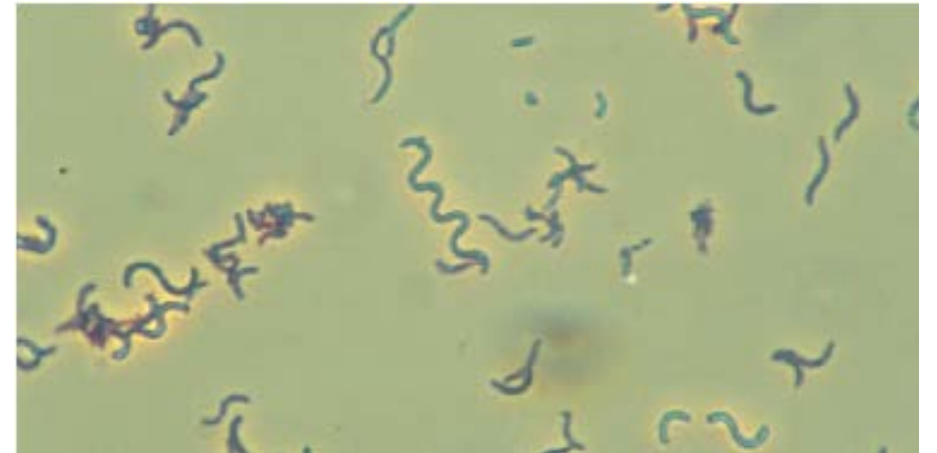
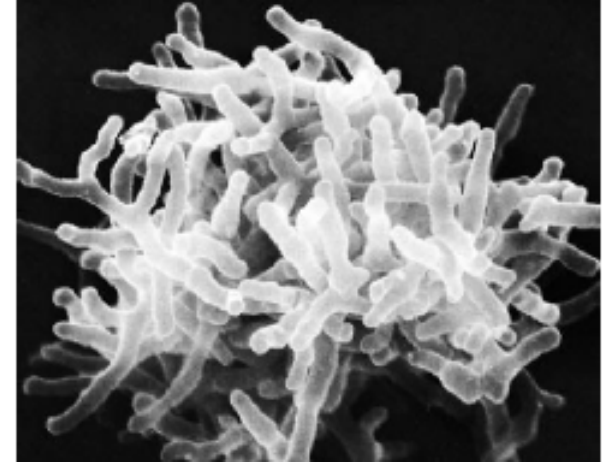
... Rod, often called a bacillus (pl., bacilli)

- Although many rods do occur singly, they may remain together after division to form pairs or chains (e.g., *Bacillus megaterium* is found in long chains).
- A few rod-shaped bacteria, the **vibrios**, are curved to form distinctive commas or incomplete spirals.



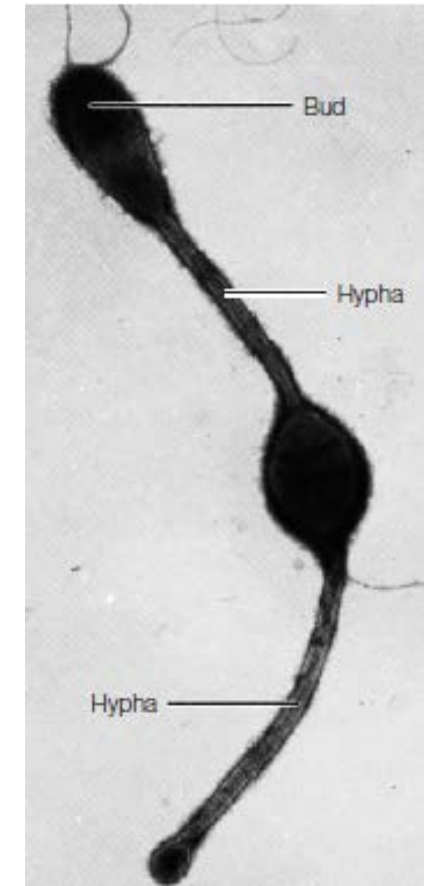
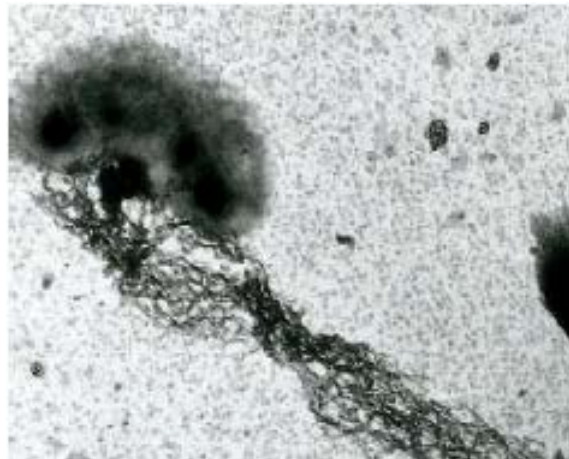
Other Shapes

- Bacteria can assume a great variety of shapes, although they often are simple spheres or rods.
- Actinomycetes characteristically form long multinucleate filaments or hyphae that may branch to produce a network called a **mycelium**.
- Many bacteria are shaped like long rods twisted into spirals or helices:
 - they are called **spirilla** if rigid
 - **Spirochetes**:-: when flexible



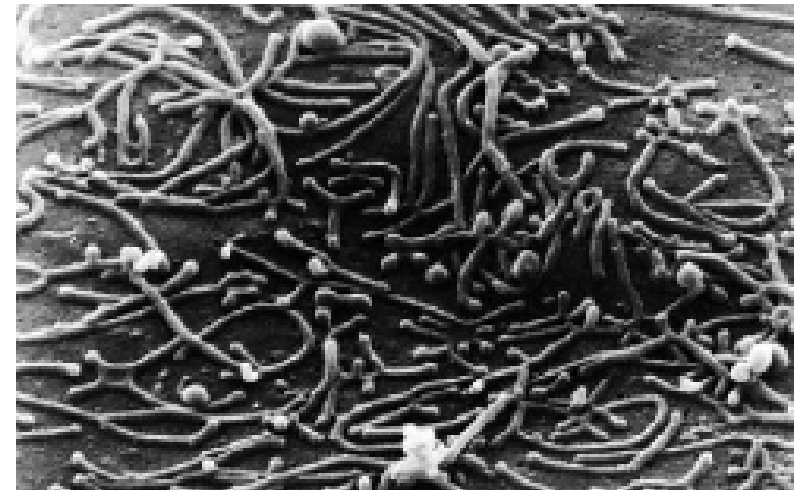
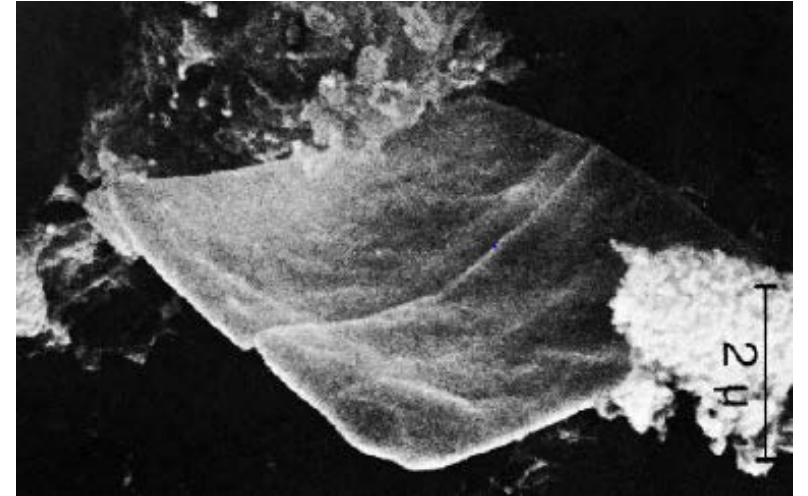
...Other Shapes

- The oval- to pear-shaped *Hyphomicrobium* produces a bud at the end of a long hypha.
- Other bacteria such as *Gallionella* produce nonliving stalks.



...Other Shapes

- A few bacteria actually are flat. For example, Anthony E. Walsby has discovered square bacteria living in salt ponds.
- These bacteria are shaped like flat, square-to rectangular boxes about $2\ \mu\text{m}$ by 2 to $4\ \mu\text{m}$, and only $0.25\ \mu\text{m}$ thick.
- Finally, some bacteria are variable in shape and lack a single, characteristic form. These are called **pleomorphic** even though they may, like *Corynebacterium*, have a generally rodlike form.



Bacteria Size

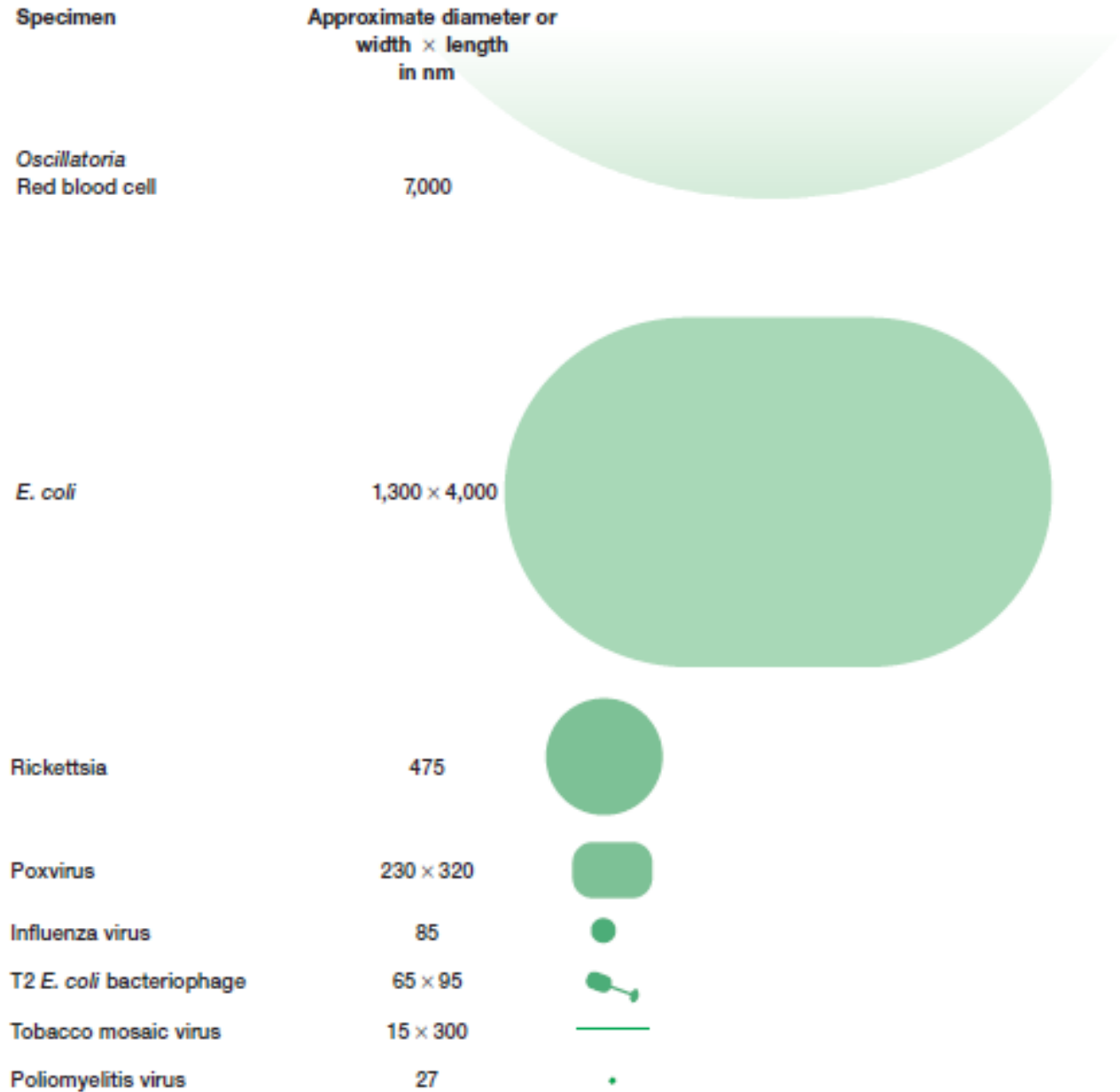


Figure 3.3 Sizes of Bacteria and Viruses. The sizes of selected bacteria relative to the red blood cell and viruses.

Bacteria Size

- Bacteria vary in size as much as in shape (figure 3.3).
- The smallest (e.g., some members of the genus *Mycoplasma*) are about 0.3 μm in diameter, approximately the size of the largest viruses (the poxviruses).
- Recently there have been reports of even smaller cells.
- Nanobacteria or ultramicrobacteria appear to range from around 0.2 μm to less than 0.05 μm in diameter.
- A few strains have been cultured, but most are simply very small bacteria-like objects only observed microscopically.
- It has been thought that the smallest possible cell is about 0.14 to 0.2 μm in diameter, but many nanobacteria are reported to be smaller.
- Some microbiologists think nanobacteria are artifacts, and more research will be required before the significance of these forms becomes clear.

...Bacteria Size

- *Escherichia coli*, a bacillus of about average size, is 1.1 to 1.5 μm wide by 2.0 to 6.0 μm long.
- A few bacteria become fairly large; some spirochetes occasionally reach 500 μm in length, and the cyanobacterium *Oscillatoria* is about 7 μm in diameter (the same diameter as a red blood cell).
- A huge bacterium lives in the intestine of the brown surgeonfish, *Acanthurus nigrofuscus*.
- *Epulopiscium fishelsoni* grows as large as 600 by 80 μm .
- More recently an even larger bacterium, *Thiomargarita namibiensis*, has been discovered in ocean sediment.
- Thus a few bacteria are much larger than the average eucaryotic cell (typical plant and animal cells are around 10–50 μm in diameter).



(a)



(b)

Giant Bacteria. (a) This photograph, taken with pseudo dark-field illumination, shows *Epulopiscium fishelsoni* at the top of the figure dwarfing the paramecia at the bottom ($\times 200$). (b) A chain of *Thiomargarita namibiensis* cells as viewed with the light microscope. Note the external mucous sheath and the internal sulfur globules.