General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

Lecturer: Michael Gotesman, PhD
Email: mgotesman@citytech.cuny.edu

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER

Lecture: https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:

Exams (4): 20% Each
Quizzes: 20% Average

Recap: Meeting 9

A. Proteins

1) Amino acids: amino terminal NH_2 carboxyl CO_2H R-variable
2) R can cause → Hydrophobic, Hydrophilic, Polar, Acid/Base
3) Polymers extend via condensation – peptide bonds =>
   Proteins are also known as (aka) polypeptides
4) Structural vs Enzymatic vs Functional

B. Protein Structure

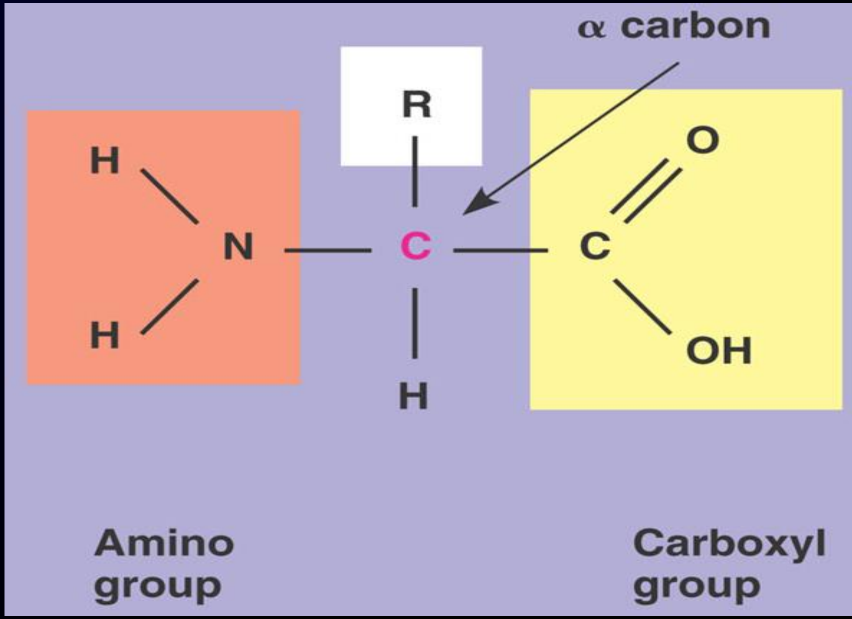
Primary (1^o) – Sequence of AA
Secondary (2^o) – alpha helix vs beta sheets
Tertiary (3^o) – overall structure
Quaternary (4^o) – interaction with 2 or more proteins

C. Nucleosides vs Nucleotides:

Components: Penotose (Ribose), base (A, C, G, T/U), phosphate group
DNA/RNA – similarities and differences
Complimentary base pairing
DNA double helix – James Watson and Francis Crick

Amino Acids

- 20 that commonly appear in nature
- Each has an amino group, a carboxyl group, and a unique side chain
  - At neutral pH, both the amino group and carboxyl group are ionized!
- The Sequence of amino acids in a protein dictates shape, function, etc.

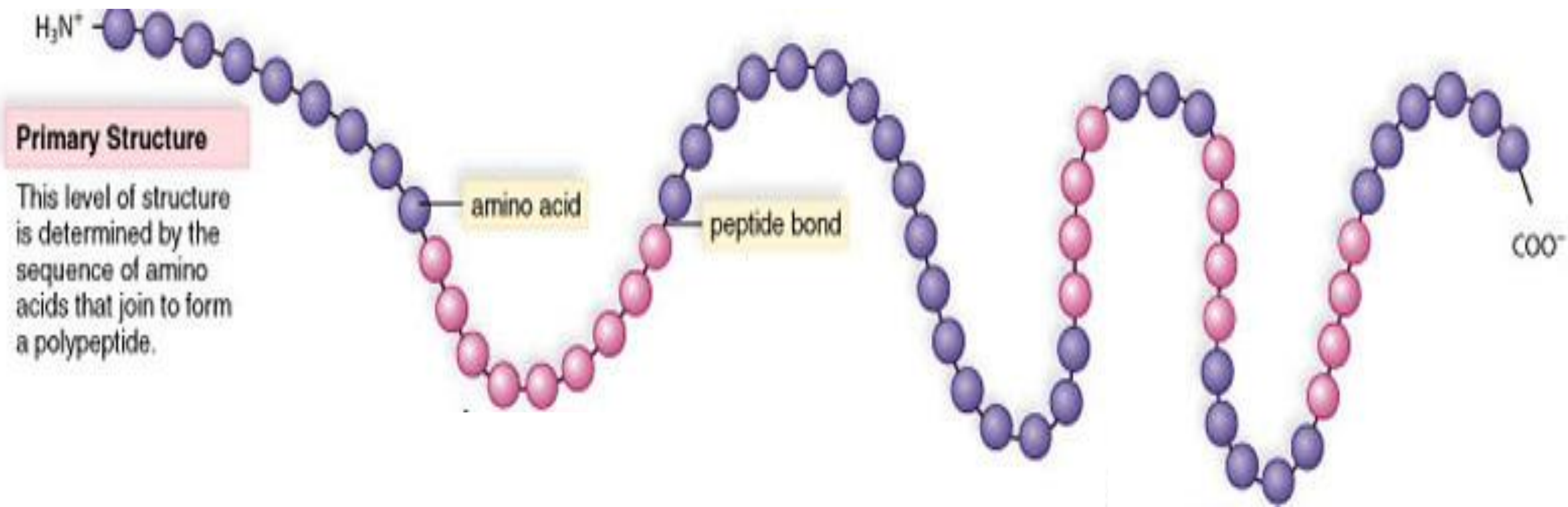


Levels of Protein Structure

Primary (1^o) Structure – the amino acid sequence

Example: Met-gly-ser-tyr-trp-ser-val-Ile-Phe-Arg-Asn…

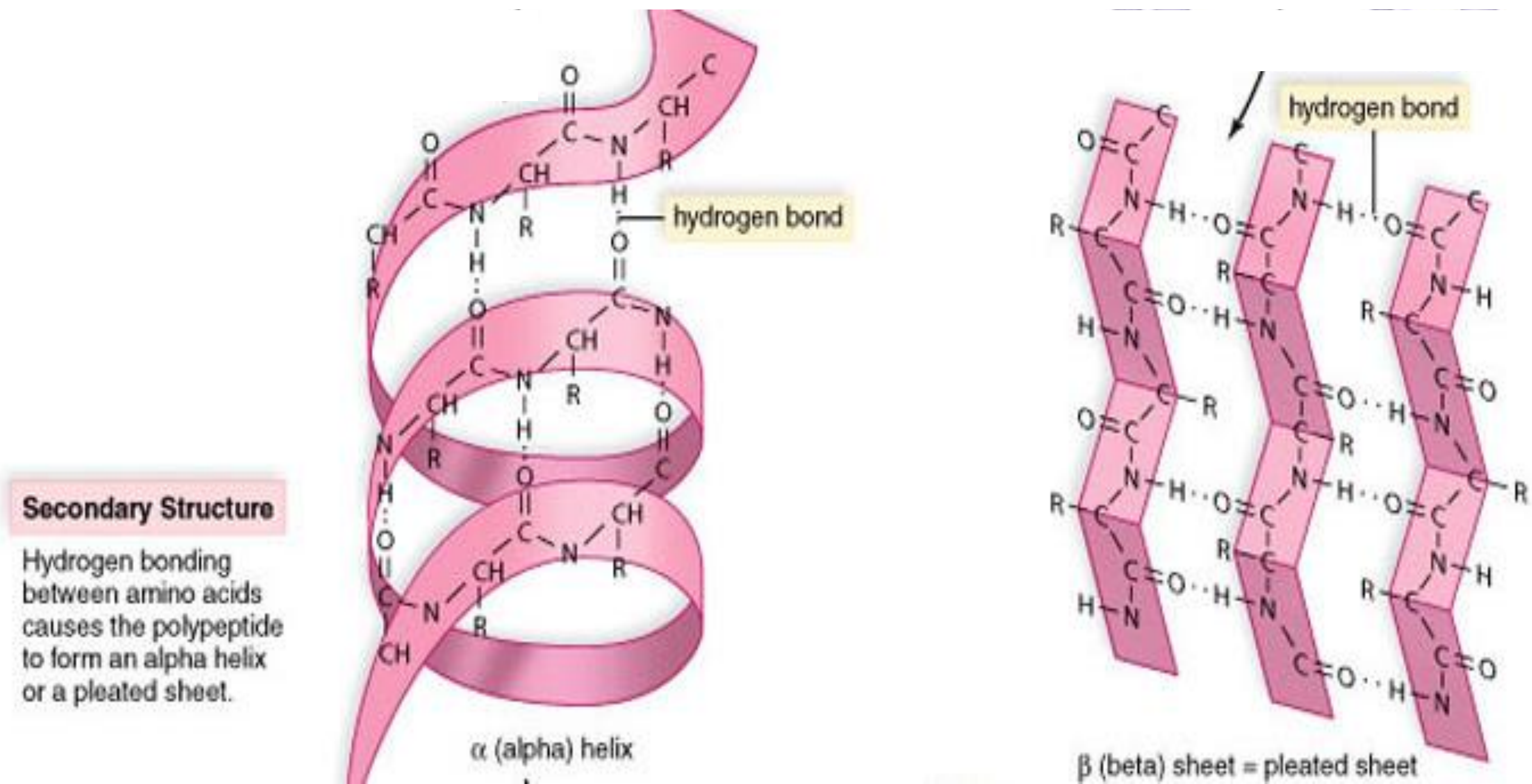
Everything else depends on this!



Levels of Protein Structure

Secondary (2^{o}) Structure – the folding of the polypeptide chain into helices and sheets

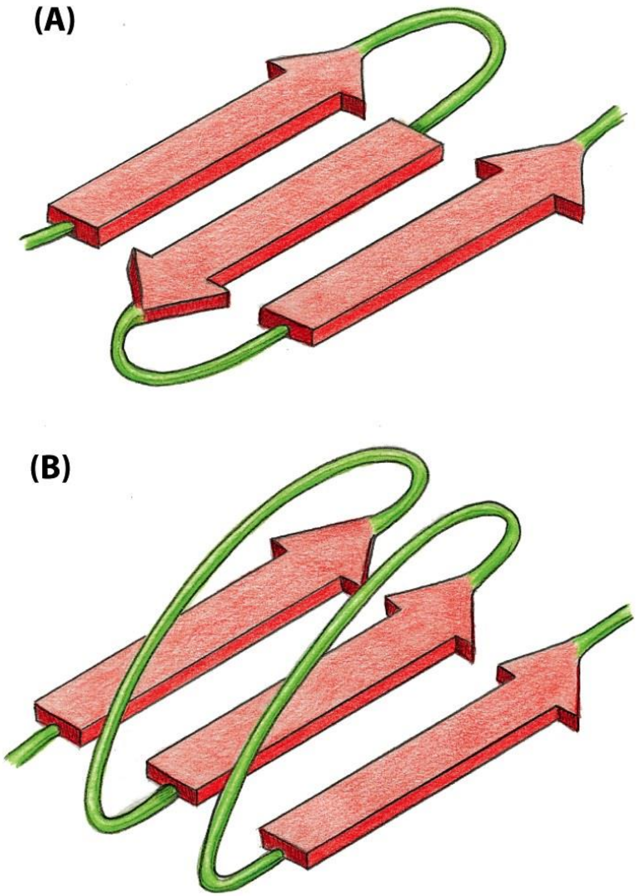
Called **alpha-helix** and **beta-sheet**

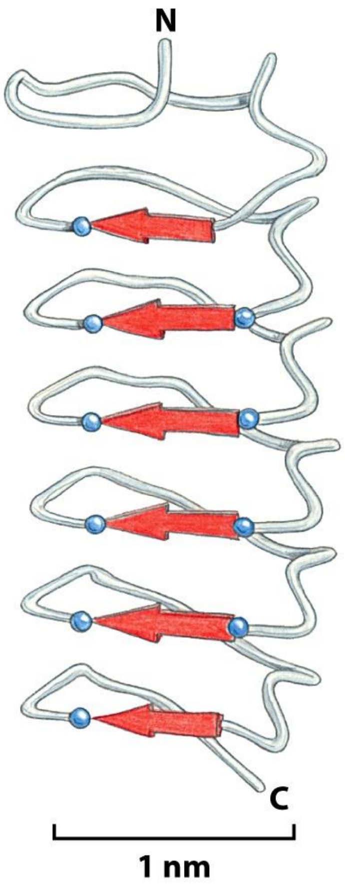


Anti-parallel

β Sheet

Parallel





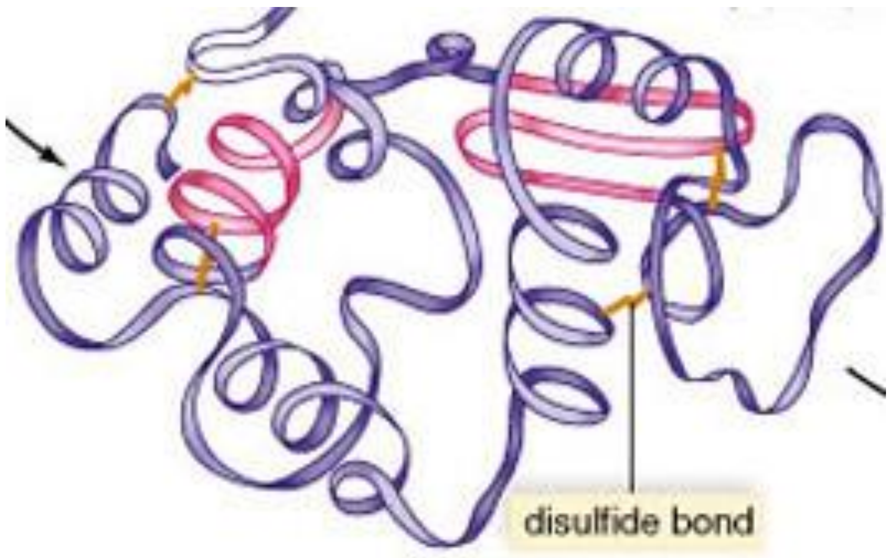
Anti-freeze
protein

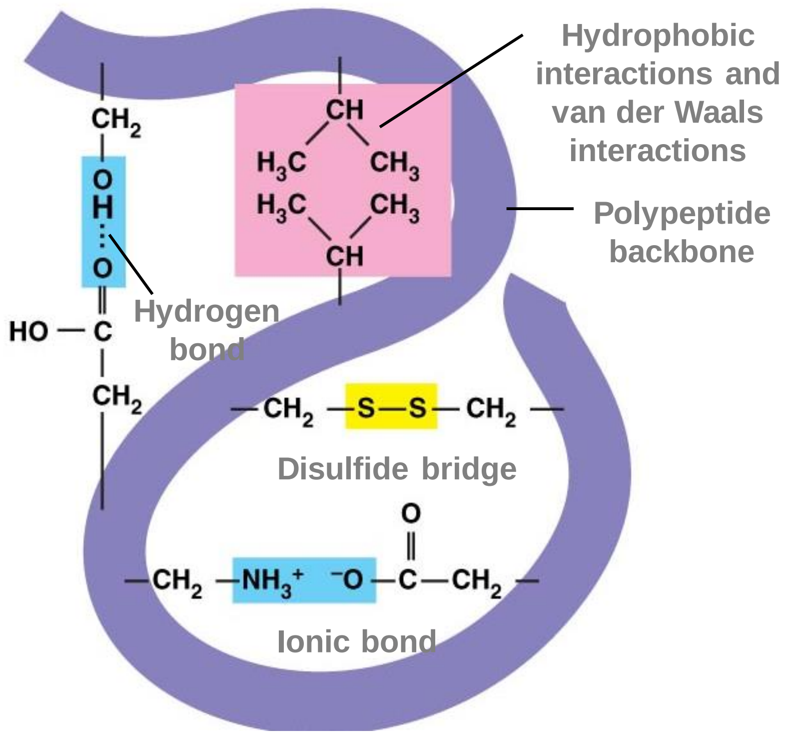
β Sheets provide rigid structure

Levels of Protein Structure

Tertiary (3º) Structure – The complex final overall shape that a polypeptide takes

H-bonding, disulfide bridges, hydrophobic interactions, ionic bonds, van der Waals, etc.

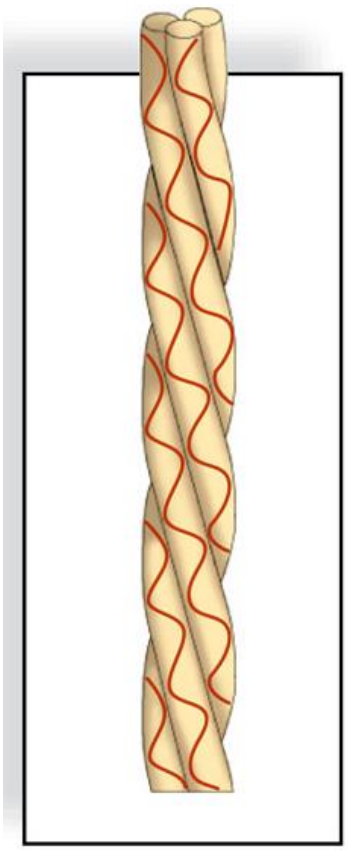




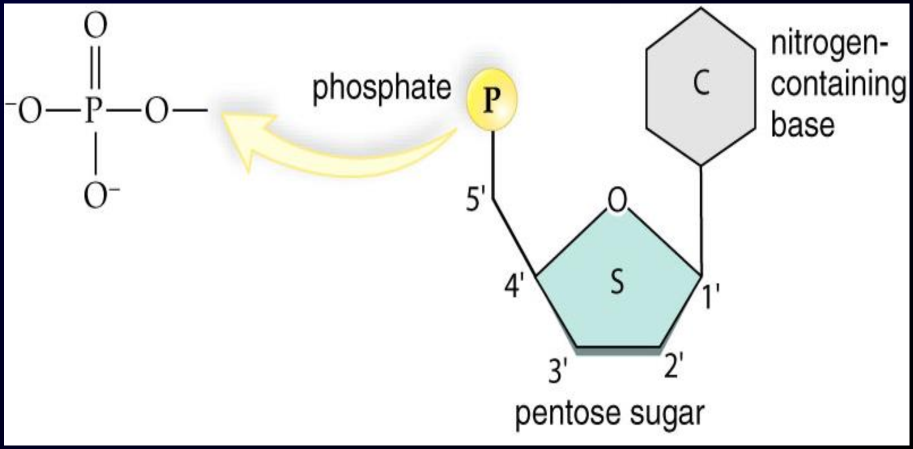
Levels of Protein Structure

Quaternary (4º) Structure – Interaction of multiple polypeptides to form one functional protein

Example: Hemoglobin, collagen, keratin



Nucleosides

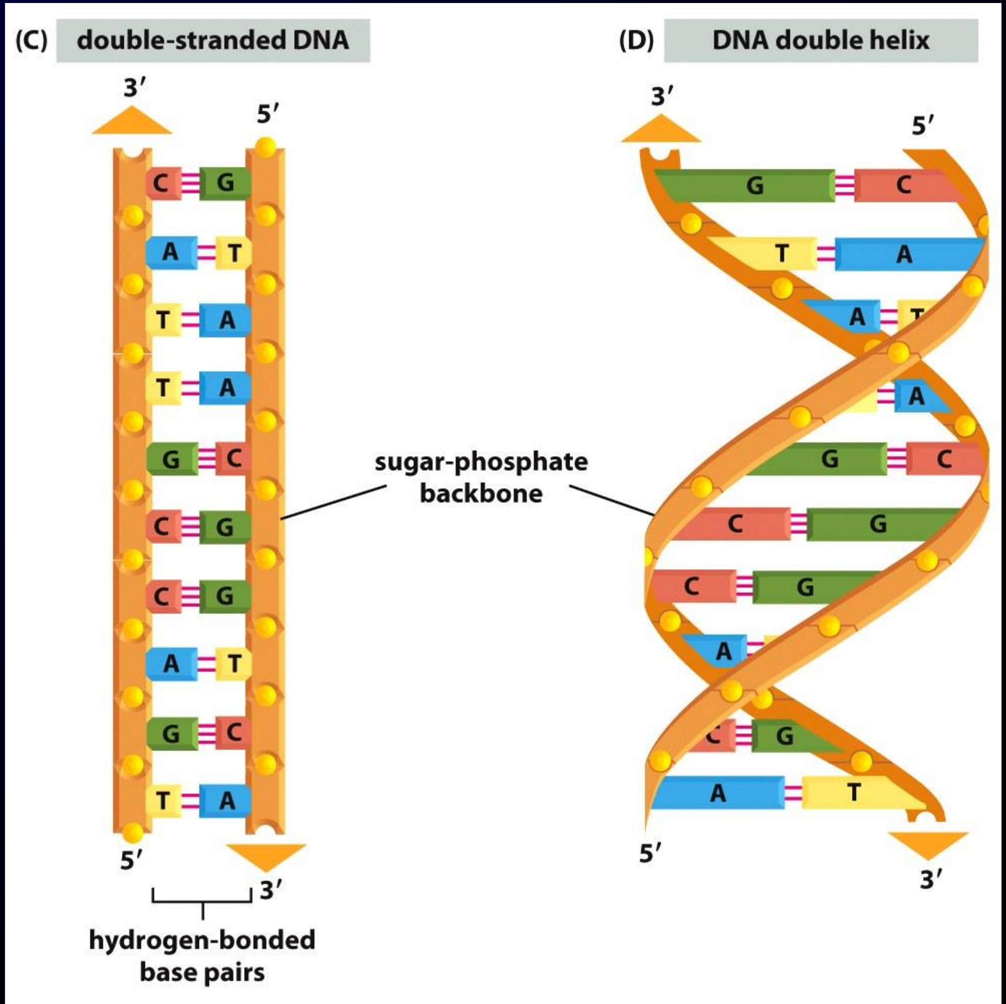


- Three parts to a nucleoside:
  - Five-carbon sugar
  - Nitrogenous base ([DNA] A, C, G, T, or [RNA] U)
  - 1,2, or 3 phosphate groups (NTP Nucleotide Tri Phosphate)
- There are two families of nitrogenous bases:
  - Pyrimidines have a single six-membered ring (C,T)
  - Purines have a six-membered ring fused to a five-membered ring (A,G)

- In DNA, the sugar is deoxyribose
- In RNA, the sugar is ribose

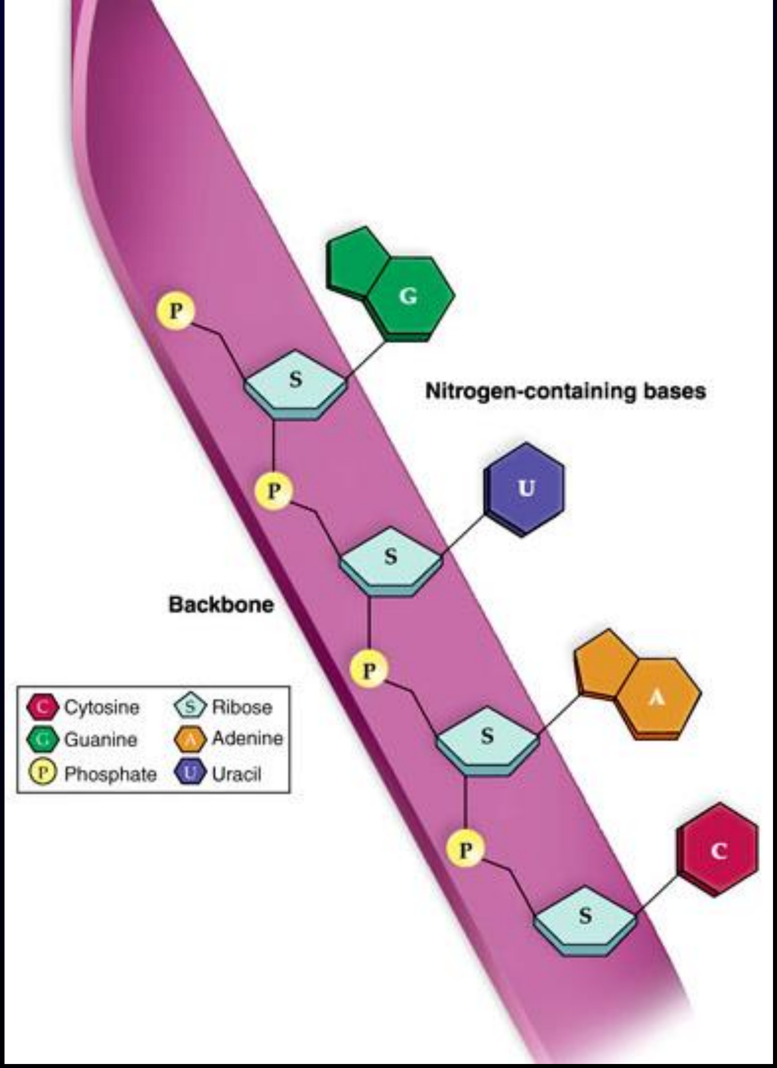
Elongation: 5’ → 3’ (phosphodiester linkage)

Each phosphodiester bond holds two DNA/RNA molecules together



RNA

- Single stranded
- A, U, G, C (no T)
- Sugar: pentose/ribose



Name: Quiz 4 10/02/16

Q1 (10 points): Do molecules polymerize/elongate by hydrolysis or condensation?

Q2 (30 points): name the monomeric subunit for each polymer (Full name for full credit):

A: Carbohydrate are poly…: B: Protein: C: DNA/RNA:

Q3 (20 points): Name 2 polymers that plants or animals use for structure

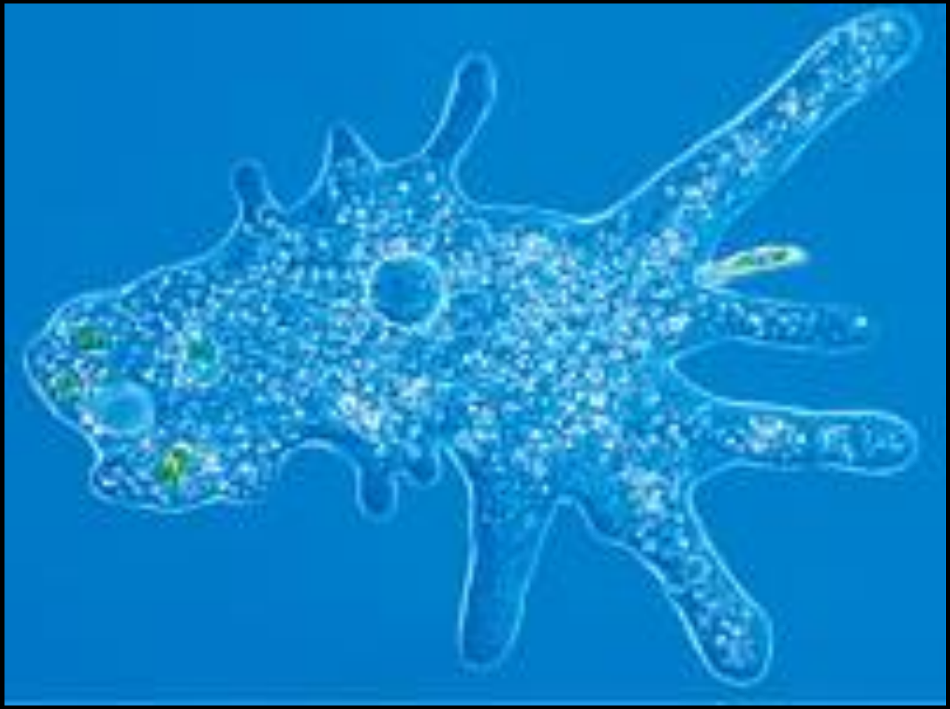
Q4 (20 points): Name and draw out the terminal regions (ends) of the protein subunit (2 different ends):

1) One end is a) called and has this b) chemical make up:
2) The other end is a) called and has this b) chemical make up:

Q5 (20 points): Describe 2 differences between DNA and RNA

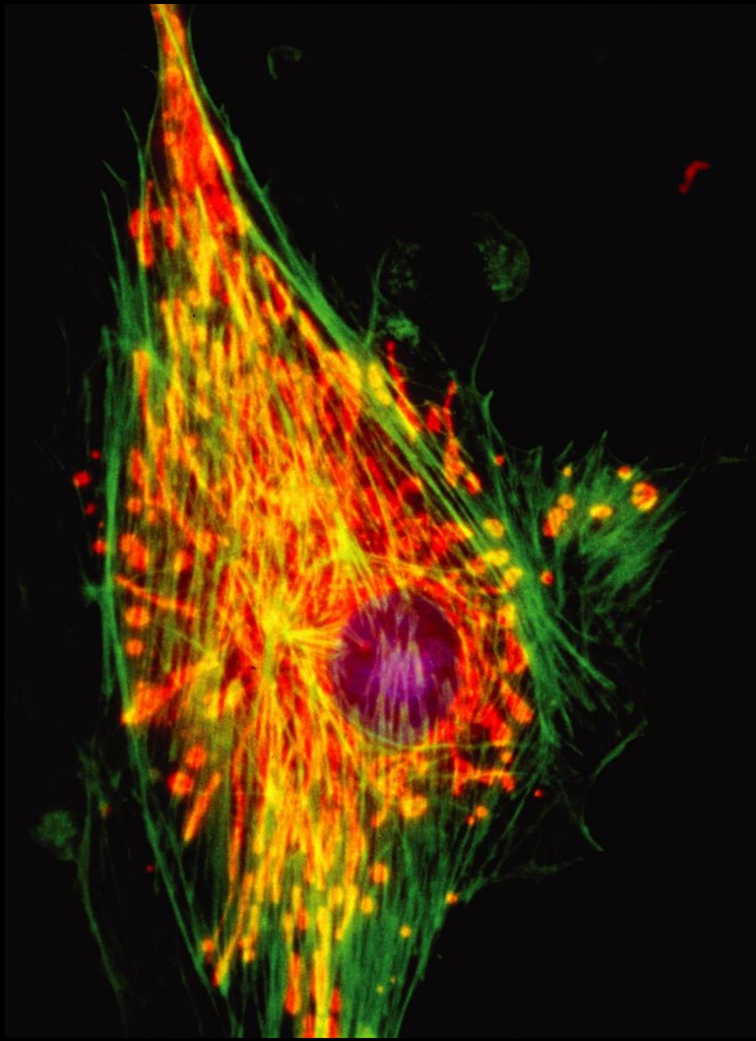
1) DNA is… and RNA is…. 2) DNA is… and RNA is….

The Cell



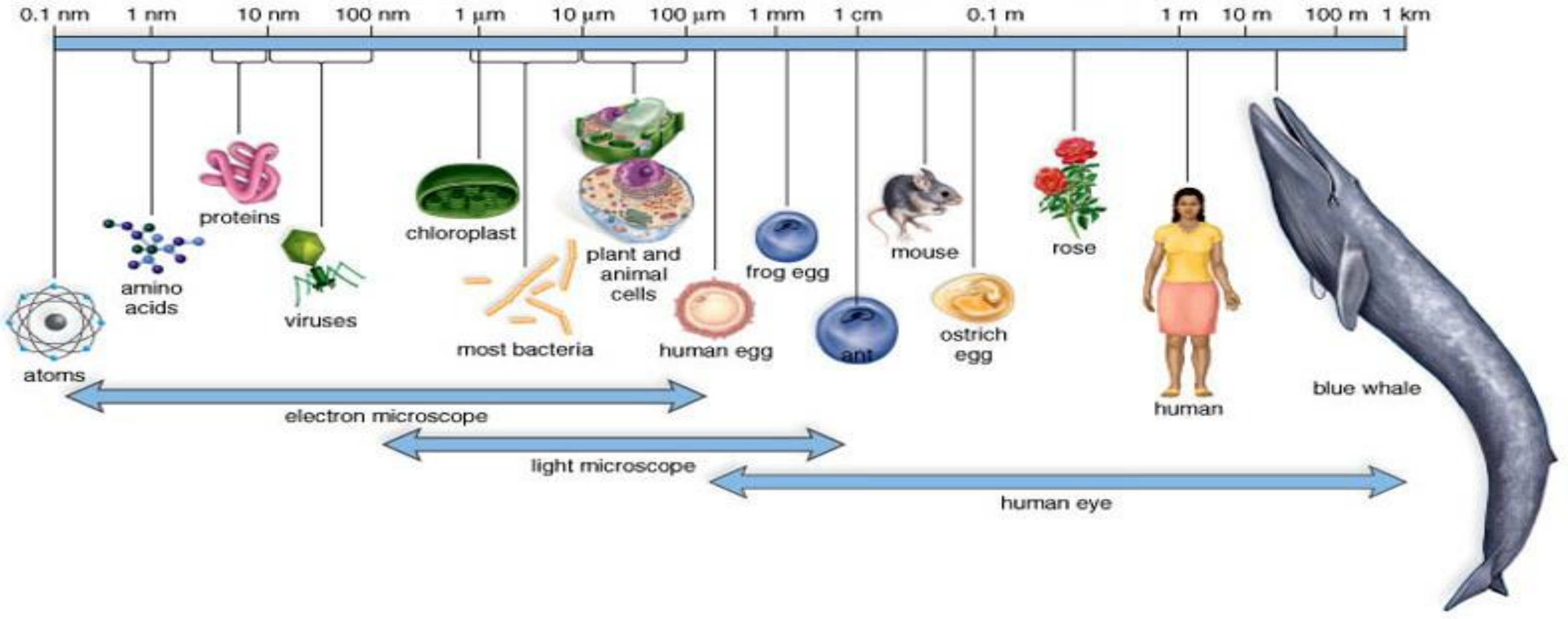
An overview of the cell

- The fundamental Unit of Life
- Cells interact with and respond to their environment
- All organisms are made of cells
- All cells come from other cells
- Throughout biology, cells are incredibly diverse and highly specialized

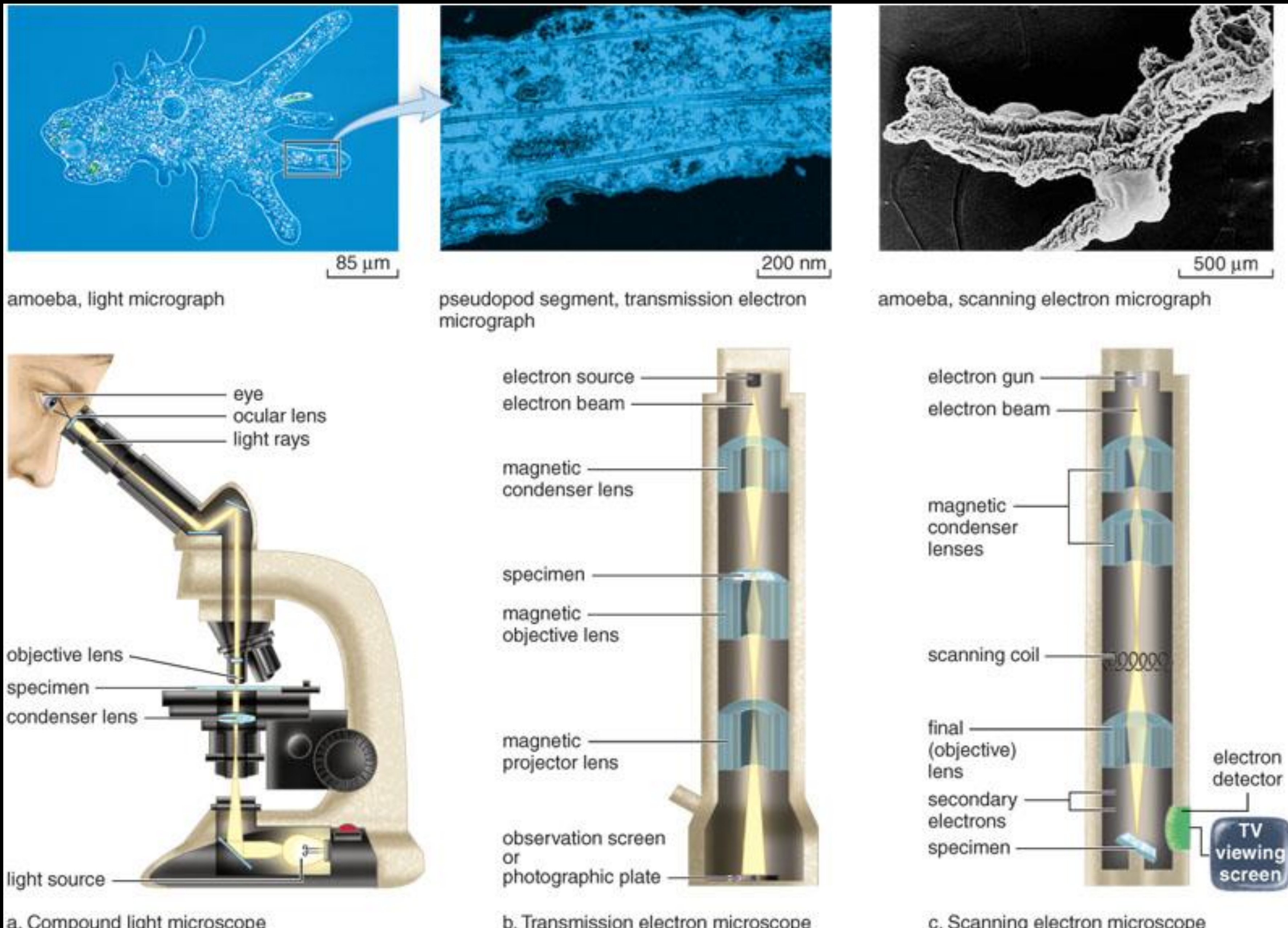


Size range of cells

- Most prokaryotes (bacteria) = 1-10μm
- Most eukaryotes = 10-100μm
- Regular light or fluorescent microscope can only resolve down to 0.2 μm
- Electron Microscope needed to see most cell organelles



Microscopy and *Amoeba proteus*



Types of Cells

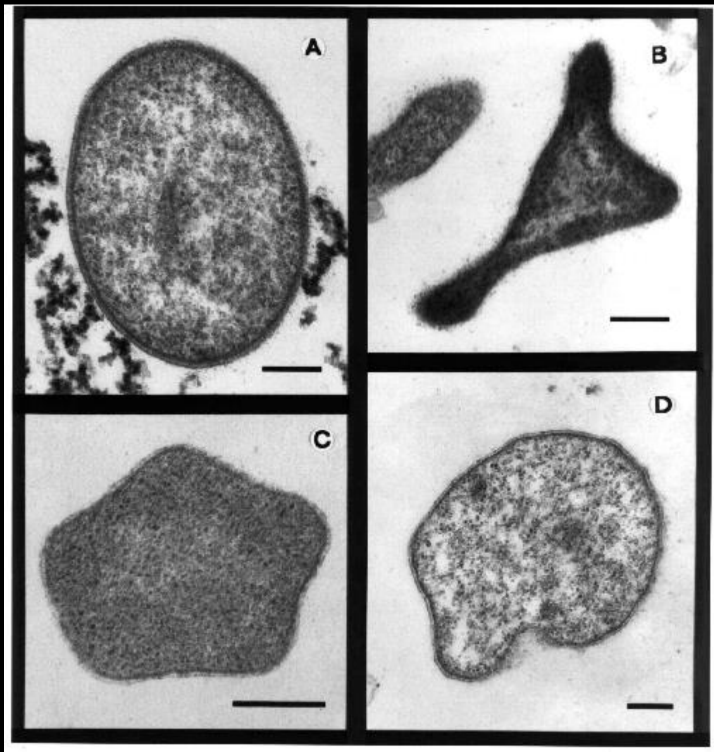
- **Prokaryotic and Eukaryotic**
  - Both have P.M. (**plasma membrane**) (lipid bilayer)
  - Both have cytosol (semifluid gel)
  - Both have chromosomes made of DNA, containing genes
  - Both have ribosomes for protein synthesis
- Eukaryotes also have:
  - Membrane-bound nucleus containing DNA
  - Other membrane-bound organelles:
    - Endoplasmic Reticulum, Golgi, mitochondria

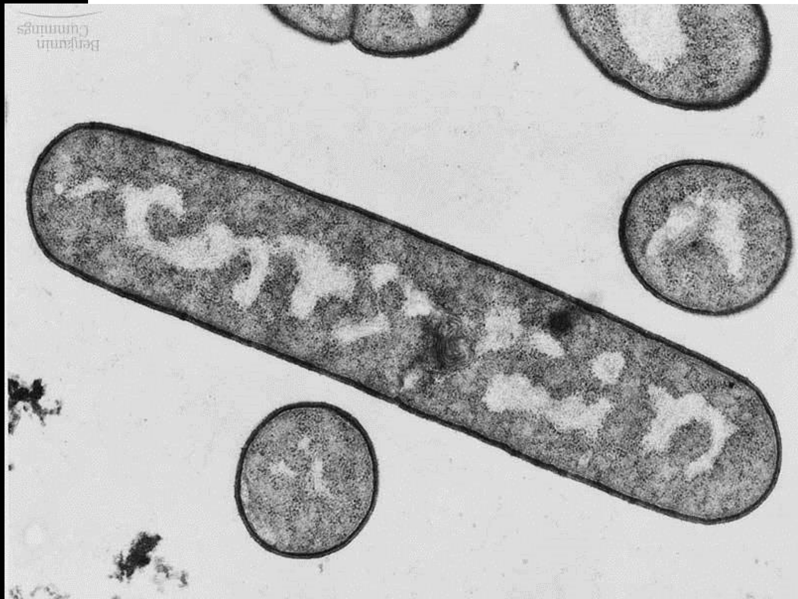
Types of Cells

5 µm

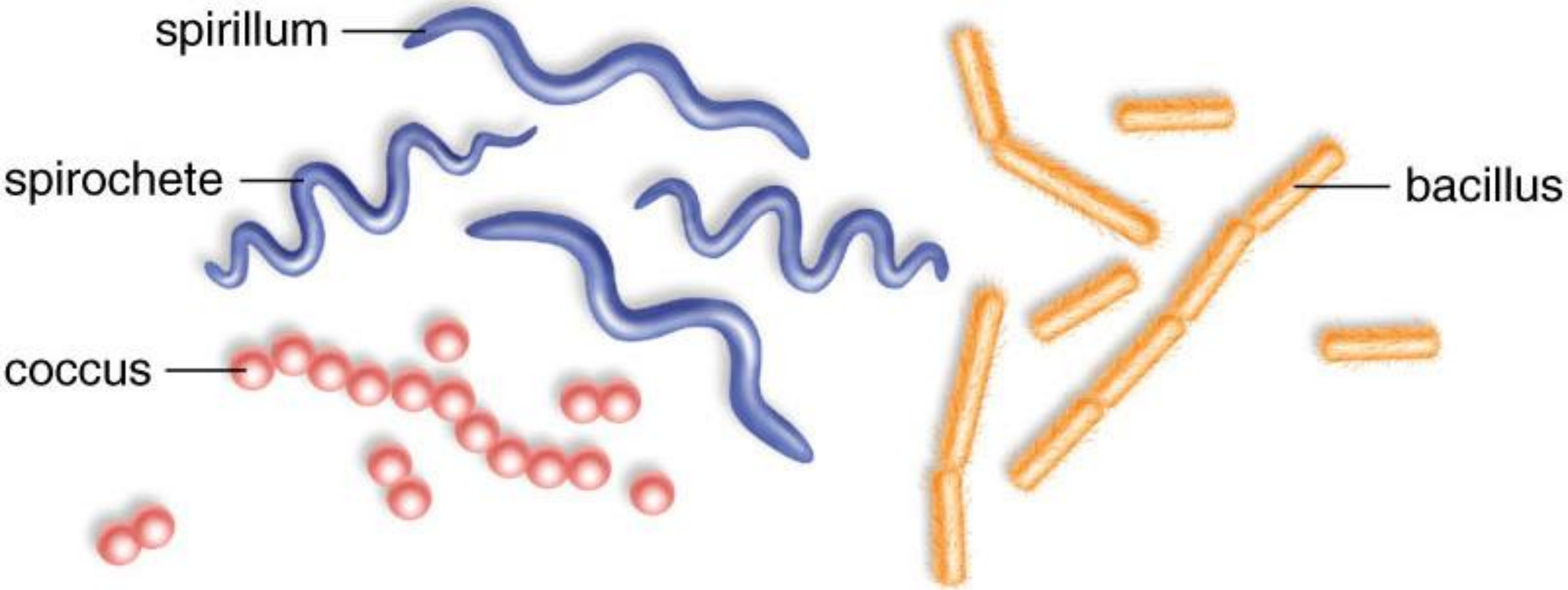
Prokaryotes

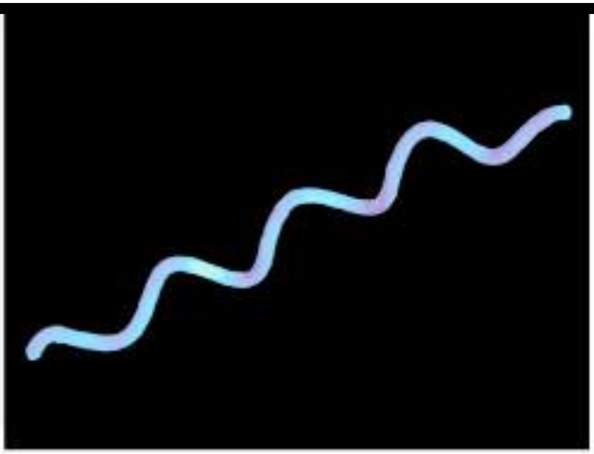
- Only **Bacteria** and **Archaea** are Prokaryotes
- These small cells **do have** organelles (just not membrane-bound ones!)
  - All have P.M. and ribosomes
  - May have cell wall, flagella, cilia, pili



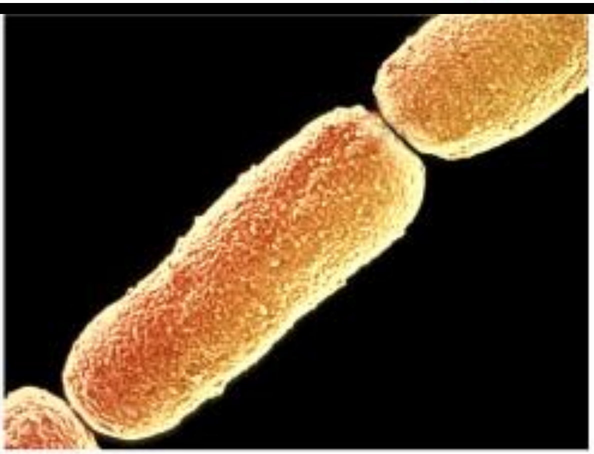


Shapes of Bacterial Cells





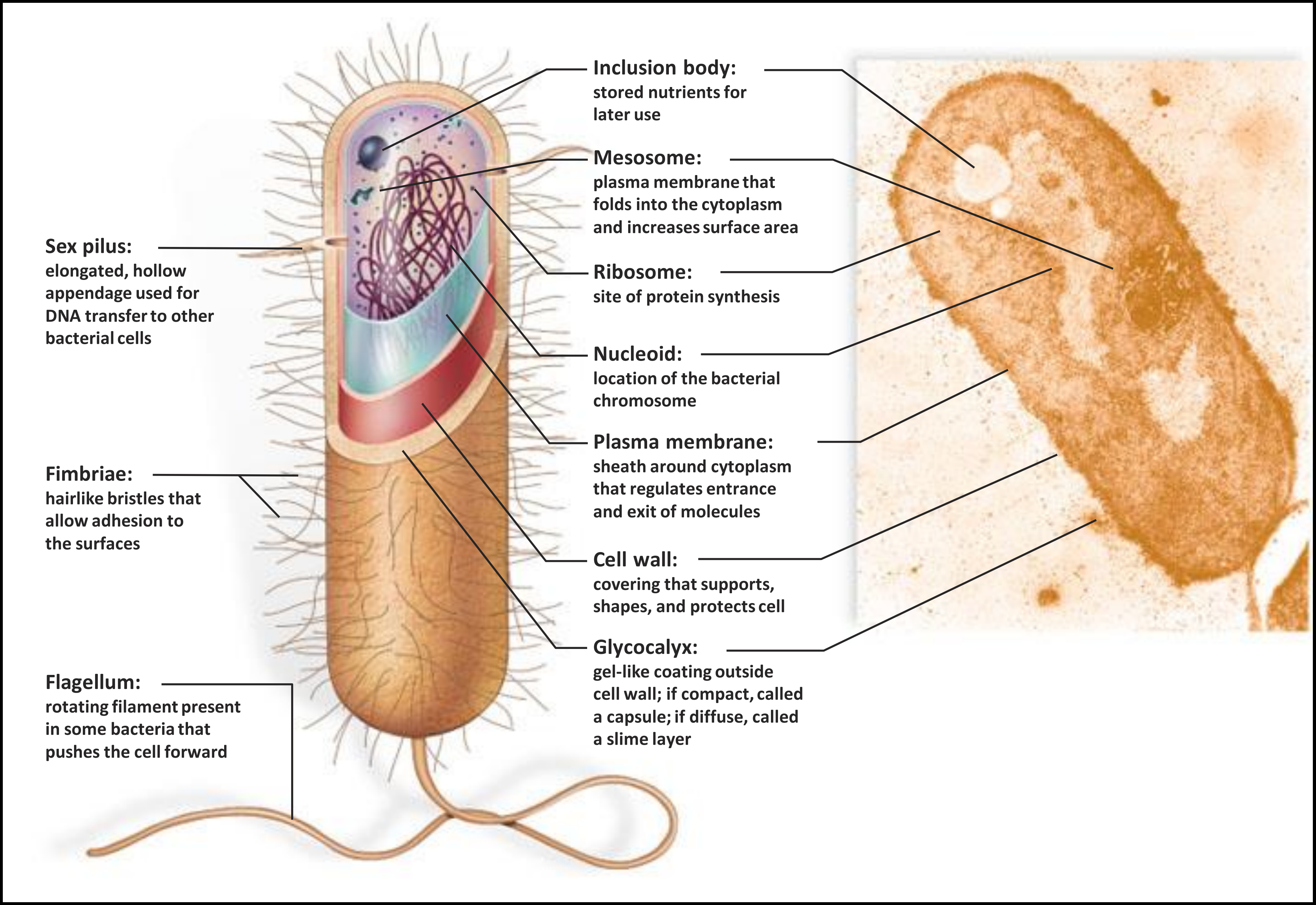
a. Spirillum: *Spirillum volutans* SEM 3,520×



b. Bacilli: *Bacillus anthracis* SEM 35,000×

c. Cocci: *Streptococcus thermophilus* SEM 6,250×

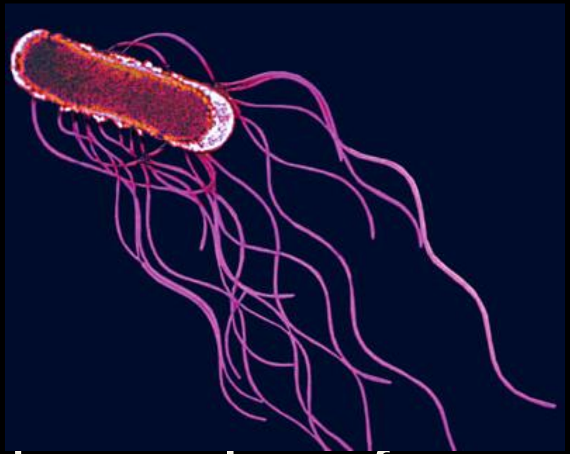
Prokaryotic Cell



Prokaryotic Cells:
The Envelope

- **Cell Envelopes**
  - **Glycocalyx**
    - Layer of **polysaccharides** outside cell wall
    - May be slimy and easily removed, or
    - Well organized and resistant to removal (capsule)
  - **Cell wall – Polysaccharide**
  - **Plasma membrane**
    - Like in eukaryotes
    - Form internal pouches (mesosomes)

Prokaryotic Cells:
Cytoplasm & Appendages

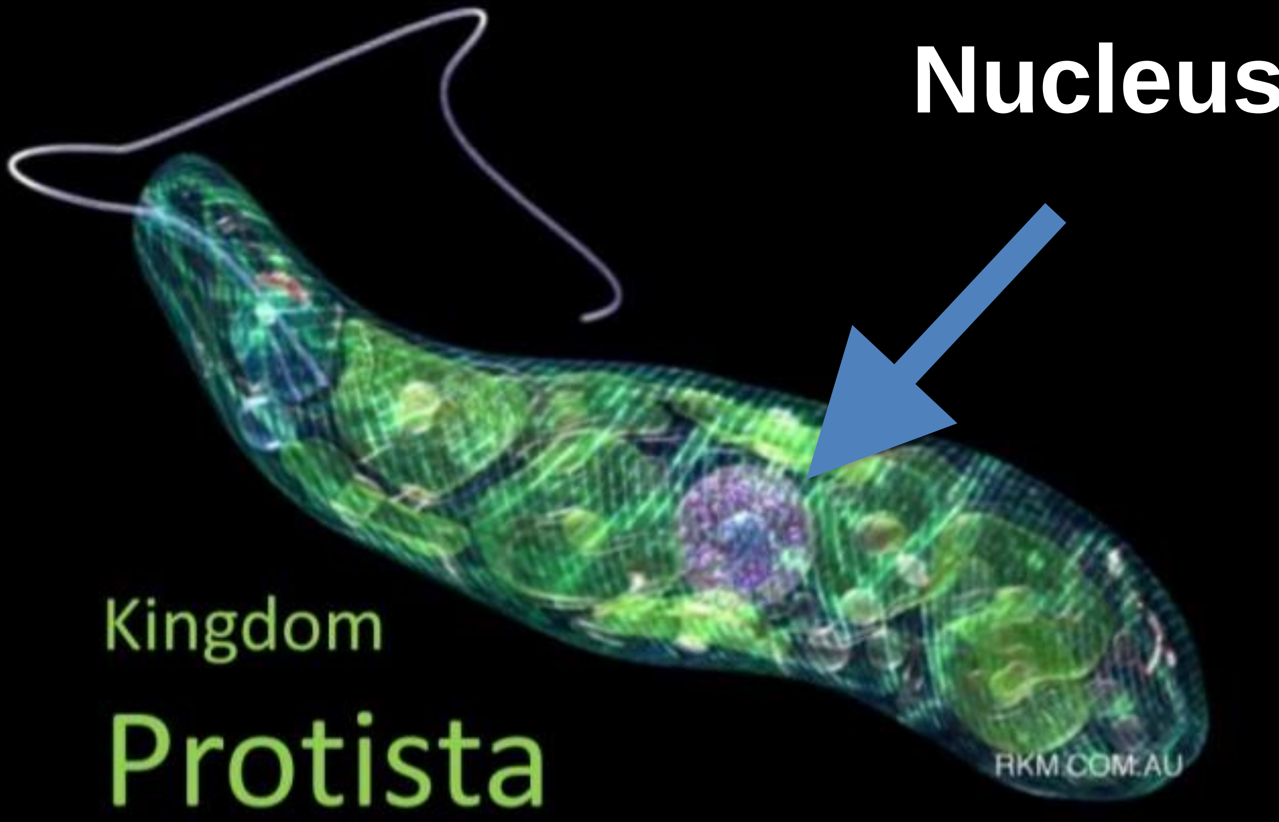


- **Cytoplasm**
  - Semifluid solution
    - Bounded by plasma membrane
    - Contains inclusion bodies – Stored granules of various substances
- **Appendages**
  - Flagella – Provide motility
  - Fimbriae – small, bristle-like fibers that sprout from the cell surface
  - Sex pili – rigid tubular structures used to pass DNA from cell to cell

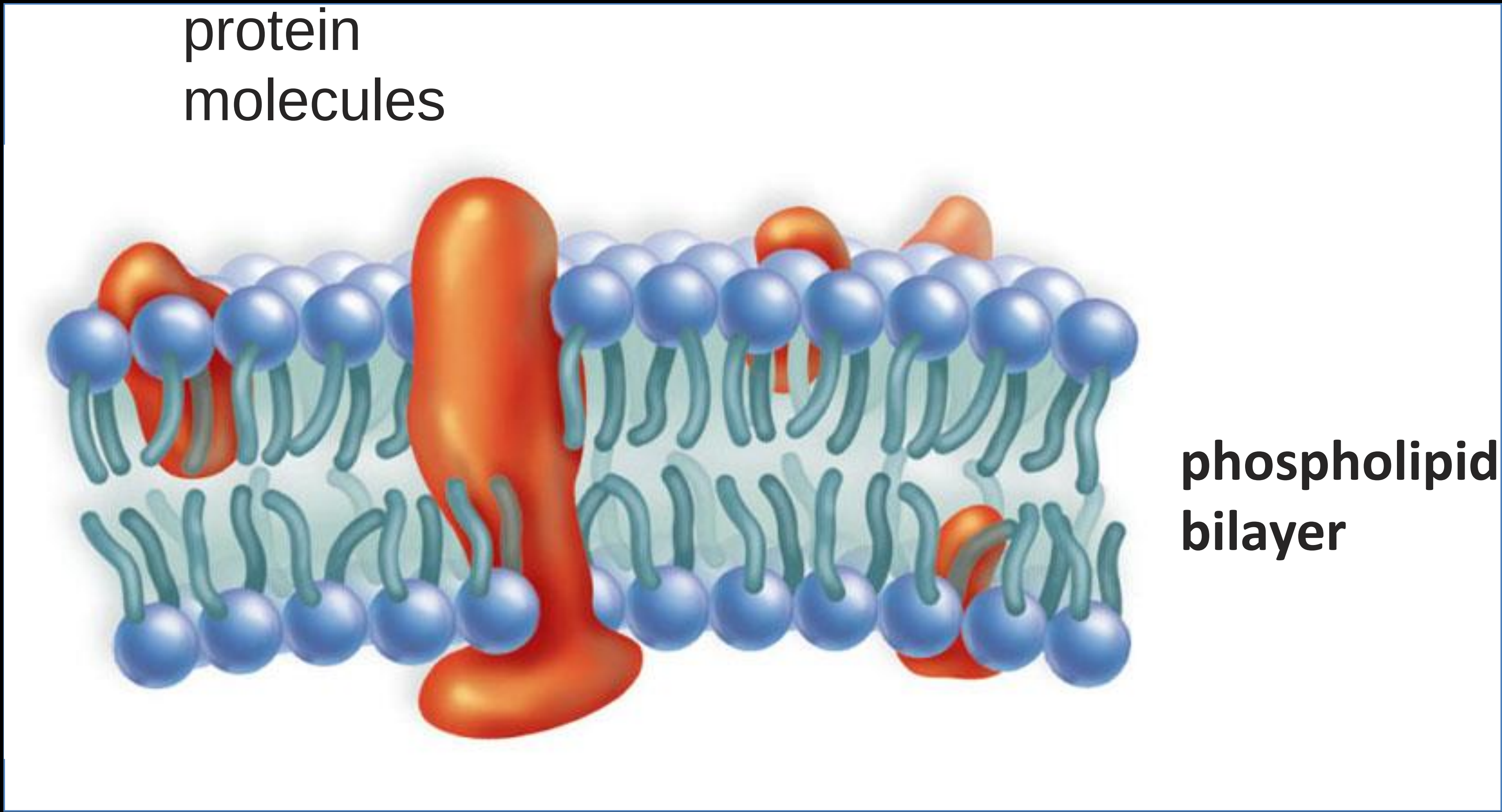
Eukaryotes: many organelles

- All Protists, Fungi, Animal, and Plant cells
- Keep chromosomes in a double-membrane **nucleus**
- Everything inside the P.M., but outside nucleus is the **cytoplasm** (cytosol + other organelles)
- All **internal membranes** are lipid bilayers (just like the P.M.)
- Membrane-bound organelles:
  - E.R., Golgi, Lysosomes, Mitochondria, Nucleus, Chloroplasts, Vacuoles, Peroxisomes,
- Non-membrane bound organelles:
  - Ribsomes, Cytoskeleton, Centrosome, Flagellum, Cilia, Cell Wall, Cell Junctions

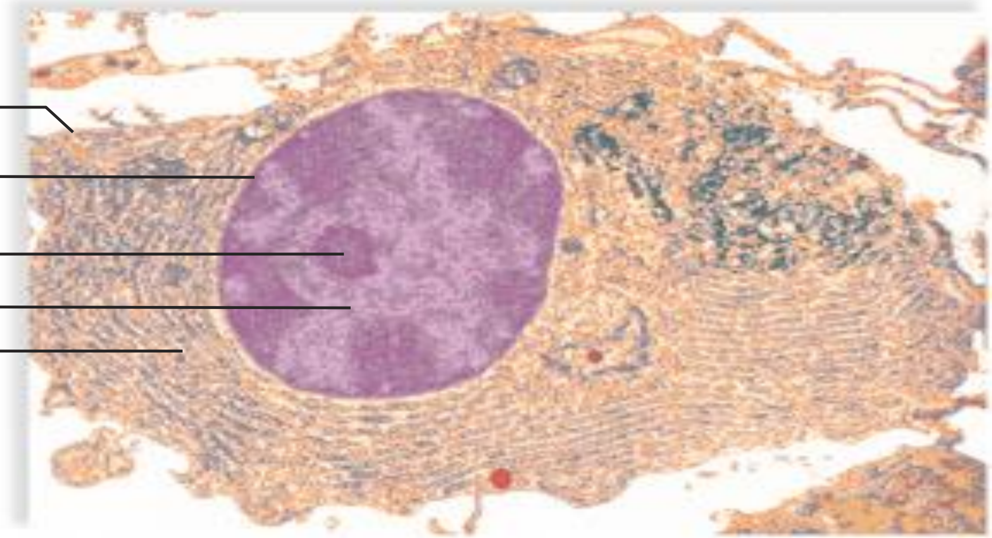
Protista are not prokaryotes

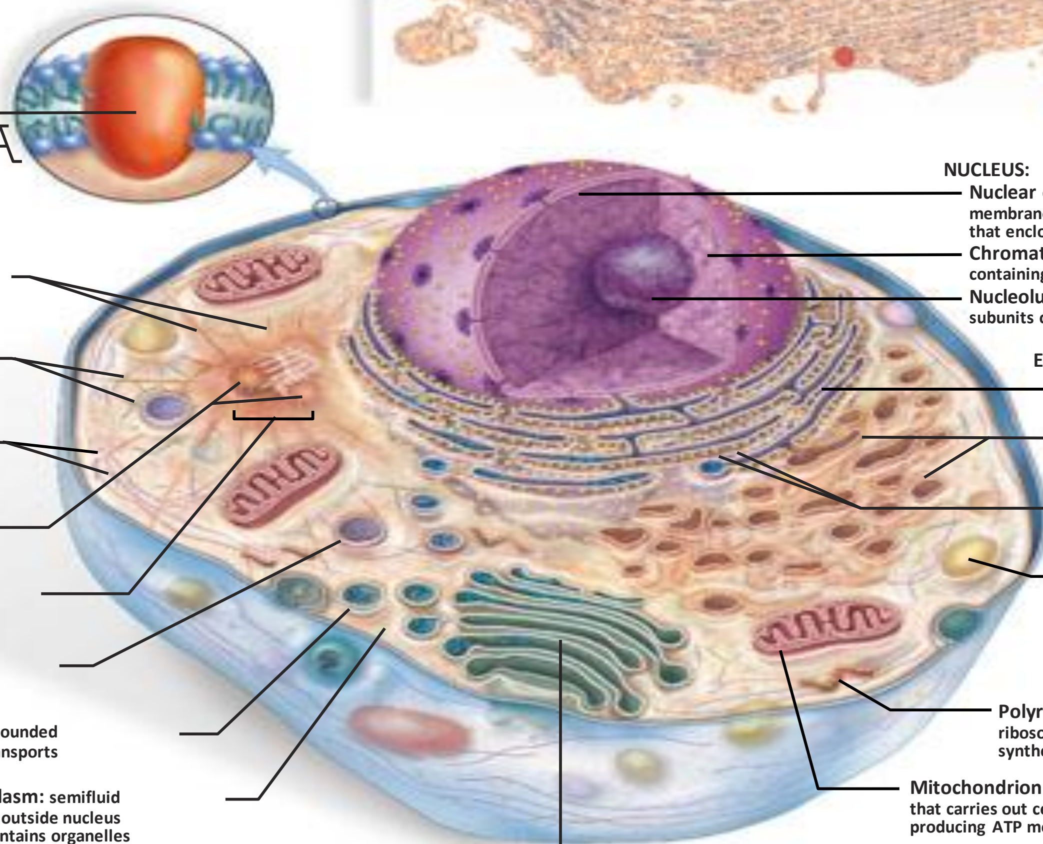


The Plasma Membrane



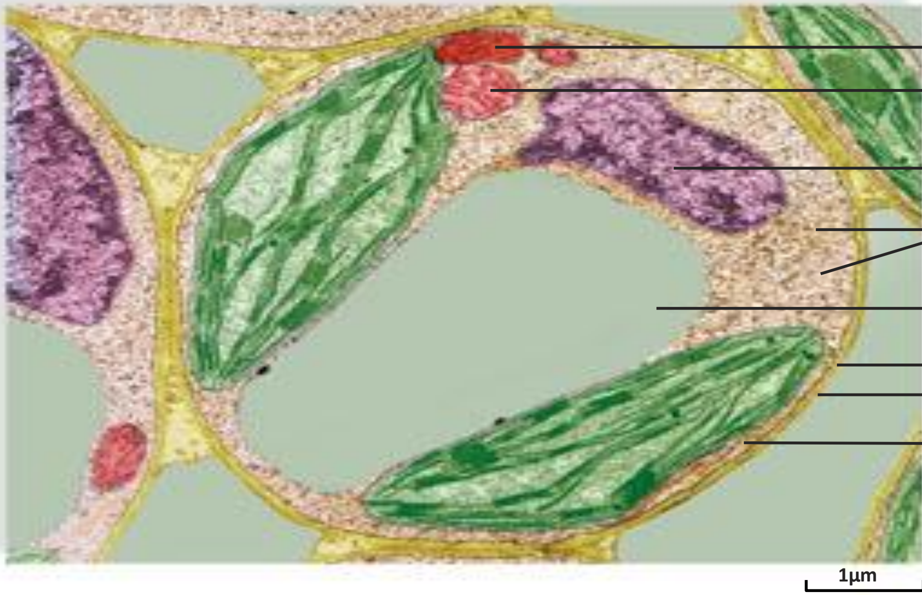
Animal Cell

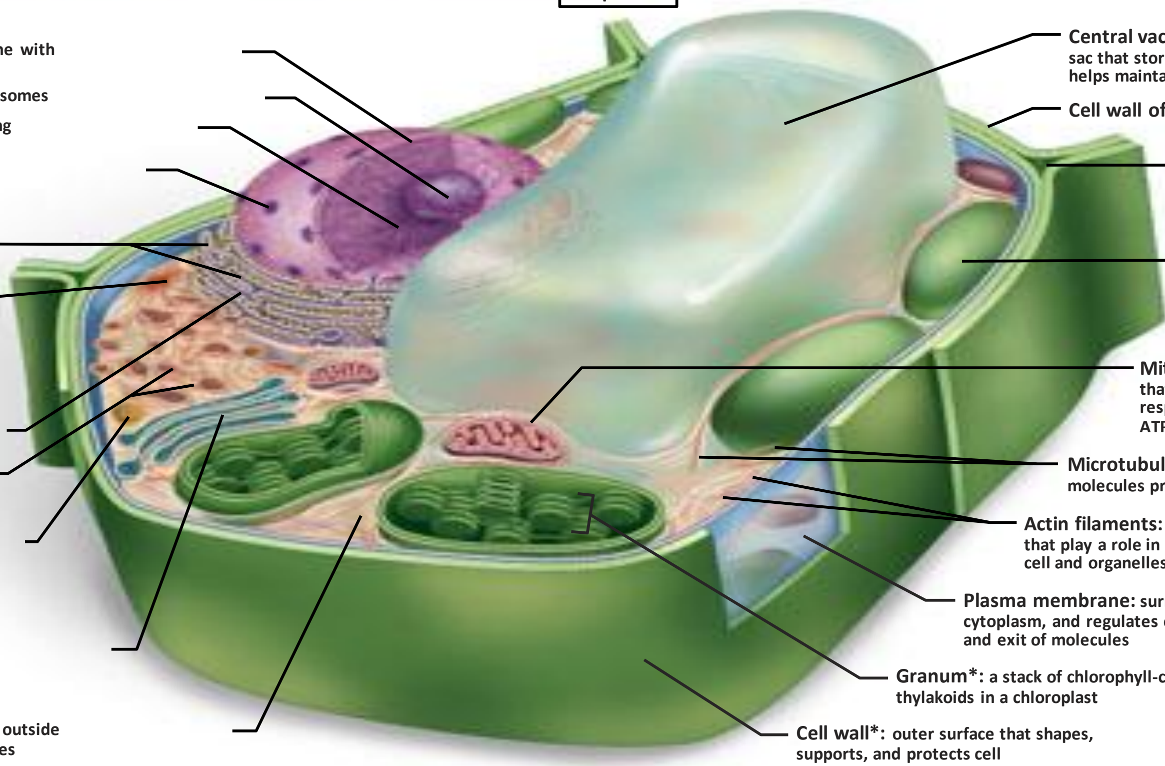




*not in plant cells

Plant Cell





*not in animal cells

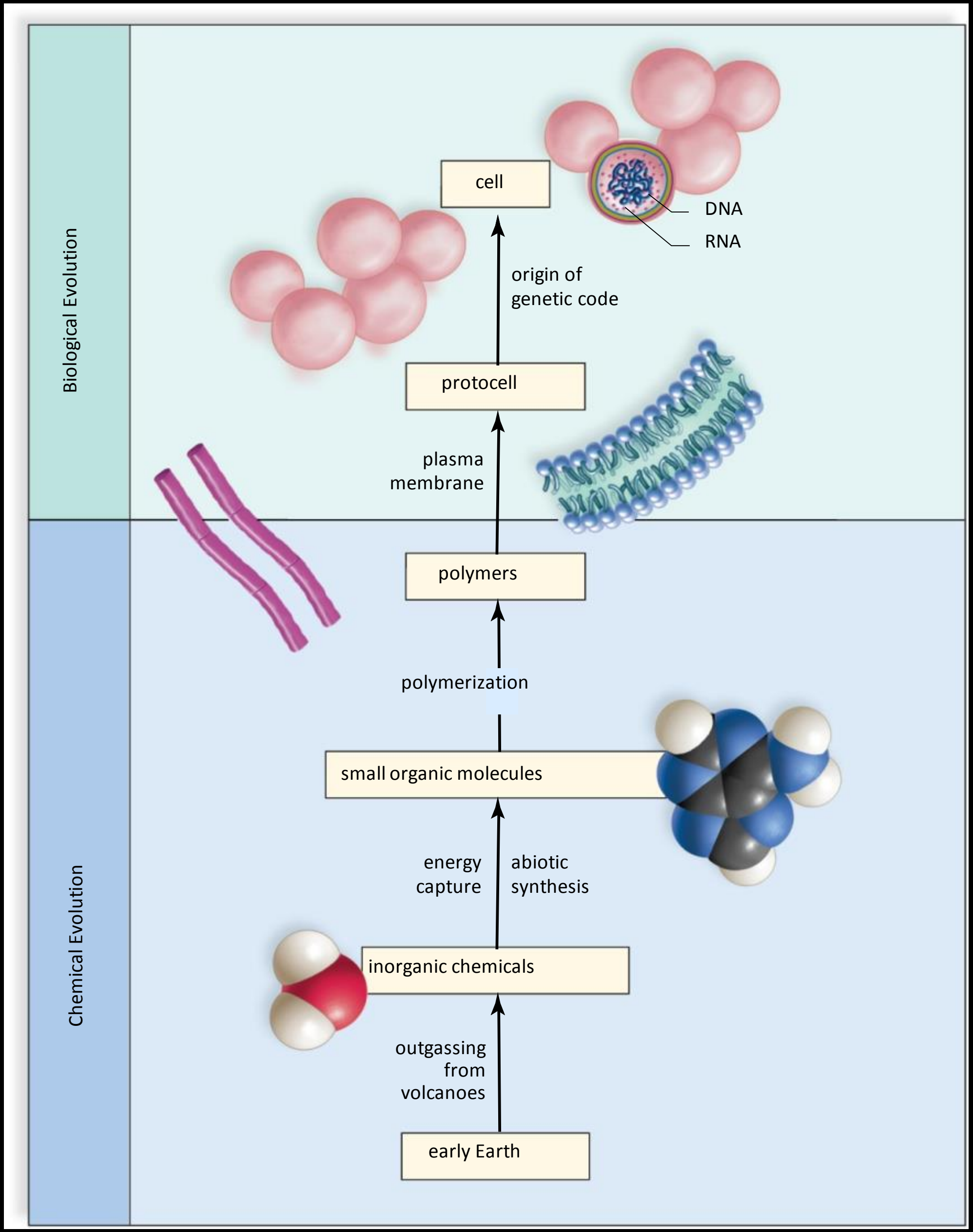
Prokaryotic and Eukaryotic

TABLE 4.1

Comparison of Prokaryotic Cells and Eukaryotic Cells

	Prokaryotic Cells	*Eukaryotic Cells*	
		Animal	*Plant*
Size	*Smaller (1–20 μm in diameter)*	*Larger (10–100 μm in diameter)*	
Cell wall	Usually (peptidoglycan)	No	Yes (cellulose)
Plasma membrane	Yes	Yes	Yes
Nucleus	No	Yes	Yes
Nucleolus	No	Yes	Yes
Ribosomes	Yes (smaller)	Yes	Yes
Endoplasmic reticulum	No	Yes	Yes
Golgi apparatus	No	Yes	Yes
Lysosomes	No	Yes	No
Mitochondria	No	Yes	Yes
Chloroplasts	No	No	Yes
Peroxisomes	No	Usually	Usually
Cytoskeleton	No	Yes	Yes
Centrioles	No	Yes	No
9 + 2 cilia or flagella	No	Often	No (in flowering plants) Yes (sperm of bryophytes, ferns, ar

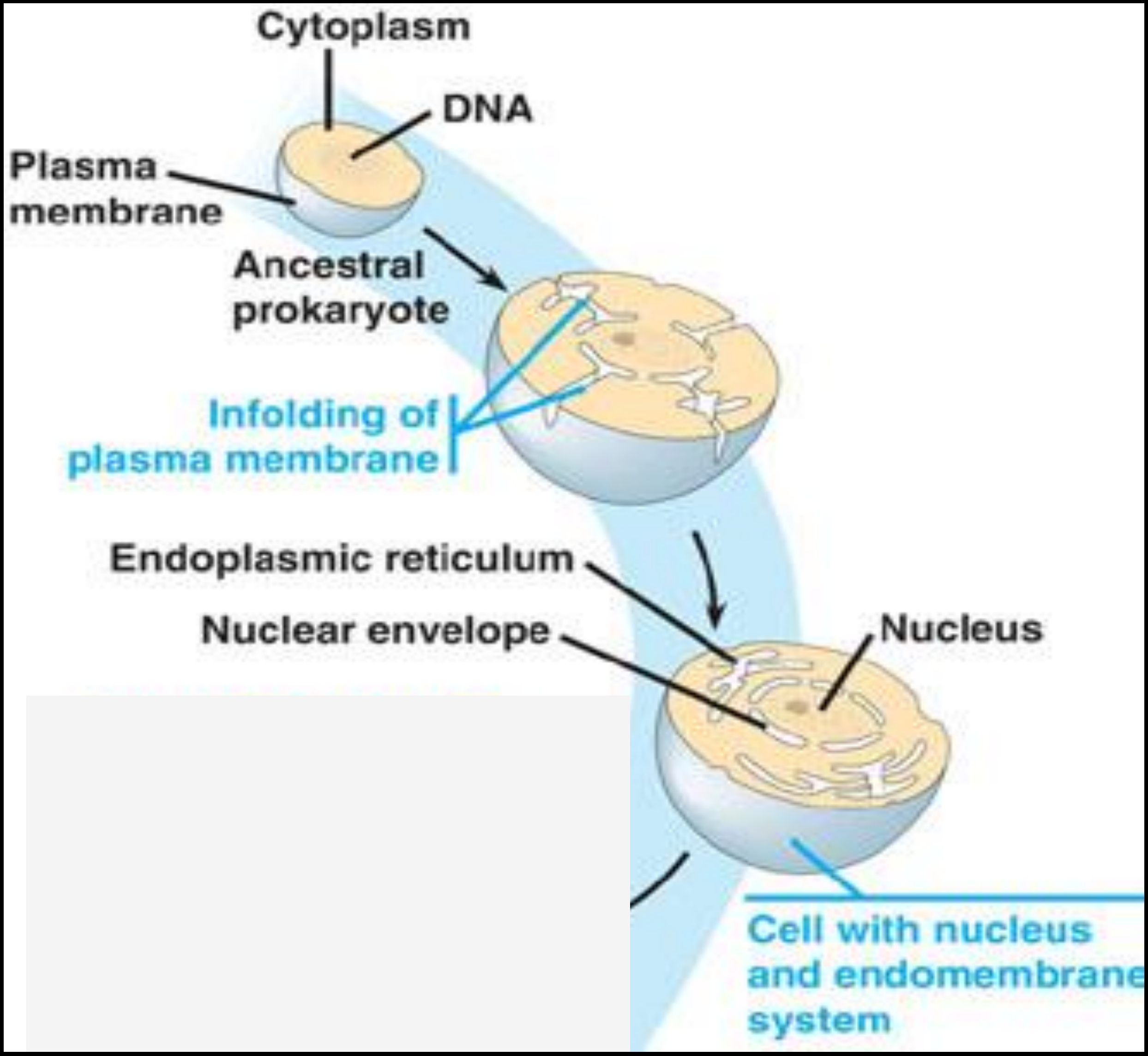
Origin of the First Cell(s)



The emergence of Eukaryotes
the Endomembranes

- As the prokaryotes were growing larger, infoldings of the plasma membrane developed (probably as a site for electron transport and H^+ pumping/gradients)
- These infoldings separated from the plasma membrane entirely and gave rise to the **Endoplasmic Reticulum**
- Parts of the ER could then develop into the **Golgi, lysosomes, and the nuclear envelope**
- The packaging of the DNA inside the nuclear envelope protected it from damage by cytosolic chemical reactions

The emergence of Eukaryotes – the Endomembranes

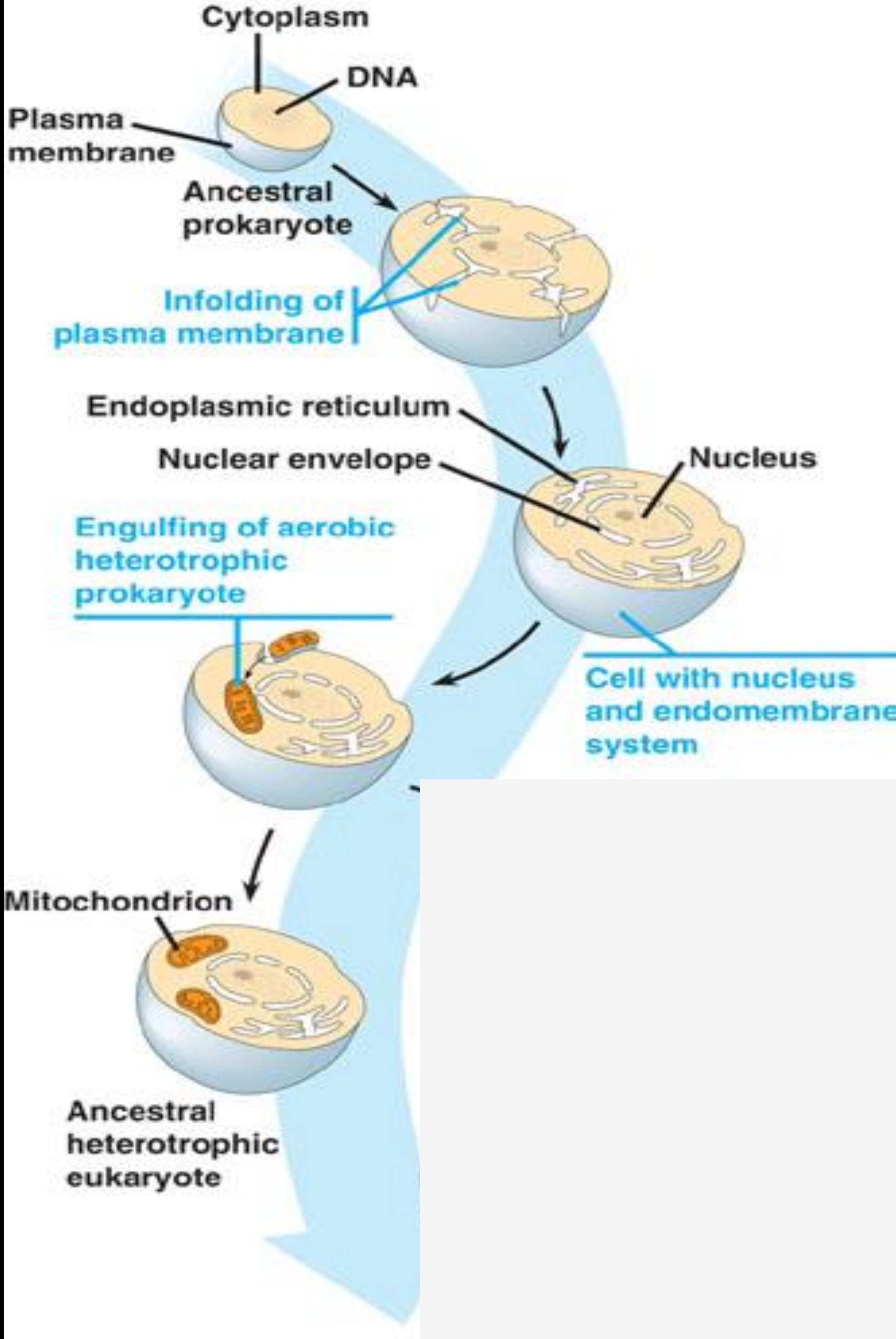


The emergence of Eukaryotes
the mitochondrion

- After O_2 appeared, prokaryotes that were able to utilize O_2 as an e^- acceptor quickly evolved
- At one point, a smaller aerobe was engulfed by (or was a parasite of) a larger <u>an</u>aerobe
- The relationship turned into a mutually beneficial **<u>symbiosis</u>**
- To this day, mito replicate independently and have some of their own DNA, tRNA, ribosomes, proteins, etc.

The emergence of Eukarytotes – **the mitochondrion**

A model for the origin of Eukaryotes through serial **endosymbiosis**

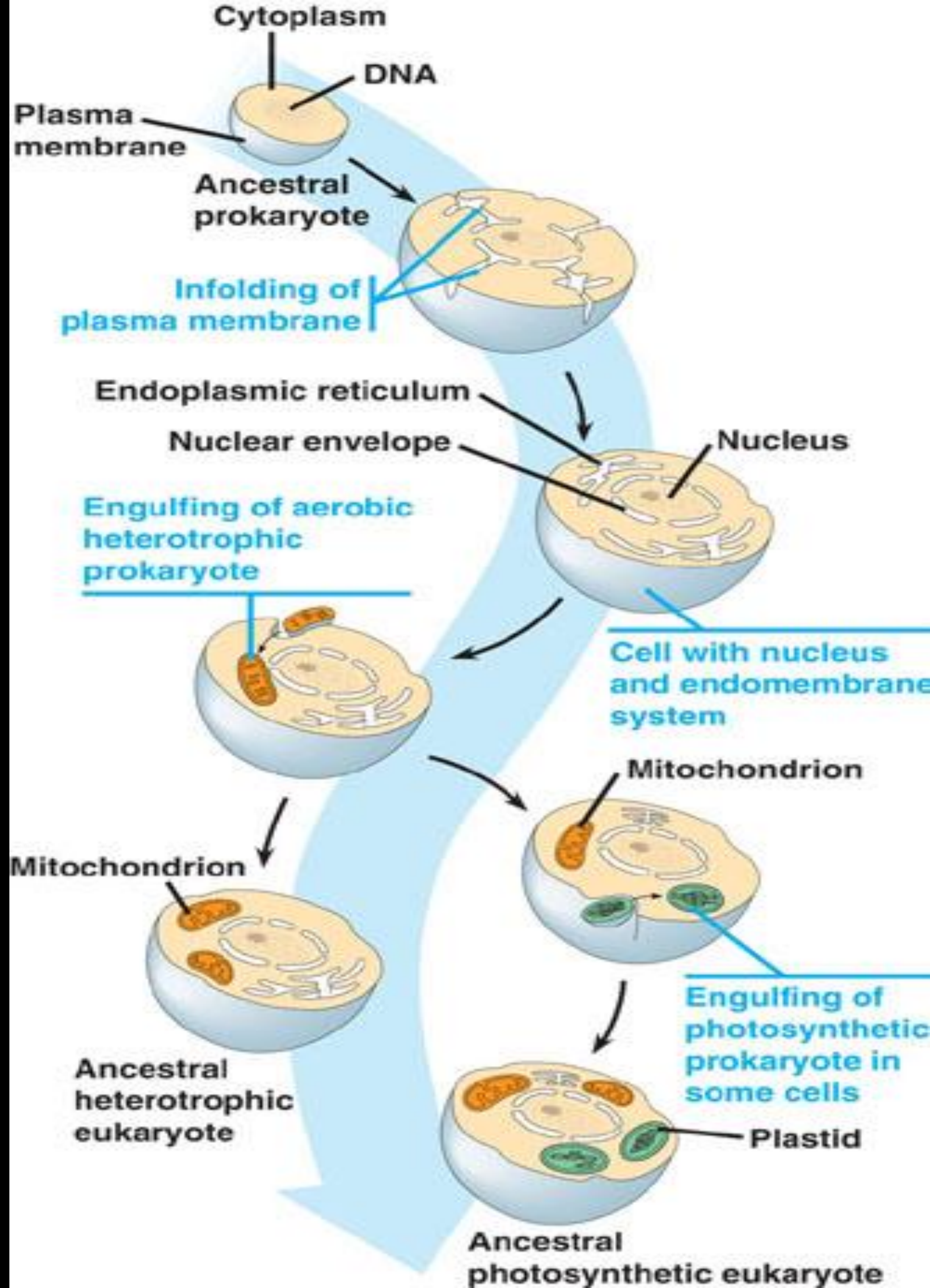


The emergence of Eukaryotes
the chloroplast

- At first, the buildup of O_2 in the oceans was very slow. Then it increased very suddenly causing the Oxygen Revolution:
  - This was probably caused by the incorporation of one photosynthetic prokaryote inside another prokaryote… thereby evolving into…
  - THE CHLOROPLAST!!! An organelle totally dedicated to photosynthesis, generates ***lots*** of O_2
- Chloroplasts, like mito, replicate independently and have some of their own DNA, RNA, ribosomes

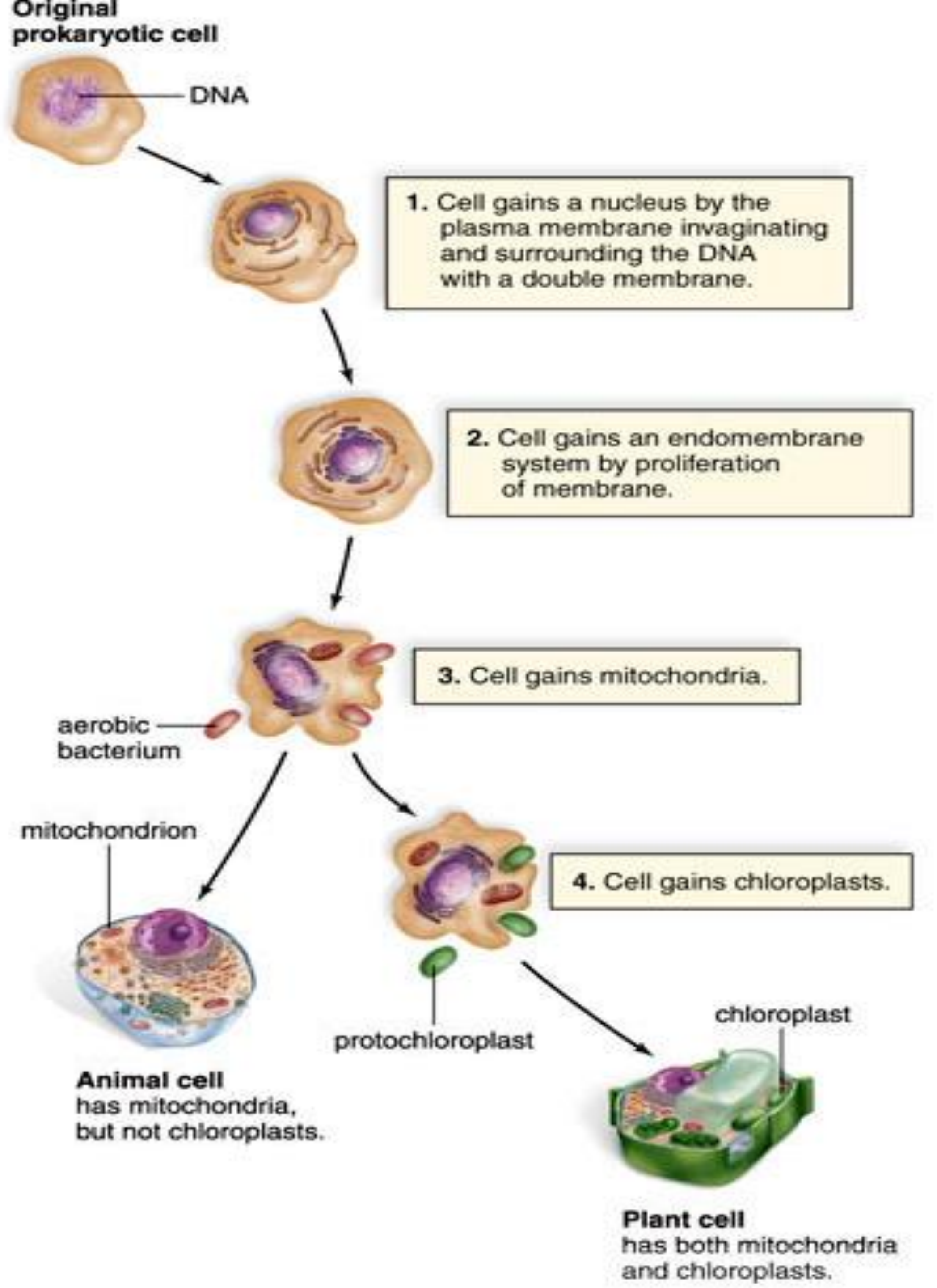
The emergence of Eukaryotes – **the chloroplast**

A model for the origin of Eukaryotes through serial **endosymbiosis**



Acquisition of Organelles

A model for the origin of Eukaryotes through serial **endosymbiosis**



Multicellularity

- A single cell is the common ancestor of all Eukaryotes, but not all Eukaryotes are multicellular
- Therefore, Scientists believe that multicellularity must have evolved multiple separate times.
  - Once for animals, once for plants, once for fungi, once for algae, etc.

A colonial Eukaryote

Eukaryote Evolution

- **About 1.8 bya**
  - Most aerobic
  - Contains nucleus as well as other membranous organelles
- **Endosymbiotic Hypothesis**
  - Mitochondria were probably once free-living aerobic prokaryotes.
  - Chloroplasts were probably once free-living photosynthetic prokaryotes.
  - A nucleated cell probably engulfed these prokaryotes that became various organelles.
- **Multicellularity** arises (about 1.4 bya)

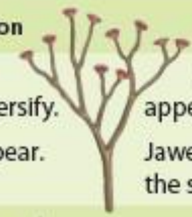
Paleozoic and Precambrian Time Eras

TABLE 18.1

The Geologic Timescale: Major Divisions of Geologic Time and Some of the Major Evolutionary Events of Each Time Period

			Mass Extinction	
Paleozoic	Permian	(299–251)	Gymnosperms diversify.	Reptiles diversify; amphibians decline.
	Carboniferous	(359.2–299)	Age of great coal-forming forests; ferns, club mosses, and horsetails flourish.	Amphibians diversify; first reptiles appear; first great radiation of insects.
			Mass Extinction	
	Devonian	(416–359.2)	First seed plants appear. Seedless vascular plants diversify.	First insects and first amphibians appear on land.
	Silurian	(443.7–416)	Seedless vascular plants appear.	Jawed fishes diversify and dominate the seas.
			Mass Extinction	
	Ordovician	(488.3–443.7)	Nonvascular land plants appear on land.	First jawless and then jawed fishes appear.
	Cambrian	(542–488.3)	Marine algae flourish.	All invertebrate phyla present; first chordates appear.
Precambrian Time		630	Soft-bodied invertebrates	
		1,000	Protists diversify.	
		2,100	First eukaryotic cells	
		2,700	O_2 accumulates in atmosphere.	
		3,500	First prokaryotic cells	
		4,570	Earth forms.	






Cenozoic and Mesozoic Eras

TABLE 18.1

The Geologic Timescale: Major Divisions of Geologic Time and Some of the Major Evolutionary Events of Each Time Period

Era	*Period*	*Epoch*	*Millions of Years Ago (MYA)*	*Plant Life*	*Animal Life*
Cenozoic*	Quaternary	Holocene	(0.01–0)	Human influence on plant life	Age of *Homo sapiens*
				Significant Mammalian Extinction	
		Pleistocene	(1.80–0.01)	Herbaceous plants spread and diversify.	Presence of Ice Age mammals. Modern humans appear.
	Tertiary	Pliocene	(5.33–1.80)	Herbaceous angiosperms flourish.	First hominids appear.
		Miocene	(23.03–5.33)	Grasslands spread as forests contract.	Apelike mammals and grazing mammals flourish; insects flourish.
		Oligocene	(33.9–23.03)	Many modern families of flowering plants evolve.	Browsing mammals and monkeylike primates appear.
		Eocene	(55.8–33.9)	Subtropical forests with heavy rainfall thrive.	All modern orders of mammals are represented.
		Paleocene	(65.5–55.8)	Flowering plants continue to diversify.	Primitive primates, herbivores, carnivores, and insectivores appear.
				Mass Extinction: Dinosaurs and Most Reptiles	
Mesozoic	Cretaceous		(145.5–65.5)	Flowering plants spread; conifers persist.	Placental mammals appear; modern insect groups appear.
	Jurassic		(199.6–145.5)	Flowering plants appear.	Dinosaurs flourish; birds appear.
				Mass Extinction	
	Triassic		(251–199.6)	Forests of conifers and cycads dominate.	First mammals appear; first dinosaurs appear; corals and molluscs dominate seas.