References

1- Essentials of biology 3rd edition Mader, S.S.and Windelspencht,M. (2012).McGraw-Hill.

3- Essential Cell Biology ,Davey, J.; and Lord, M.(2002). Volume 2: Cell Function A Practical Approach. Oxford university Prees. P: 251.

Introduction of cell biology

Cell biology

The branch of biology dealing with the study of structure, function, molecular organization, growth, reproduction and genetics of the cells, is called **cytology or cell biology**.

The discovery of the cells

- 1665 - Robert Hooke looks at cork under a microscope. Calls the chambers he saw "cells"

- 1665 -1675 Anton van Leeuwenhoek, the invention of the microscope ,studies organisms living in pond water (like you did in lab). He called them "Animalcules."
- 1838-1839 German scientists Schleiden and Schawann ,all living organisms are made of cells. This forms the basis of the Cell Theory of Biology.

The Cell Theory of Biology

1- All living organisms (animals, plants and microbes) are made up of one or more cells and cell products.

2-All metabolic reactions in unicellular and multicellular organisms take place in cells.

3- Cells arise by division of preexisting cells.

4- The smallest clearly defined unit of life is the cell.

5-Cells can be cultured to produce more cells

Properties of Cells

1- Cells are complex and highly organized

- They contain numerous internal structures
- Some are membrane bound (organelles) while others do not

2-Cells contain a genetic blueprint and machinery to use it

- Genes are instructions for cells to create specific proteins
- All cells use the same types of information
  - The genetic code is universal
  - The machinery used for synthesis is interchangeable
- Information transfer must be error free
  - Errors are called mutations

Genetic Code- Table

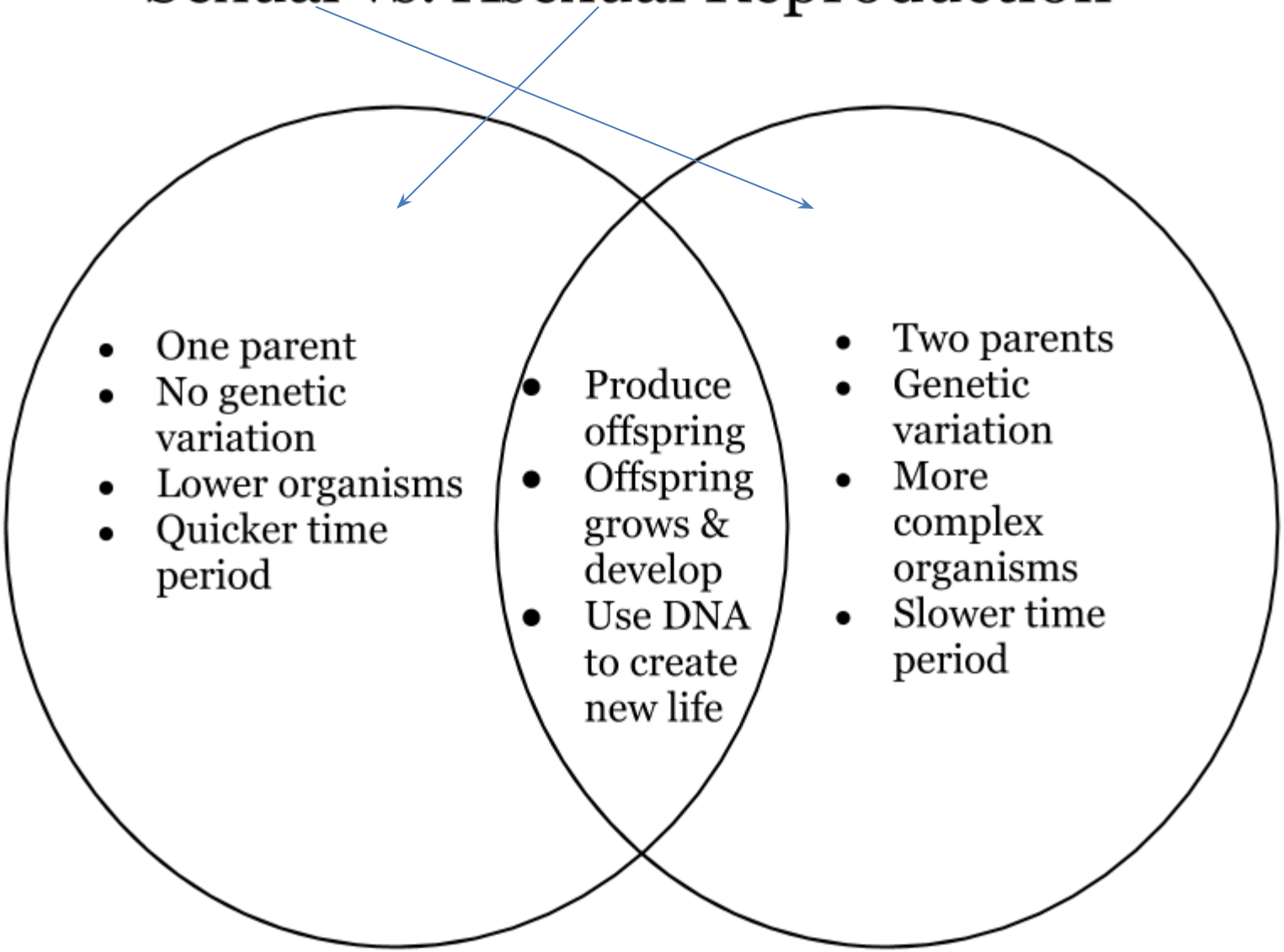
1st letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	3rd letter
U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U
	UUC	UCC	UAC	UGC	C
	UUA Leu	UCA	UAA Stop	UGA Stop	A
	UUG	UCG	UAG Stop	UGG Trp	G
C	CUU Leu	CCU Pro	CAU His	CGU Arg	U
	CUC	CCC	CAC	CGC	C
	CUA	CCA	CAA Gln	CGA	A
	CUG	CCG	CAG	CGG	G
A	AUU Ile	ACU Thr	AAU Asn	AGU Ser	U
	AUC	ACC	AAC	AGC	C
	AUA	ACA	AAA Lys	AGA Arg	A
	AUG Met	ACG	AAG	AGG	G
G	GUU Val	GCU Ala	GAU Asp	GGU Gly	U
	GUC	GCC	GAC	GGC	C
	GUA	GCA	GAA Glu	GGA	A
	GUG	GCG	GAG	GGG	G

3-Cells arise from the division of other cells

- Daughter cells inherit the genes from the mother cells
- Daughter cells inherit cytoplasm and organelles from the mother cells
- Binary fission - cell division in bacteria
- Mitosis - the genetic complement of each daughter cell is identical to the other and to the mother cell. This is asexual reproduction
- Meiosis - the genetic complement of each daughter cell is reduced by half. This is sexual reproduction

The difference between sexual and sexual reproduction as in the following scheme:

Sexual vs. Asexual Reproduction



4-Cells acquire and utilize energy

- Plant cells undergo photosynthesis

o convert light energy and CO_2 to chemical energy (ATP and glucose)

- Most cells respire

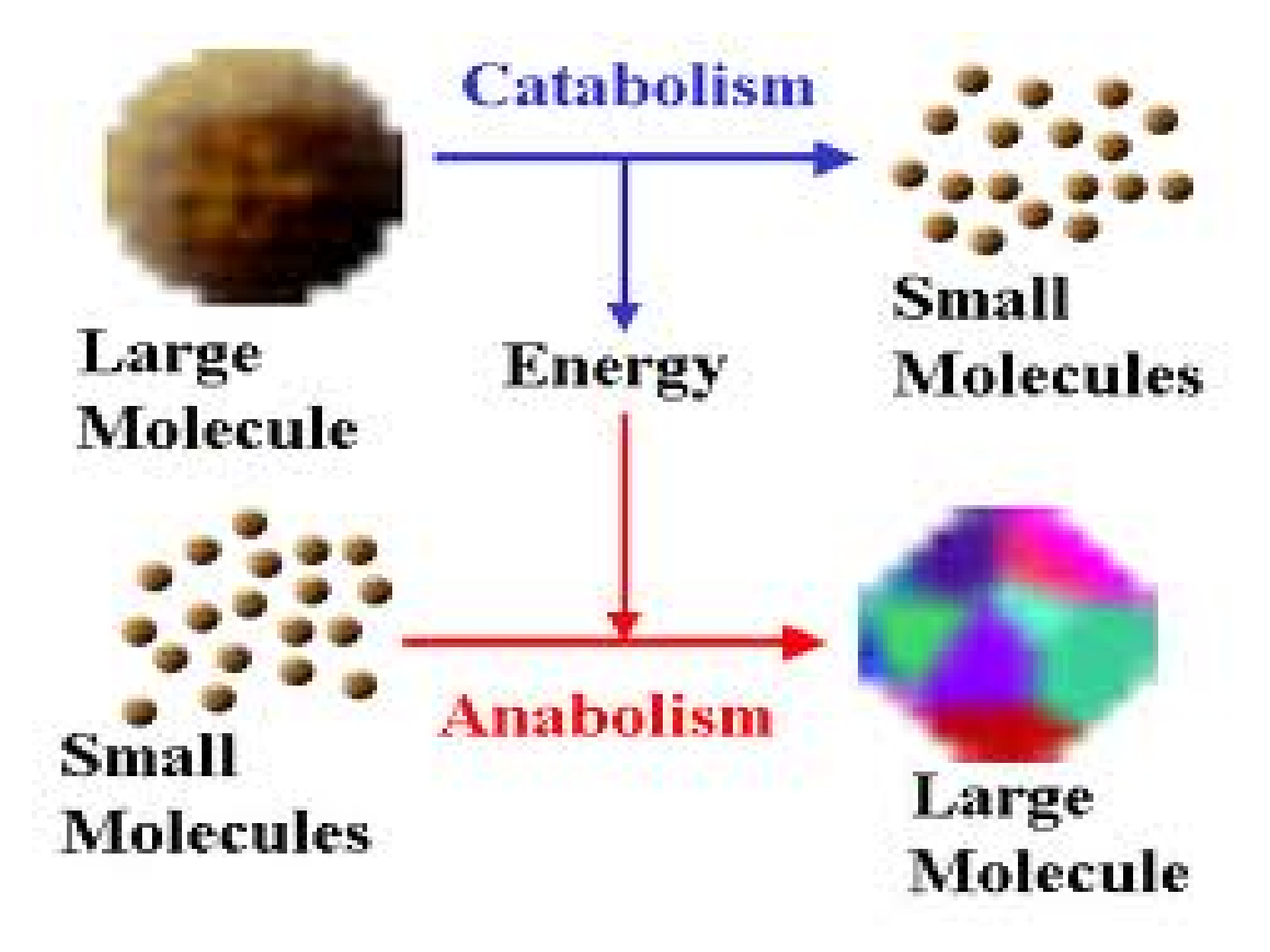
o release energy found in organic compounds

o convert organic compounds to CO_2 and O_2

o make ATP

5-Cells can perform a variety of chemical reactions

- convert simple organic molecules into complex molecules (anabolism)
- Breakdown complex molecules to release energy (catabolism)
- Metabolism = all reactions by cells


Catabolism
Large Molecule
Energy
Small Molecules
Small Molecules
Anabolism
Large Molecule

6-Cells can engage in mechanical activities

- Cells can move
- Organelles can move
- Cells can respond to stimuli

o chemotaxis - movement towards chemicals
o phototaxis - movement towards light
o hormone responses
o touch responses

7-Cells can regulate activities

- Cells control DNA synthesis and cell division
- Gene regulation - cells make specific proteins only when needed
- Turn on and off metabolic pathways

8-Cells all contain the following structures:

- Plasma membrane - separates the cell from the external environment
- Cytoplasm - fluid-filled cell interior
- Nuclear material - genetic information stored as DNA

Major Cell Structures and Primary Functions

Cell Membrane

Protects the cell; provides for communication via receptor proteins; surface proteins serve as positive identification tags; allows some substances to pass into and out of the cell while denying passage to other substances; this selectivity allows cells to receive nutrition and dispose of waste.

Cytoplasm

Provides storage and work areas for the cell; the work and storage elements of the cell, called organelles, are the ribosomes, endoplasmic reticulum, Golgi apparatus, mitochondria, lysosomes, and centrioles.

Ribosomes

Make enzymes and other proteins; nicknamed "protein factories".

Endoplasmic reticulum (ER)

Carries proteins and other substances through the cytoplasm.

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Carries proteins and other substances through the cytoplasm.

Golgi apparatus

Chemically processes the molecules from the endoplasmic reticulum and the packages them into vesicles; nicknamed "chemical processing and packaging center".

Mitochondria

Involved in cellular metabolism and respiration; provides the principle source of cellular energy and is the place where complex, energy-releasing chemical reactions occur continuously; nicknamed "power plants".

Lysosomes

Contain enzymes that can digest food compounds; nicknamed "digestive bags".

Centrioles

Play an important role in cell reproduction

Cilia

Hair-like processes that project from epithelial cells; help propel mucus, dust particles, and other foreign substances from the respiratory tract.

Flagellum

"Tail" of the sperm that enables for the sperm to "swim" or move toward the ovum.

Nucleus

Controls every organelle (little organ) in the cytoplasm; contains the generic matter necessary for cell reproduction as well as control over activity within in the cell's cytoplasm; responsible for the cell's metabolism, growth, and reproduction.

Types of Cells

1-Prokaryotes

- Pro = before; karyon = nucleus
- relatively small 5 - 10 um
- lack membrane-bound organelles
- earliest cell type

2-Archaea

- Originally thought to be prokaryotes
- relatively small 5 - 10 um
- lack membrane-bound organelles
- Usually live in extreme environments (thermophiles, halophiles) etc)

3-Eukaryotes

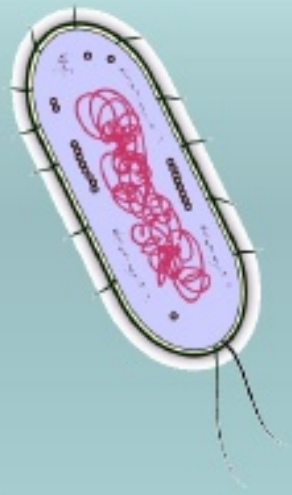
- Eu = true; karyon = nucleus
- contain membrane-bound organelles
- Evolved from prokaryotes by endosymbiosis association
- Include Protozoans , Fungi, Animals, and Plants

A comparison of a few traits of bacteria, archaea, and eukarya.

Property	Bacteria	Archaea	Eukaryotes
Cell type	Prokaryotic	Prokaryotic	Eukaryotic
Cell wall	Madeof peptidoglycan	Does not contain peptidoglycan	In plants and fungi, composed of polysaccharides
Sensitivityto antibiotics	Yes	No	No
Firstaminoacid duringprotein synthesis	Formylmethionine	Methionine	Methionine
DNA	Mostlycircular chromosomeand plasmids	Circular chromosomeand plasmids	Linear chromosome, rarely plasmids
Histones	No	Yes	Yes
Organelles	No	No	Yes

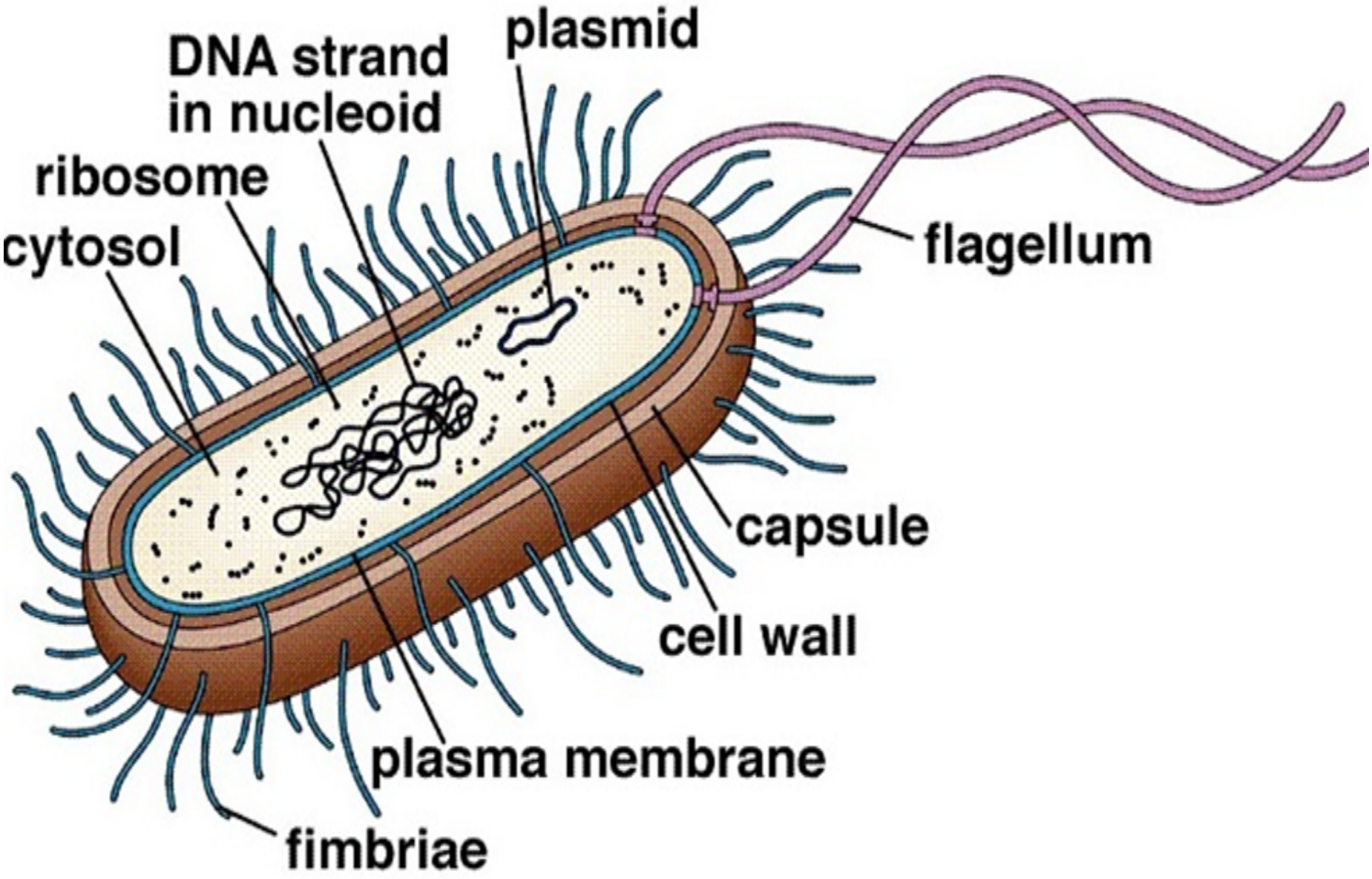
Characteristics of Prokaryotic cells

- No membrane bound organelles.
- DNA not enclosed in membrane bound nucleus.
  - DNA is localized in a **nucleoid** region
- Genome is one circular chromosome.
- DNA is not associated with histones.
- Cell wall made of **peptidoglycan**.
- Divide by **binary fission**.



- Generally: Smaller & less complex than eukaryotic cells.

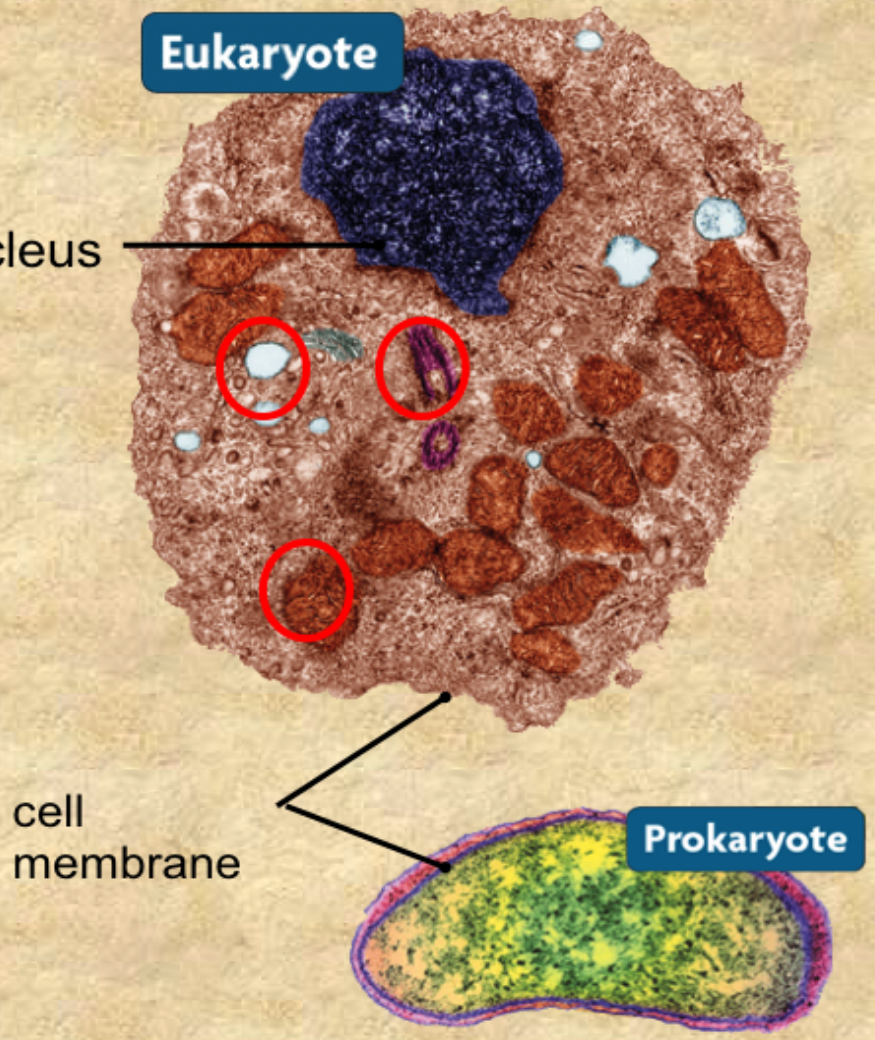
structure of typical prokaryotic cells:

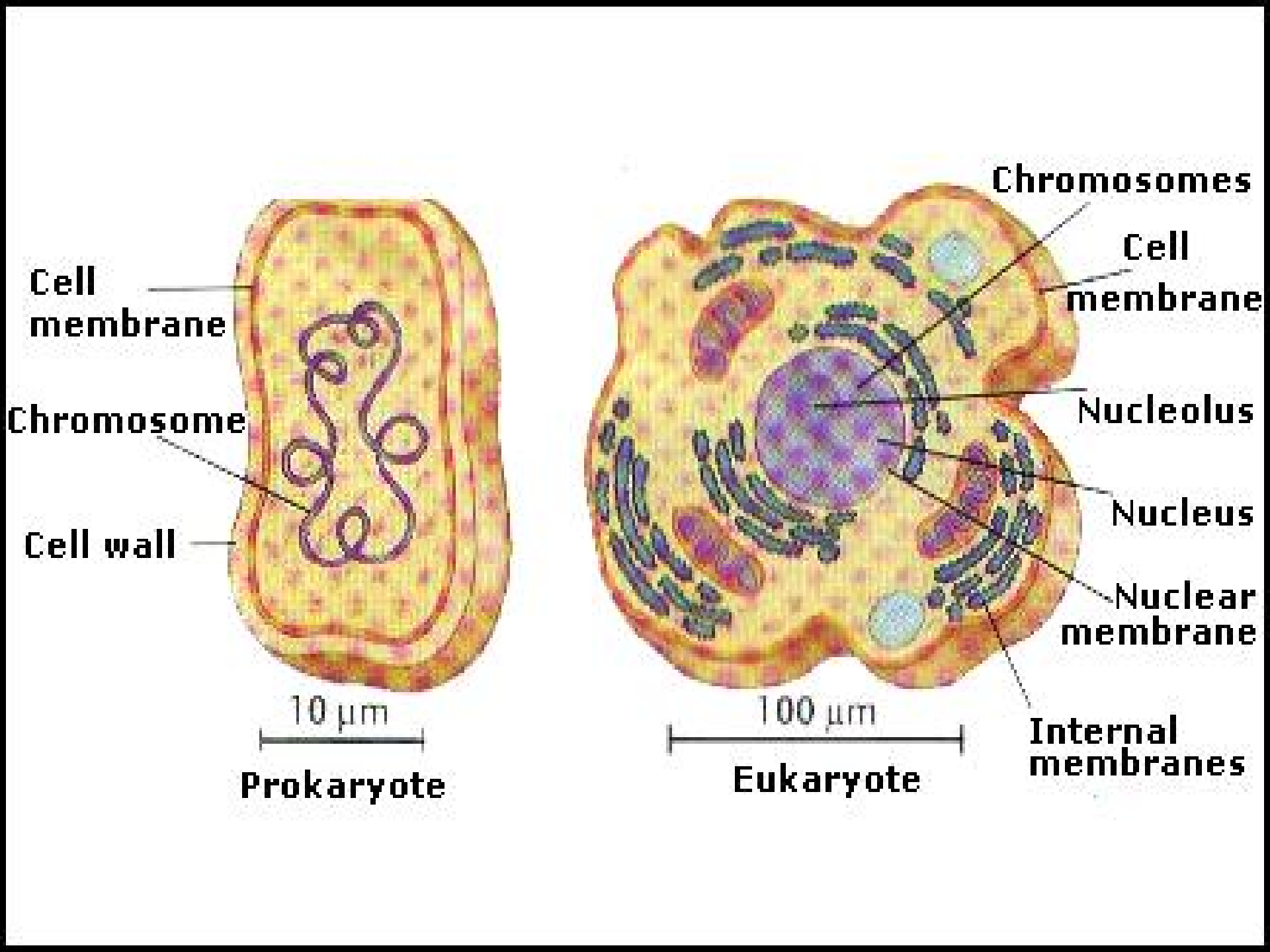


characteristic of eukaryotic cells:

- **Eukaryotic cells** have a nucleus

- Have many membrane-bound organelles (mitochondria, vacuole, endoplasmic reticulum, ribosomes, lysosomes, ***plastids in plants***).
- DNA contained in "linear chromosomes".
- Cytoplasm present.
- Outer boundary is cell membrane except in ***plant cells – wall made of cellulose***
- Cell membrane inside wall (plants)
- Some have flagella/cilia for movement.
- Larger, more complex
- Examples: protozoans, algae, fungi, plants, animals




Cell membrane
Chromosome
Cell wall
10 µm
Prokaryote
Chromosomes
Cell membrane
Nucleolus
Nucleus
Nuclear membrane
Internal membranes
100 µm
Eukaryote

What is the difference between prokaryotic and eukaryotic:

Prokaryotic cells	Eukaryotic
Small cells 5 ym	Larger cells 10 ym
Always unicellular	Often multicellular
No nucleus or any membrane-bound organelles, such as mitochondria	Always have nucleus and other membrane bund organelles
DNA is circular, without proteins	DNA is linear and associated with proteins to form chromatin
Ribosomes are small (70s)	Ribosomes are large (80)
No cytoskeleton	Always has a cytoskeleton
Motility by rigid rotating flagellum. Made of flagellin	Motility by flexible waving cilia or flagellae. Made of tubulin
Cell division is by binary fission	Cell division is by mitosis or meiosis
Reproduction is always asexual	Reproduction is asexual or sexual
Huge variety of metabolic pathways	Common metabolic pathways

What is the difference between an animal cell and a plant cell?

Animal cell	Plant cell
1. Animal cells are generally small in size	1. Plant cells are larger than animal cells.
2.Cell wall is absent.	2. Rigid cell wall of cellulose
3. absent plastids.	3. present plastids.
4. Vacuoles are many and small.	4. Vacuoles are few and large
5. Single highly complex Golgi apparatus.	5. many simpler units of Golgi apparatus, called dictyosomes.
6. present centrosome and centrioles.	6. Absent centrosome and centrioles.

Characteristics of Viruses

Virus are nonliving!

- Are not made of cells
- Do not have organelles or cytoplasm
- Can't carry out metabolic processes such as metabolism and homeostasis
- Do not grow through Cell Division
- Can't reproduce outside their host cell (Need host cells structures to reproduce)

Wendell Stanley was the first scientist to crystalize a virus. This is evidence that viruses are not made of cells and are not alive.

Virus Sizes and shapes

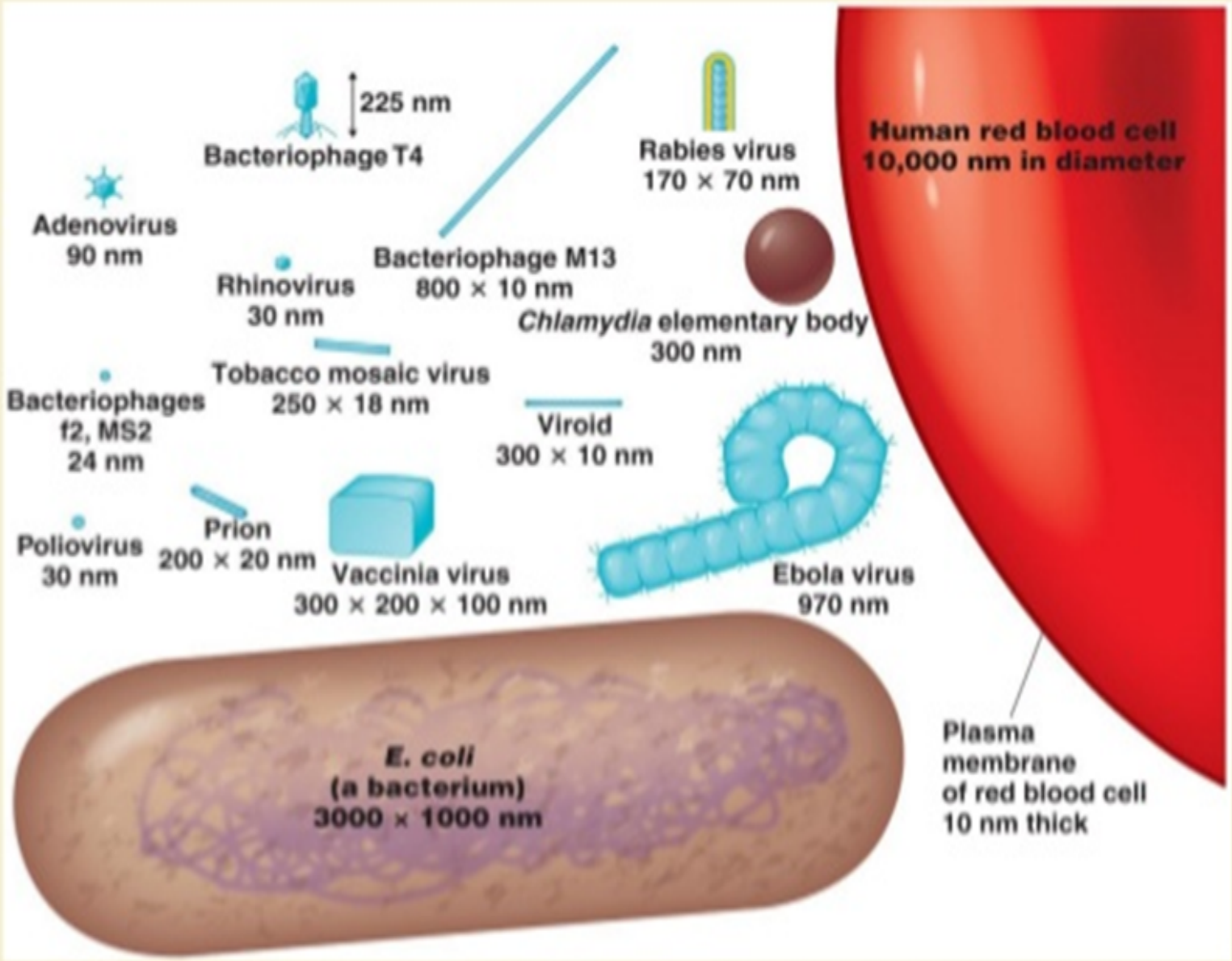


Figure 13.1

TABLE 1-2 METRIC MEASUREMENTS OF SIZE

1 meter (m)	=	39.4 inches (in.)
1 meter (m)	=	100 centimeters (cm)
1 centimeter (cm)	=	10 millimeters (mm)
1 millimeter (mm)	=	1000 micrometers (μm) or microns (μ)
1 micrometer (μm)	=	1000 nanometers (nm) or millimicrons (mμ)
1 nanometer (nm)	=	10 angstroms (Å)


THANK YOU