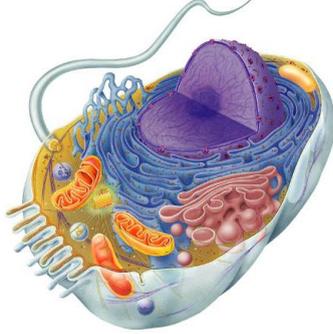
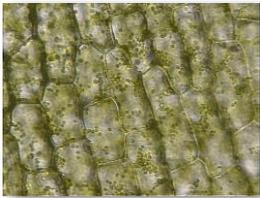


## Chapter 5.1 – 5.2 The Cell: Basic Unit of Life



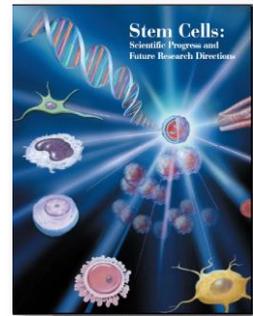
### Cell Theory

- All organisms are made up of cells
- The cell is the basic *living* unit of organization for all organisms
- All cells come from pre-existing cells...



### Biological diversity & unity

- Underlying the diversity of life is a striking unity
  - ♦ Cells are the basic units of structure & function
    - lowest level of structure capable of performing all activities of life
  - ♦ DNA is universal genetic language



### Activities of life

- Most everything you think of a whole organism needing to do, must be done at the cellular level...
  - ♦ reproduction
  - ♦ growth & development
  - ♦ energy utilization
  - ♦ response to the environment
  - ♦ homeostasis

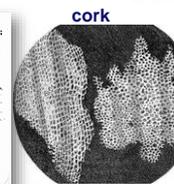
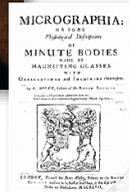


### How do we study cells?

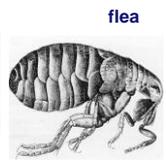
- Microscopes opened up the world of cells
  - Robert Hooke (1665)
    - ♦ the 1st cytologist



Drawings by Hooke



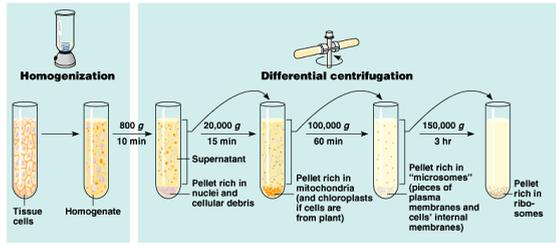
cork



flea

## Isolating organelles

- Cell fractionation
  - ◆ separate organelles from cell
  - ◆ variable density of organelles
    - ultracentrifuge



## Ultracentrifuge

- spins up to 130,000 rpm
  - ◆ forces > 1 million X gravity (1,000,000g)

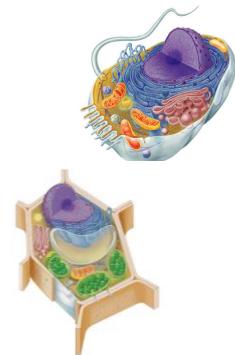
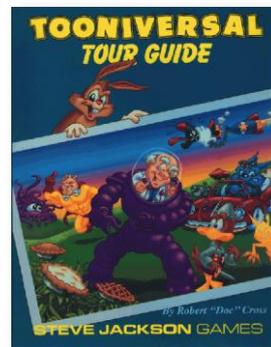


## Microcentrifuge

- Biotechnology research
  - ◆ study cells at protein & genetic level



## A Tour of the Cell



## Cell characteristics

- ALL CELLS HAVE THE FOLLOWING:
  - ◆ surrounded by a **plasma membrane**
  - ◆ have **cytosol**
    - semi-fluid substance within the membrane
    - **cytoplasm** = cytosol + organelles
  - ◆ contain **chromosomes** which have genes in the form of **DNA**
  - ◆ have **ribosomes**
    - tiny "organelles" that make proteins using instructions contained in genes

## Types of cells

- Prokaryotic vs. eukaryotic cells
  - ◆ Location of chromosomes

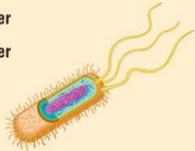
### Prokaryotic cell

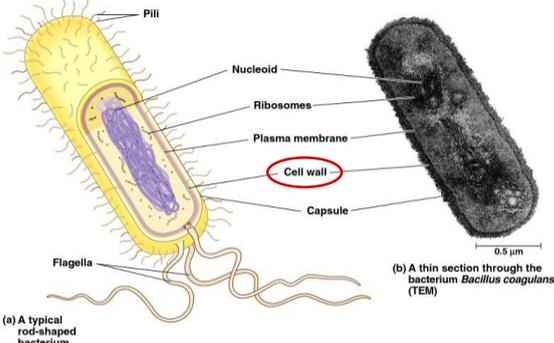
- DNA in **nucleoid** region, without a membrane separating it from rest of cell

### Eukaryotic cell

- chromosomes in **nucleus**, membrane-enclosed organelle

### Cell types

Prokaryotes	Eukaryotes
<ul style="list-style-type: none"> <li>• Smaller</li> <li>• Simpler</li> </ul> 	<ul style="list-style-type: none"> <li>• Larger</li> <li>• More complex</li> </ul> 
<ul style="list-style-type: none"> <li>• Most do not have membrane-enclosed organelles</li> <li>• Bacteria and archaea</li> </ul>	<ul style="list-style-type: none"> <li>• Membrane-enclosed organelles</li> <li>• Protists, plants, fungi, animals</li> </ul>



(a) A typical rod-shaped bacterium

(b) A thin section through the bacterium *Bacillus coagulans* (TEM)

The prokaryotic cell is much simpler in structure, lacking a nucleus and the other membrane-enclosed organelles of the eukaryotic cell.

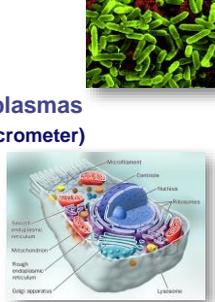
### Eukaryotic cells

- Eukaryotic cells are more complex than prokaryotic cells
  - ♦ within cytoplasm is a variety of membrane-bounded organelles
  - ♦ specialized structures in form & function
- Eukaryotic cells are generally bigger than prokaryotic cells



### Limits to cell size

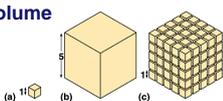
- Lower limit
  - ♦ smallest bacteria, mycoplasmas
    - 0.1 to 1.0 micron ( $\mu\text{m}$  = micrometer)
  - ♦ most bacteria
    - 1-10 microns
- Upper limit
  - ♦ eukaryotic cells
    - avg. 10-100 microns
    - micron = micrometer =  $1/1,000,000$  meter
    - diameter of human hair = ~20 microns



### What limits cell size?

- Surface to volume ratio
  - ♦ as cell gets bigger its volume increases faster than its surface area
    - smaller objects have greater ratio of surface area to volume

Surface area increases while total volume remains constant



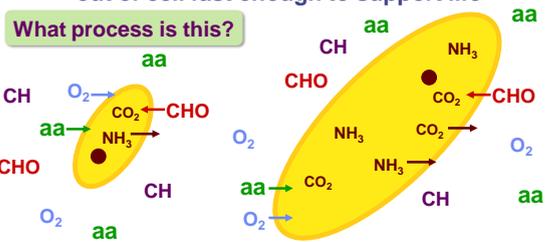
What cell organelle governs surface area?

	(a) 1 <sup>3</sup>	(b)	(c)
Total surface area (height x width x number of sides x number of boxes)	6	150	750
Total volume (height x width x length x number of boxes)	1	125	125
Surface-to-volume ratio (area ÷ volume)	6	1.2	6

### Limits to cell size

- Metabolic requirements set upper limit
  - ♦ in large cell, cannot move material in & out of cell fast enough to support life

What process is this?



### How to get bigger?

- Become multi-cellular (cell divides)

But what challenges do you have to solve now?

### Cell membrane

- Exchange organelle
  - ♦ plasma membrane functions as selective barrier
    - allows passage of O<sub>2</sub>, nutrients & wastes

### Compartmentalization

- Eukaryotic cell
  - ♦ internal membranes
    - partition cell into compartments
    - create different local environments
    - compartmentalize functions
    - membranes for different compartments are specialized for their function
      - ♦ different structures for specific functions
      - ♦ unique combination of lipids & proteins

Not in animal cells:  
 Chloroplasts  
 Central vacuole and tonoplast  
 Cell wall  
 Plasmodesmata

Not in plant cells:  
 Lysosomes  
 Centrioles  
 Flagella (in some plant sperm)