BIO 311C
Spring 2010

Instructor:	**Dr. J. Brand**
Discussion Instructor:	**Rebecca Knight**
Textbook:	**Biology; Campbell & Reece; 8th Edit.**
Brand BIO 211 Web site:	**www.sbs.utexas.edu/brand/bio311c**
User ID:	**biosci\bio311c**
Password:	**Prokaryotes!**

Please raise your hand immediately after the start of the class period if you have not yet received the introductory hand-outs for this course that were provided during the last lecture period.

Discussion sessions start today and Monday.

A Suggested Systematic Study Method

1. Read the textbook assignment and examine the Presentation Slides on line prior to the presentation of each corresponding lecture.
2. Take careful notes during the lecture
3. Within 24 hours after each lecture, prepare your own set of "expanded notes" corresponding to the lecture.[Δ](i.e. prepare a set of lecture notes in your own words that you could deliver to a classmate.)

Re-organize the lecture information in preparing your lecture notes if you wish, but always use accurate statements and correct terminology. The information content should seem complete, and should flow smoothly and logically from one statement to the next after your expanded lecture notes have been completed.

[Δ]Use the following sources of information to obtain a complete set of expanded lecture notes:

a. formal lecture information (the basis for starting your expanded notes)
b. information contained in course Presentation slides
c. the textbook
d. any appropriate information from your discussion periods
e. lecture notes from a classmate, if needed

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SOME GENERAL PROPERTIES OF ALL LIVING CELLS

- They are surrounded by a limiting membrane, which separates the living cell from its environment.

- They contain DNA, which encodes the information for determining the cell's characteristics.

- They contain a specific, characteristic mechanism for synthesizing proteins.

- They contain characteristic classes of organic molecules: including proteins, carbohydrates, lipids and nucleic acids.

- They undergo characteristic kinds of chemical (metabolic) reactions, each of which requires a specific enzyme.

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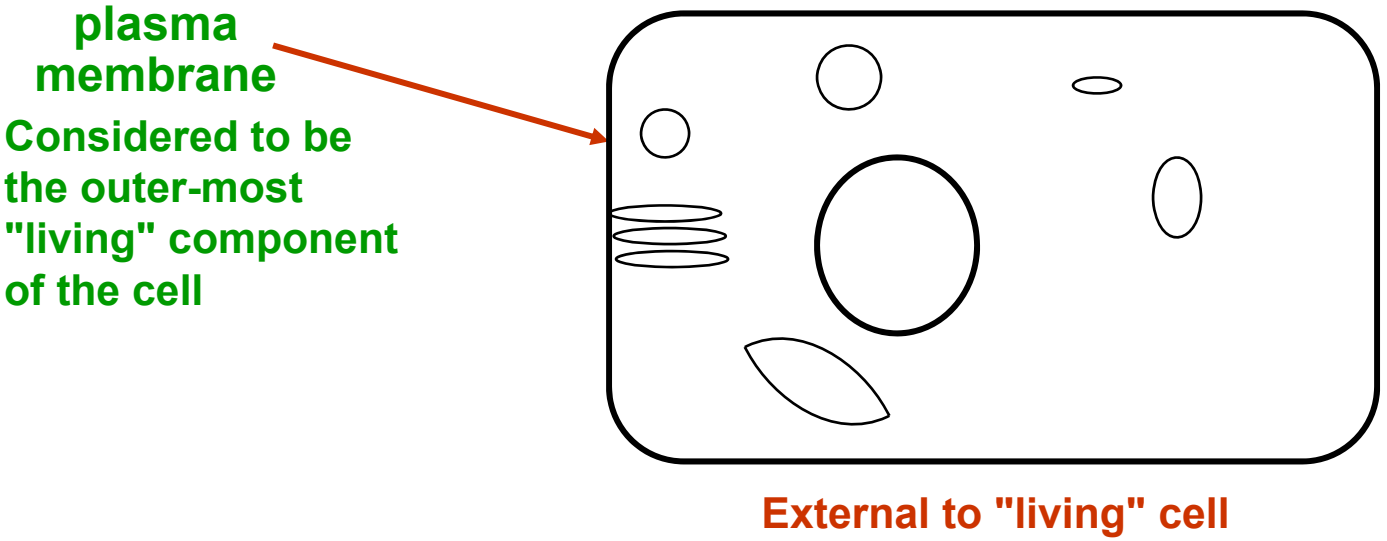
All living cells are surrounded by a limiting membrane.

It is called the plasma membrane, the plasmalemma or the cell membrane.



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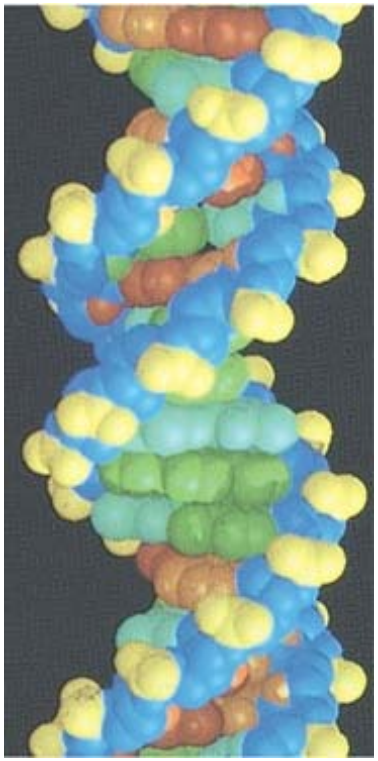
All living cells contain at least one molecule of DNA.

As the "blueprint" of the cell, DNA stores the information that determines the cell's structure and functions.



Model of a short section of a molecule of DNA

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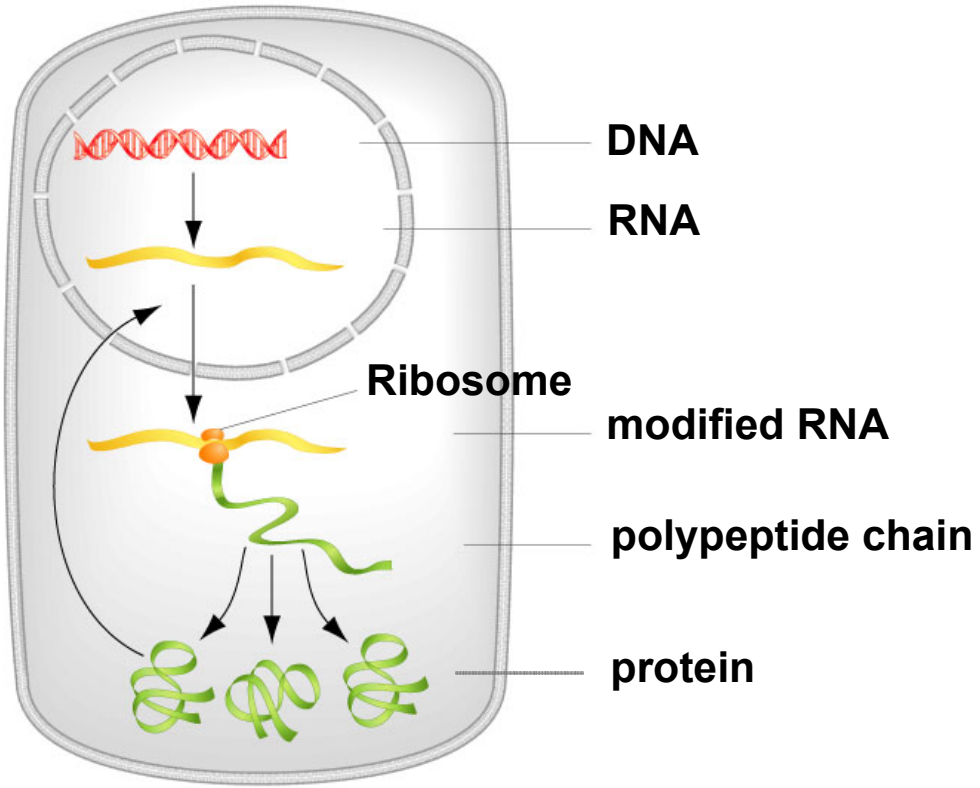
All cells utilize the same kind of mechanism to synthesize proteins.

This mechanism, sometimes called the Central Dogma of molecular biology, facilitates the transfer of information from DNA to RNA to protein.



Living Cell

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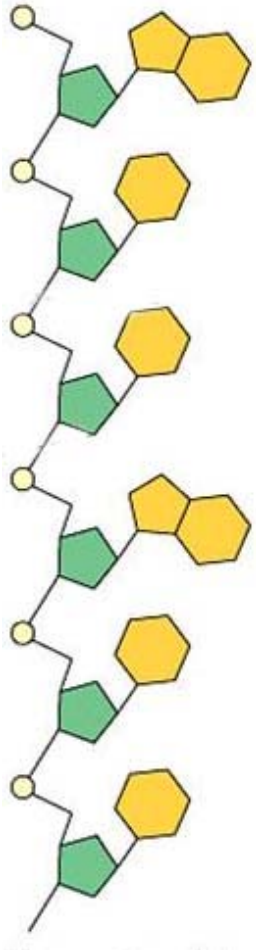
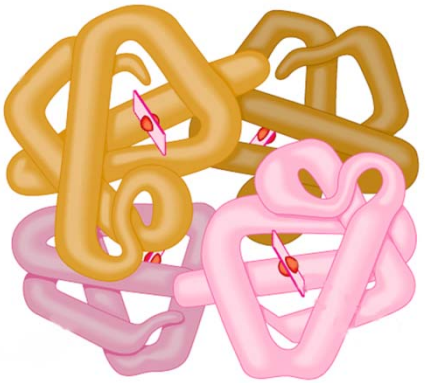
All cells utilize the same four classes of organic molecules to construct their components and perform their functions.

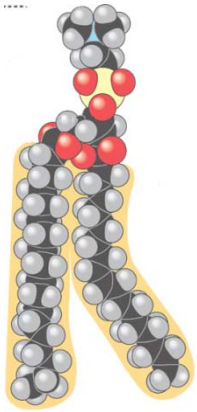
Illustrations of cellular molecules



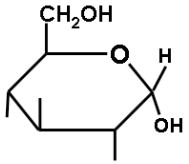
Nucleic Acids



Proteins



Lipids



Carbohydrates

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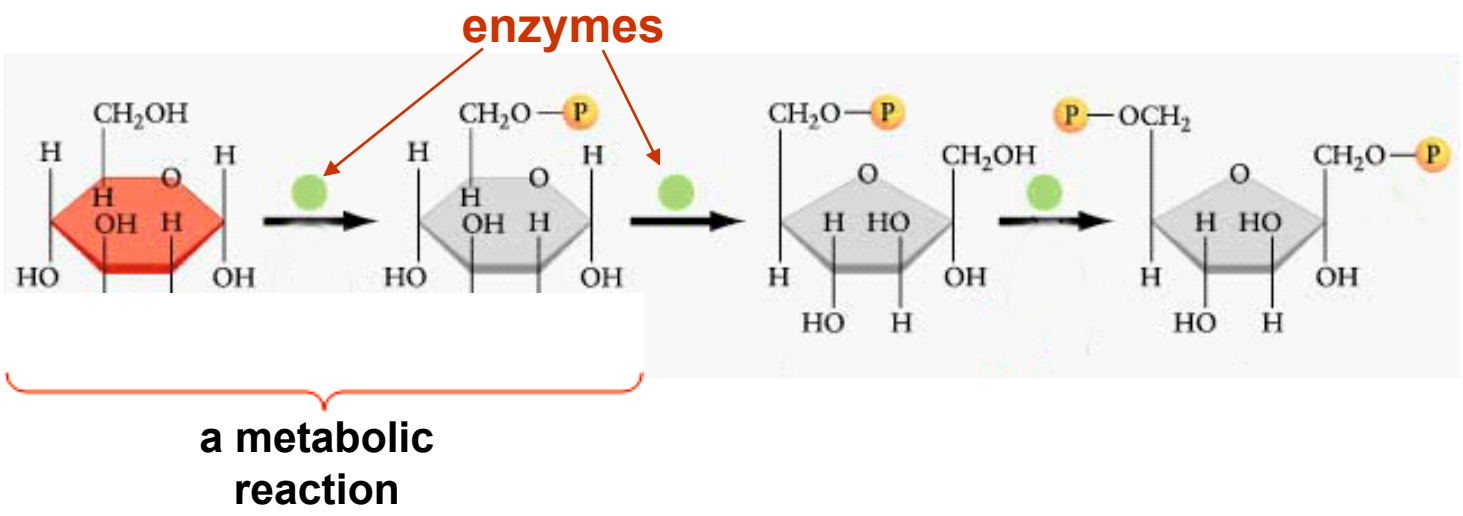
Cells undergo characteristic kinds of chemical reactions, each of which requires a specific enzyme.

Collectively, the chemical reactions associated with a living cell (or with a living organism generally) are called its metabolism. An individual chemical reaction associated with a living cell or organism is called a metabolic reaction.



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We will not discuss biological molecules or their cellular functions in any detail for several weeks. Instead we will begin by considering some characteristics of cells and of the major structures that occur within cells.

However, a little basic chemical information is necessary in order to describe the structures and functions of cellular components.

You should become familiar with the information presented in the following four slides.

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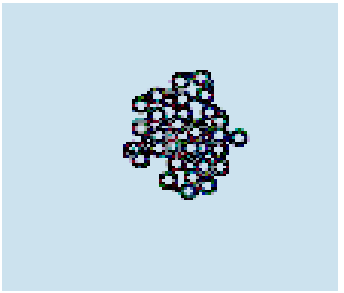
Basic Features of Some Important Biological Molecules

Proteins: Very large organic molecules made of long chains of amino acids. Proteins are the machinery for most cell functions, and are used as building materials for most cellular structures.

A stretched-out protein showing individual amino acids as circles.



A protein folded tightly into a functional globular shape in a cell.

Carbohydrates: Organic molecules which include individual sugar molecules and long chains of sugars, called polysaccharides. Carbohydrates are often attached to membrane surfaces and they form a coating outside of the plasma membrane on many kinds of cells. They also occur within cells as a major storage form of energy.

A polysaccharide, showing individual sugars as hexagons.

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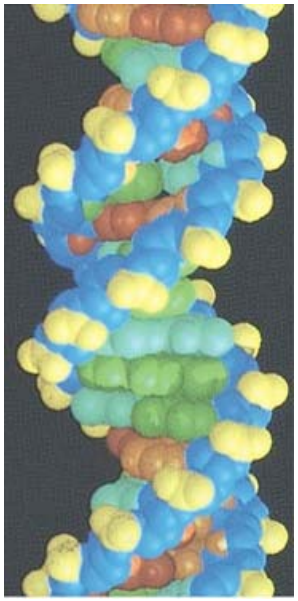
Basic Features of Some Important Biological Molecules

Lipids: Water-insoluble organic molecules of cells.

Diagrammatic illustration of the shape of a phospholipid, a kind of lipid molecule that is used to construct biological membranes.

Nucleic acids: Large to very large molecules used especially to manage information content of cells. They store cellular information, transfer information from one place to another within cell, and regulate the expression of information within cells. The two major categories of nucleic acids are called DNA and RNA.



Molecular model of a portion of a molecule of DNA, the information-storage molecules of cells, and the largest kind of molecule in the cell.

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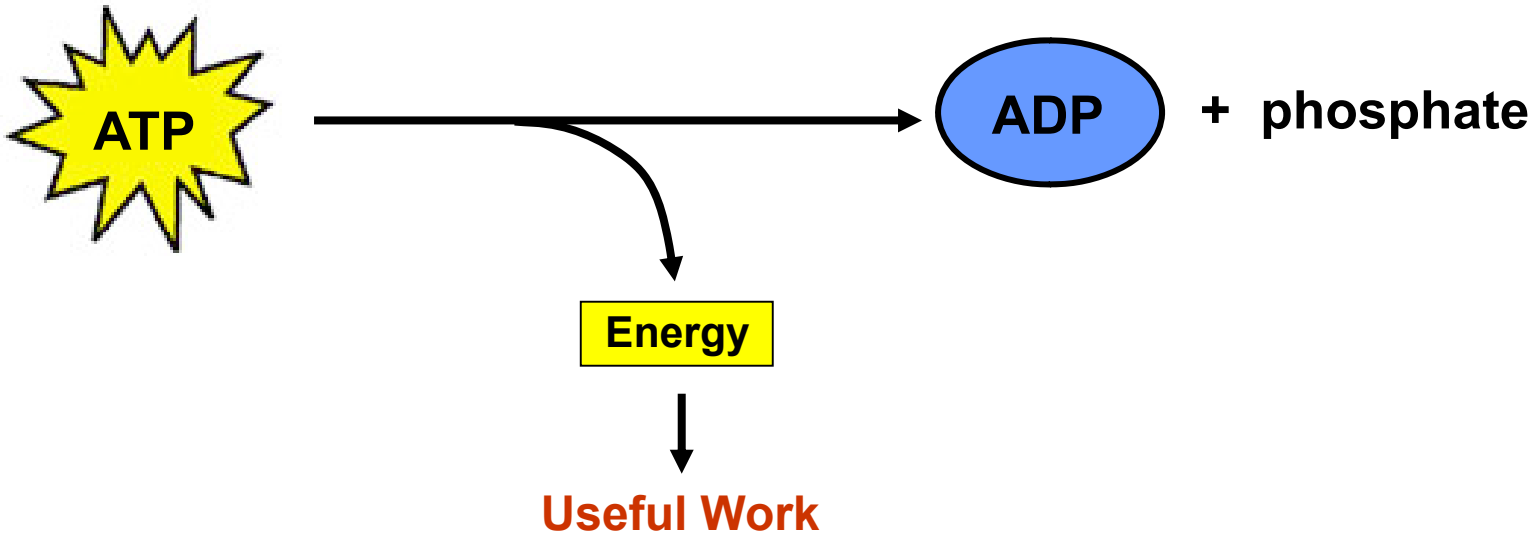
An Important Chemical Process in Cells

ATP is a kind of molecule that is used to carry energy throughout the cell, then discharge its energy when the energy is needed at a specific site by the cell.



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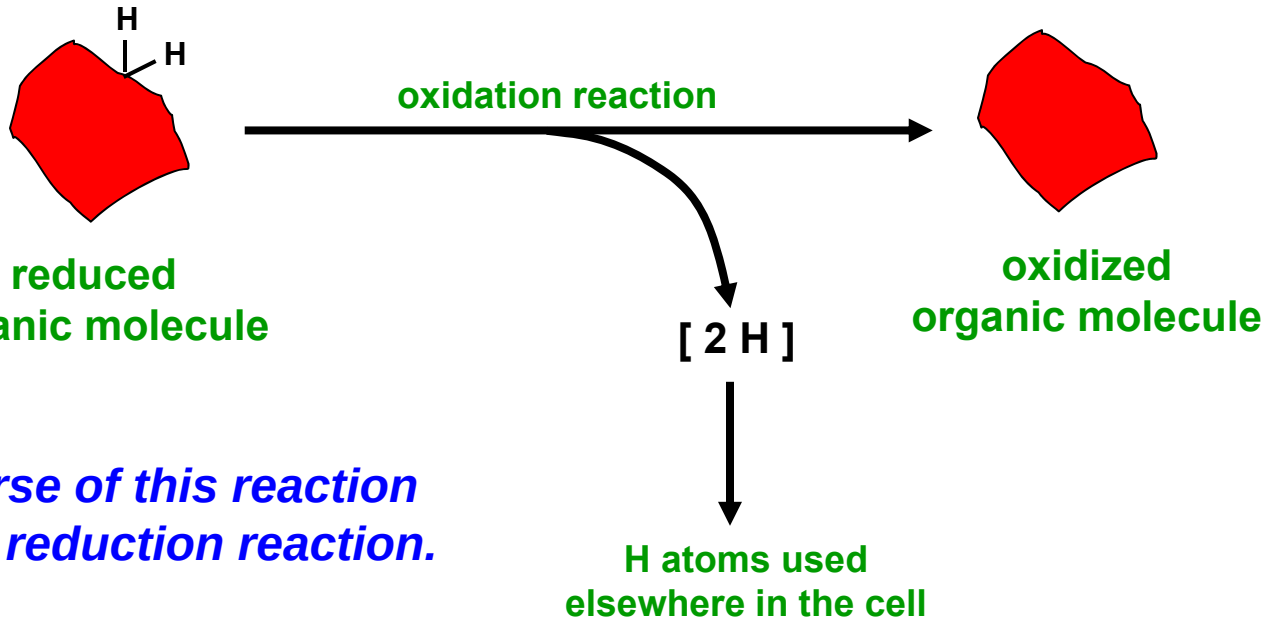
An Important Chemical Process in Cells

Virtually all organic molecules in cells contain hydrogen atoms. Some of these organic molecules can chemically bond to additional hydrogen atoms and some can lose bonded hydrogen atoms.

An organic molecule that loses hydrogen atoms becomes more oxidized, while an organic molecule that incorporates additional hydrogen atoms becomes more reduced.

example:



note: The reverse of this reaction would be a reduction reaction.

Note: we are here considering the gain or loss of hydrogen atom (including both the proton and the electron), not just the proton.

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Sizes of Cells

Very few cells are smaller than 0.5 μm in diameter.

Few cells are larger than 100 μm in diameter.

Thus, with a few exceptions, cells vary in length over a range of approximately 200.

That means cells vary in volume by more than $(200)^3$ times; i.e. they vary in volume by a factor of more than 8 million.

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Units of length of importance in cell and molecular biology

Recall that a length of 1 meter (m) is a little longer than a yard-stick.

Recall that a millimeter (mm) is 1/1000 of a meter

micrometer (μm):	1 μm = 1/1000 of a mm
nanometer (nm):	1 nm = 1/1000 of a μm
Angstrom (Å):	1 Å = 1/10 of a nm

Dimensions of cells and the largest structures within cells are measured in units of μm.

Dimensions of the smallest structures within cells are measured in units of nm.

Dimensions of individual molecules and bond lengths are measured in units of Å.

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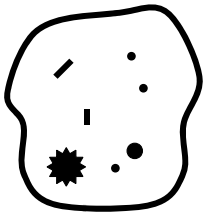
Q. Why are cells almost never smaller than ~0.5 µm diameter?



cell

Answer - Cells require a certain minimum cellular content in order to sustain the properties of life. A minimum volume is needed to contain all of the necessary cellular contents.

Exception: A few kinds of cells are only ~ 0.2 µm in diameter. These exceptions actually support the rule, because such small cells can only survive as parasites within other, larger cells, from which they acquire the partially processed food and energy that they need to live.

Example: Cells of the bacterium *Rickettsia* which causes Rocky Mountain Spotted Fever are only ~ 0.2 µm in diameter, and are obligate parasites in other cells.

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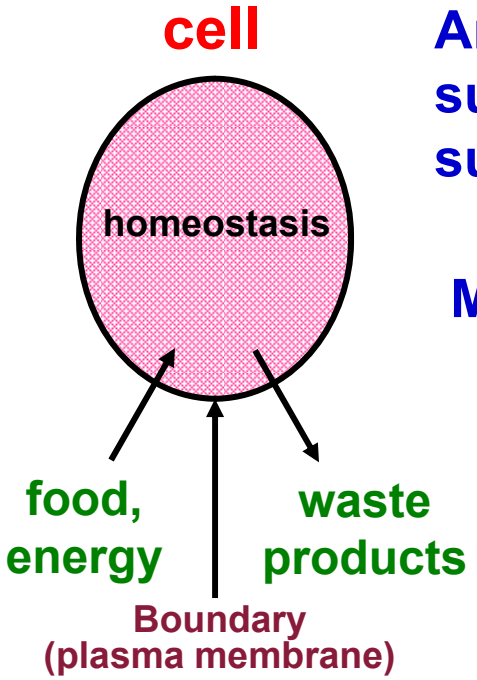
Q. Why are cells seldom larger than 100 µm diameter?



Answer - Their maximum size is limited by their surface-to-volume (S/V) ratio. Above a certain size, the surface area cannot sustain the volume of the cell.

More detailed explanation:

Food and energy must constantly enter and waste products must constantly be removed in order to sustain all parts of the volume of the cell. These substances must all pass through the cell boundary (the the plasma membrane) in order to enter or leave the cell.

As the diameter of the cell increases, the volume gets larger more quickly than does the surface area. Thus, for any given cell shape, the S/V ratio decreases as the diameter increases.

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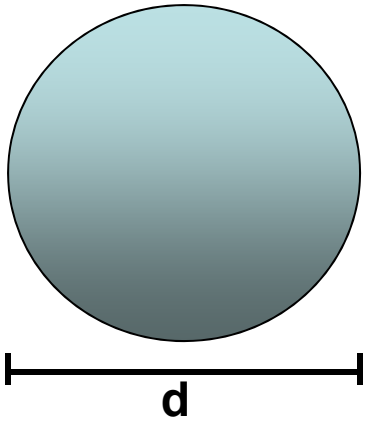
Consider a Spherical Cell



r (radius) = $\frac{1}{2} \cdot d$

$S = 4 \cdot \pi \cdot r^2$

$V = 4/3 \cdot \pi \cdot r^3$

diameter (d) (μm)	surface area (S) $(\mu m)^2$	volume (V) $(\mu m)^3$	S/V ratio (1/ μm)
1	3.14	0.52	6.0
5	78	65	1.2
20	1,260	4,190	0.3
100	31,400	523,000	0.006

The S/V ratio decreases as d increases.

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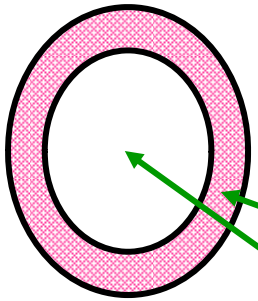
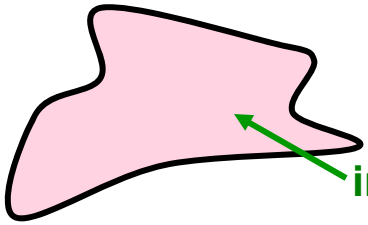
Some cells are larger than 100 µm. How?



Answer 1 - Some cells have have a large, watery, nonliving space called a vacuole that increases their surface area, thereby increasing their S/V ratio.

living part of cell (protoplasm)

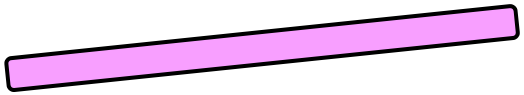
non-living part of the cell (vacuole), although the vacuolar membrane is considered to be a "living" component of the cell.



Answer 2 - Some cells have an irregular shape or are very thin in one or two dimensions in order to increase the surface area for any given volume.

irregular surface contour

long and thin →



Answer 3 - Some cells have a very slow rate of metabolism so homeostasis is maintained even when substances enter and leave the cell at a rate that would not sustain a more active cell of that same shape and volume.

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