Cells

Note: If you need to review the structure and function of the major cell organelles, be sure to read the Organelles Notes (http://kvhs.nbed.nb.ca/gallant/biology/cells_organelles_notes.html)

1. Cell Theory
    a. Three key statements
        i. All organisms are made up of one or more cells.
        ii. The cell is the smallest living organizational unit.
        iii. All cells are produced from previously existing cells (no spontaneous generation).
    b. All cells appear to be descended from the first cell which existed about 4 billion years ago
    c. Characteristics of Life
        i. Order
        ii. Respond to the environment
        iii. Exchange energy and materials with the environment
        iv. Maintain homeostasis
        v. Grow and develop
        vi. Able to reproduce
        vii. Evolve
    d. All living things can be organized into the following levels of biological organization
        i. Biosphere
        ii. Ecosystems
        iii. Communities
        iv. Populations
        v. Organisms
        vi. Organs and organ systems
        vii. Tissues
        viii. Cells
        ix. Organelles
        x. Molecules
2. Prokaryotes and eukaryotes
    a. Cells are organized into two major types:
        i. Prokaryotic cells . . .
            (1) are smaller and more primitive.
            (2) have few organelles and their organelles have no membranes. The cell has no nucleus. Many prokaryotes have a rigid cell wall. They are able to grow and multiply quickly because of their small surface area to volume ratio.
            (3) are bacteria.
        ii. Eukaryotic cells . . .
            (1) are more advanced, larger, and contain organelles. These cells have a nucleus. All species other than bacteria and cyanobacteria are eukaryotes. This includes protists, fungi, plants, and animals (including humans).
            (2) have organelles allow many activities to take place within the same cell-like a chem lab with many beakers; other reactions take place on membrane surfaces and eukaryotic cells have much more internal membrane surface that prokaryotic cells

iii.   Endosymbiont theory
    (1)   Eukaryotic cells arose from groups of prokaryotic cells living together - smaller ones inside larger ones. These cooperative arrangements provided advantages to the cells in them. Evidence for this theory includes:
        (a)   Mitochondria and chloroplasts are surrounded by a double membrane.
        (b)   Mitochondria and bacteria are similar in size.
        (c)   Mitochondrial ribosomes resemble bacterial ribosomes.
        (d)   Mitochondria and chloroplasts have their own DNA and it's circular like bacterial DNA.
        (e)   Mitochondria divide as bacteria do and do so independently of the cell.

3.   Why are cells so small?
    a.   Cells exchange all materials with their environment through the cell membrane. Exchange is faster in a smaller cell.
    b.   Secondly, cells need a surface area across which to exchange materials that is proportional to their volume and the rate at which they can exchange materials is proportional to their surface area. Many cells are roughly spherical in shape and, as a result, the volume of the cell increases faster than the surface area. In other words, the surface area to volume ratio of cells decreases as they get larger. This means less efficient exchange.
    c.   Cells that are specialized for absorption (*e.g.*, intestinal cells) are often shaped in a way that increase the surface area to volume ratio.
    d.   Let's compare the surface area to volume ratio of a cube that is 1 cm x 1 cm x 1 cm with that of a cube that is 5 cm x 5 cm x 5 cm and with that of a cube 5 cm x 5 cm x 5 cm but made up of 1 cm x 1 cm x 1 cm cubes.
        i.   Smaller cube
            (1)   Surface area of one side = 1 cm x 1 cm = 1 cm^2
            (2)   For 6 sides, the total surface area = 6 x 1 cm^2 = 6 cm^2
            (3)   Volume = 1 cm x 1 cm x 1 cm = 1 cm^3
            (4)   Surface:Volume = 6 /1 = 6. In other words, 6 cm^2 of surface area for each cm^3 of volume.
        ii.   Larger cube
            (1)   Surface area of one side = 5 cm x 5 cm = 25 cm^2
            (2)   For 6 sides, the total surface area = 6 x 25 cm^2 = 150 cm^2
            (3)   Volume = 5 cm x 5 cm x 5 cm = 125 cm^3
            (4)   Surface:Volume = 150/125 = 1.2. In other words, 1.2 cm^2 of surface area for each cm^3 of volume.
        iii.   Larger cube made of smaller cubes
            (1)   Surface area of one side = 1 cm x 1 cm = 1 cm^2
            (2)   For all cubes, the total surface area = 6 sides x 125 cubes x 1 cm^2 = 750 cm^2
            (3)   Volume = 5 cm x 5 cm x 5 cm = 125 cm^3
            (4)   Surface:Volume = 750/125 = 6 /1 = 6. In other words, 6 cm^2 of surface area for each cm^3 of volume.
        iv.   Notice that the larger cube has more surface area and more volume but less surface area for each cubic centimeter of volume. The cube made of many smaller cubes is the same size as the large cube but has the same surface:volume as the small cube.
    e.   To grow larger, organisms add more cells rather than having larger cells.