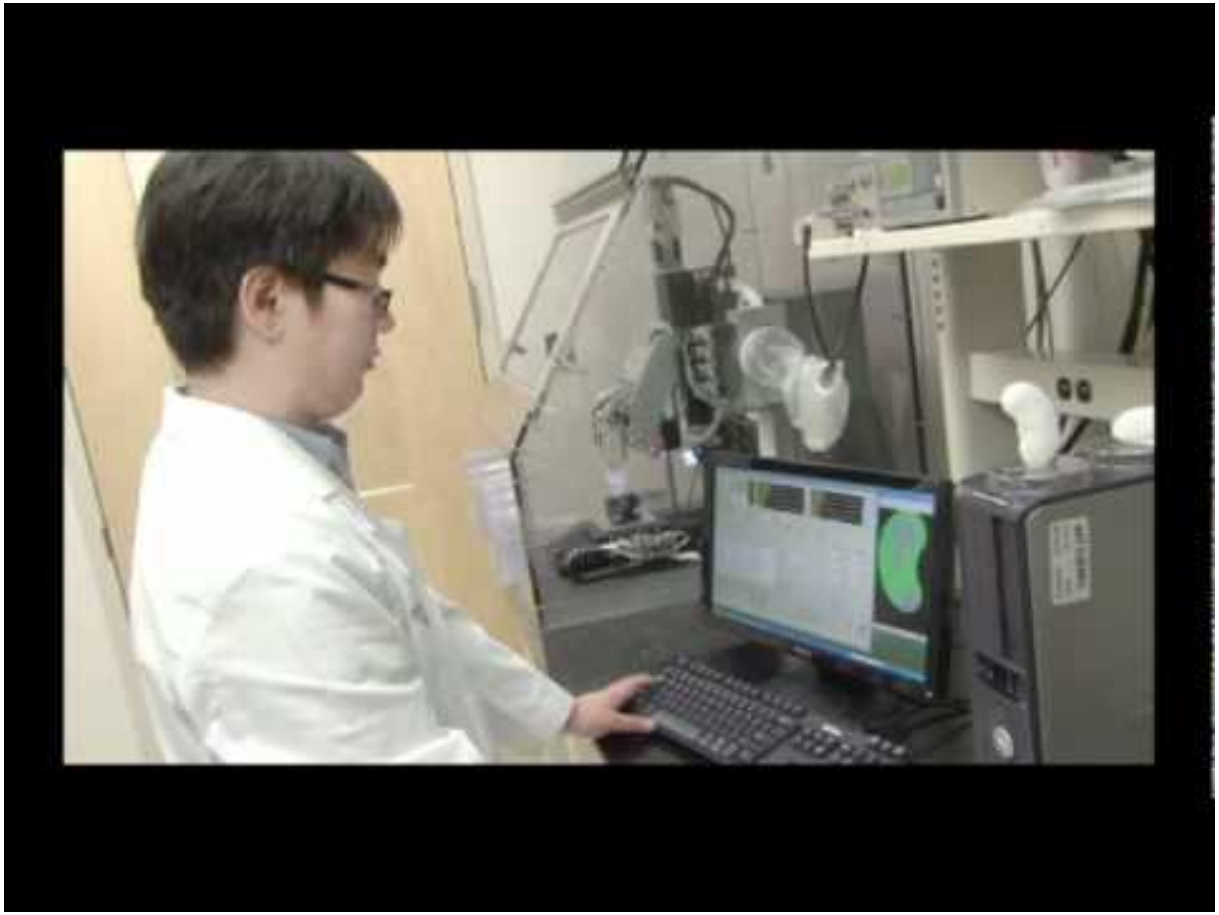
CHAPTER 3: CELLS

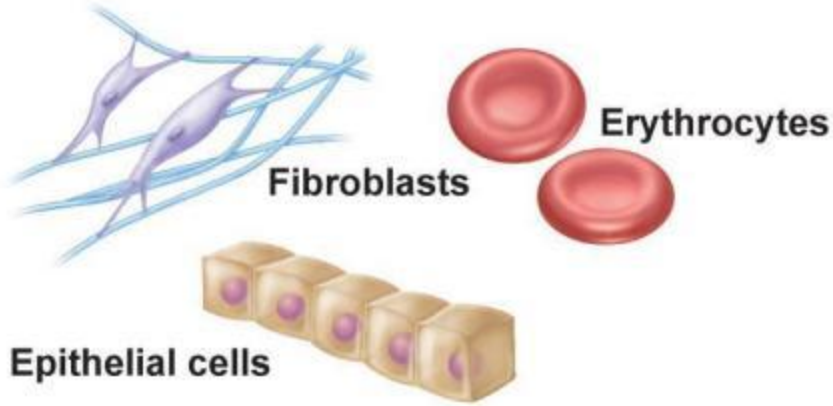
HAP in the news



HUMAN CELLS

- Basic unit of structure & function
- 200 different cell types
- Made of C, O, H, N + trace elements
- 3 main parts:
  1. Plasma membrane
  2. Cytoplasm
  3. Nucleus

CELL DIVERSITY



(a) Cells that connect body parts, form linings, or transport gases

(b) Cells that move organs and body parts

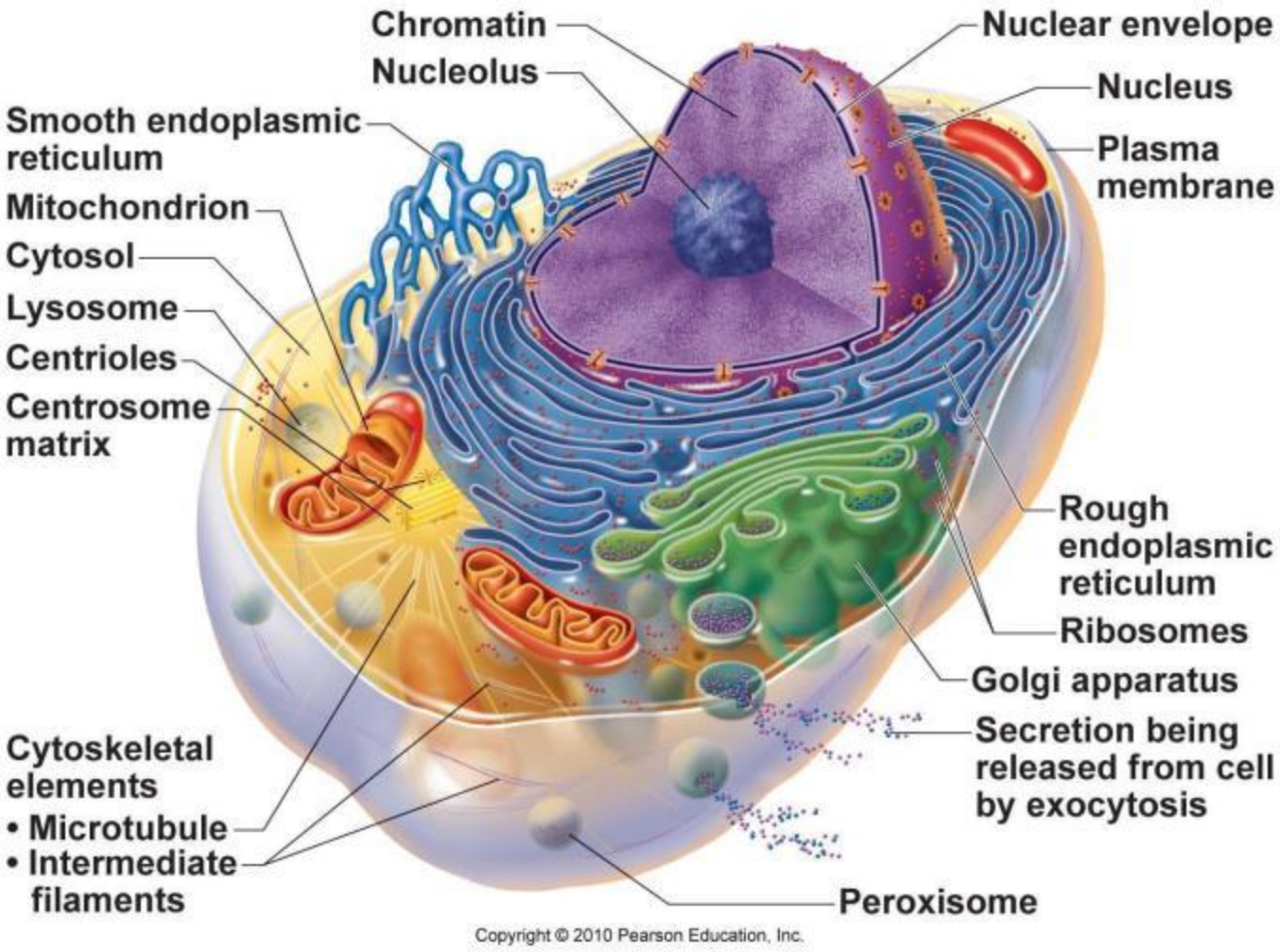
(c) Cell that stores nutrients

(d) Cell that fights disease

(e) Cell that gathers information and controls body functions

(f) Cell of reproduction

CELL STRUCTURE

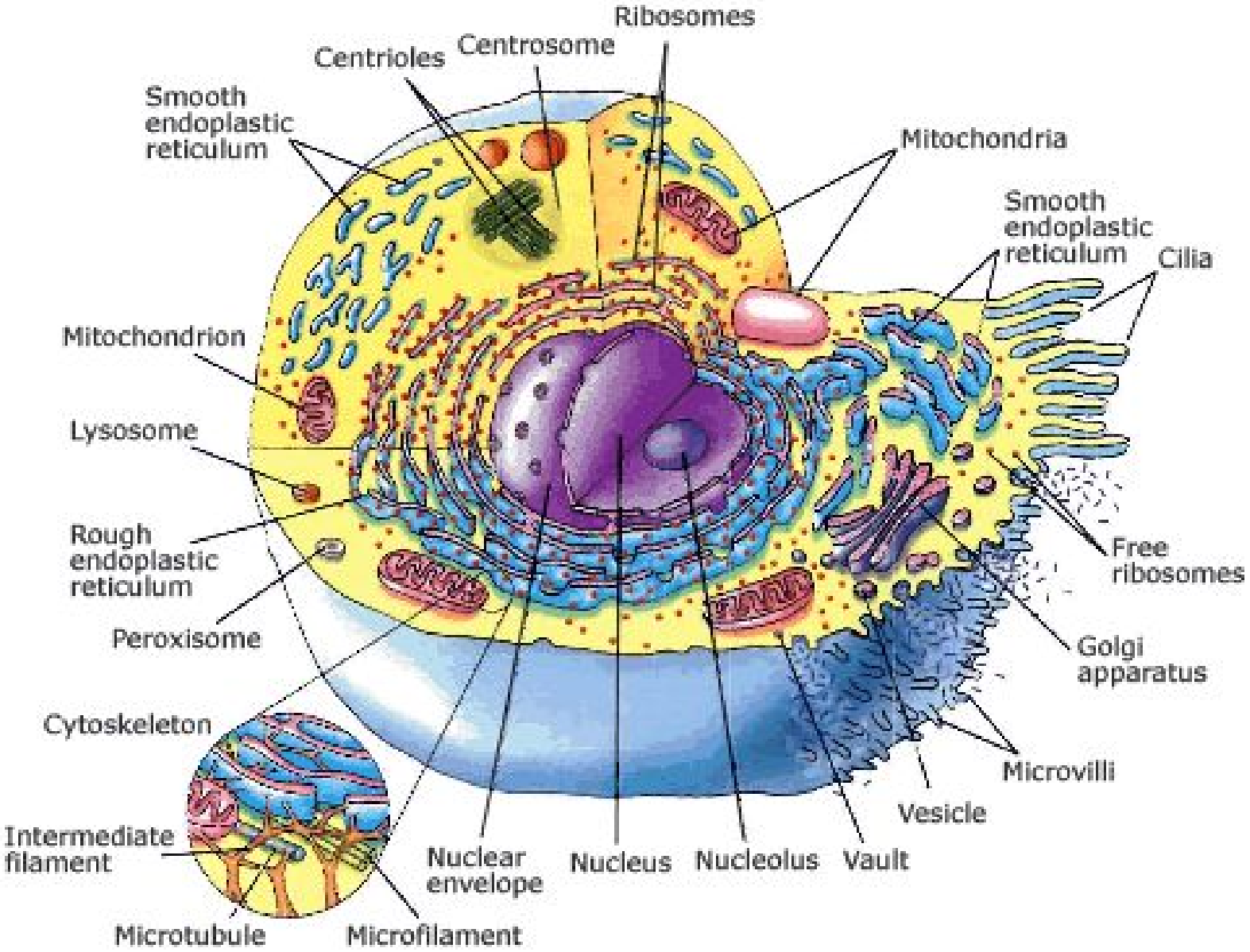


CYTOPLASM

- Between plasma membrane & nucleus
- Three elements:
  - Cytosol: fluid
    - Eg. water, proteins, salts, sugars
  - Inclusions: chemical substances that vary depending on cell type
    - Eg. glycogen (liver), lipid droplets (fat cells), melanin (skin & hair)
  - Organelles: specific functions

ORGANELLES

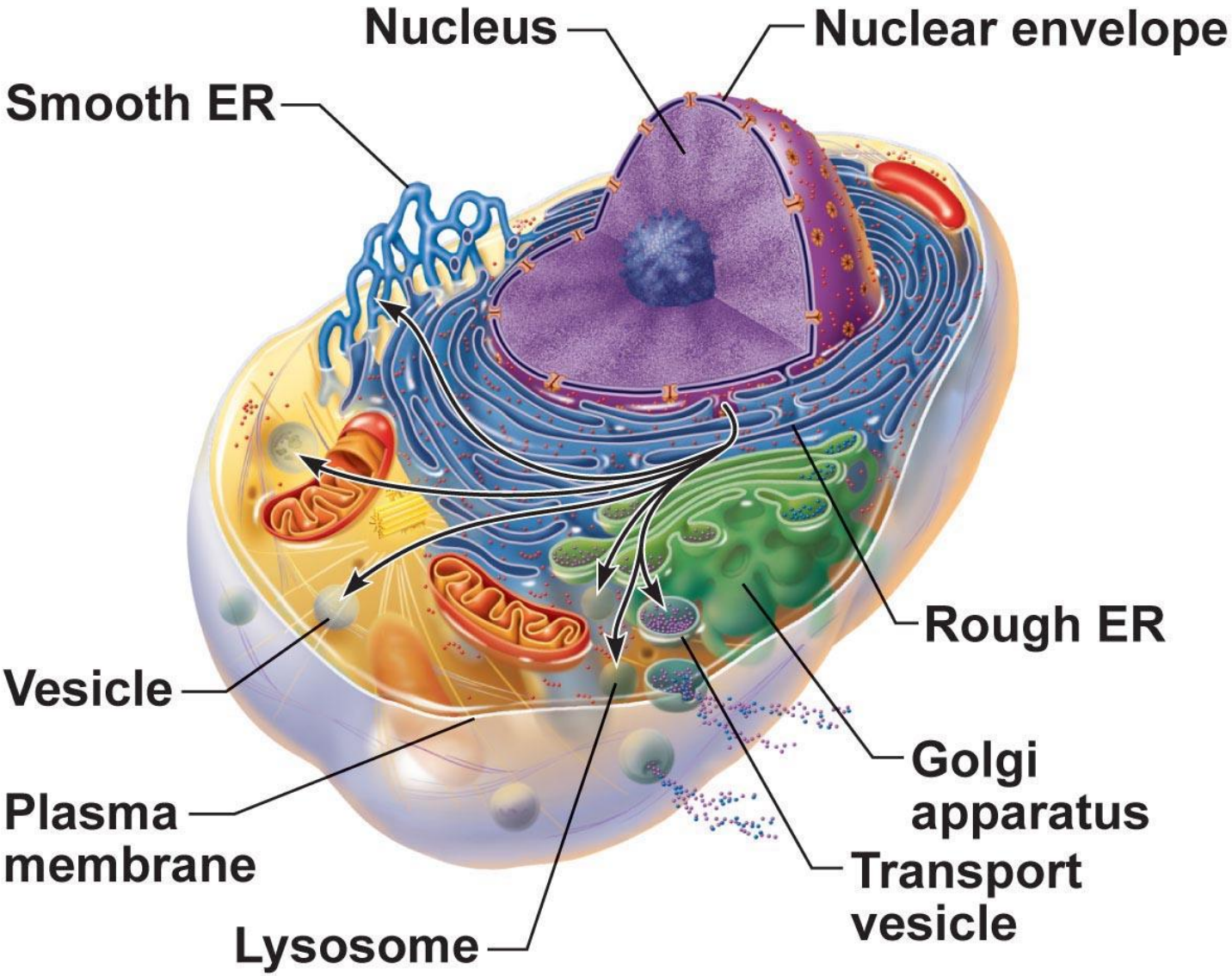
- “little organs”
- Specialized compartments → specific functions
- Membranous = membrane-bound
  - Mitochondria, peroxisomes, lysosomes, ER, Golgi apparatus
- Nonmembranous = no membrane
  - cytoskeleton, centrioles, ribosomes


Ribosomes
Centrioles
Centrosome
Smooth endoplastic reticulum
Mitochondria
Smooth endoplastic reticulum
Cilia
Mitochondrion
Lysosome
Rough endoplastic reticulum
Free ribosomes
Peroxisome
Golgi apparatus
Cytoskeleton
Microvilli
Vesicle
Intermediate filament
Nuclear envelope
Nucleus
Nucleolus
Vault
Microtubule
Microfilament

ENDOMEMBRANE SYSTEM

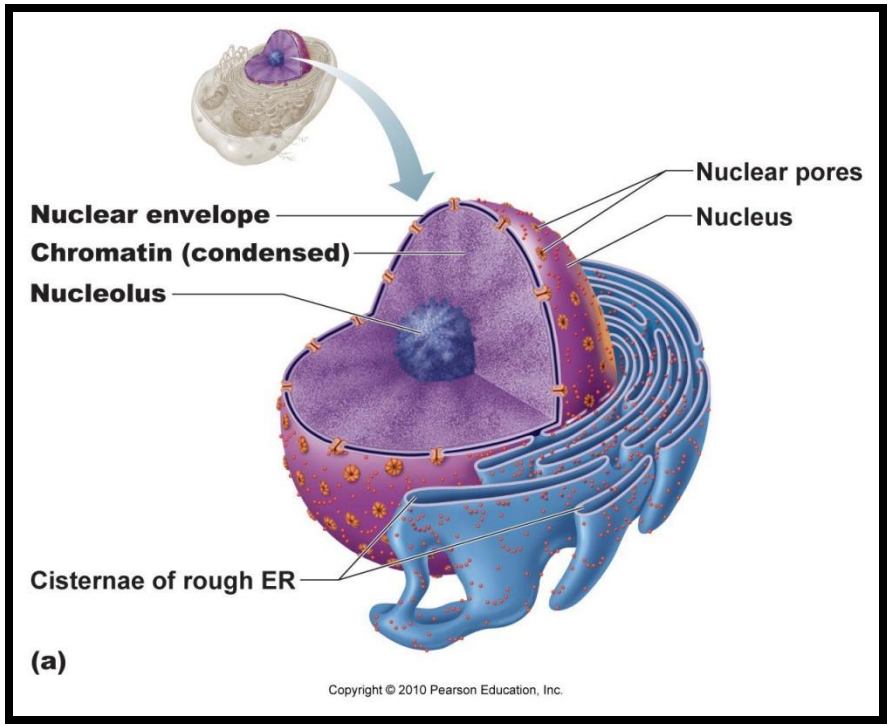
- System of organelles that work to
  1. Produce, store, export biological molecules
  2. Degrade harmful substances
- Nuclear envelope, rough ER, smooth ER, Golgi apparatus, secretory vesicles, lysosomes

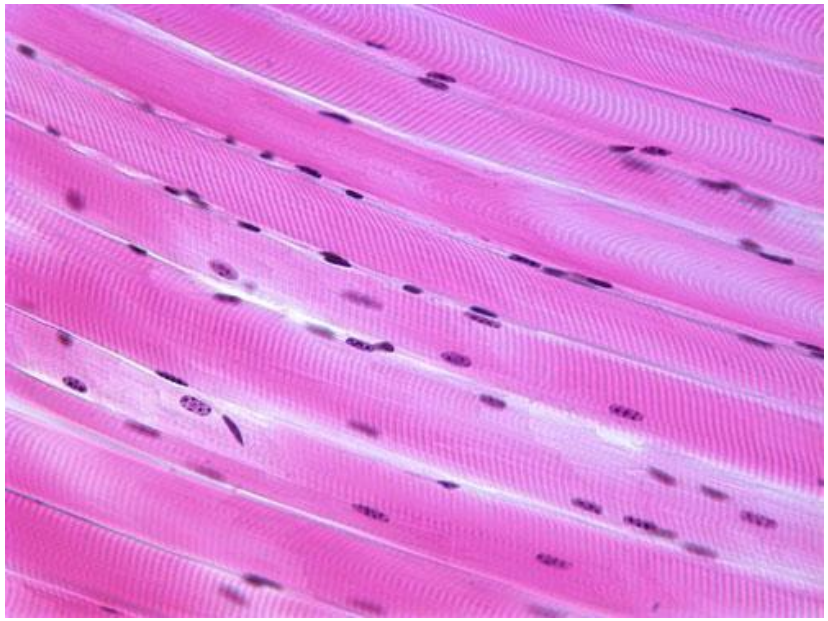
ENDOMEMBRANE SYSTEM



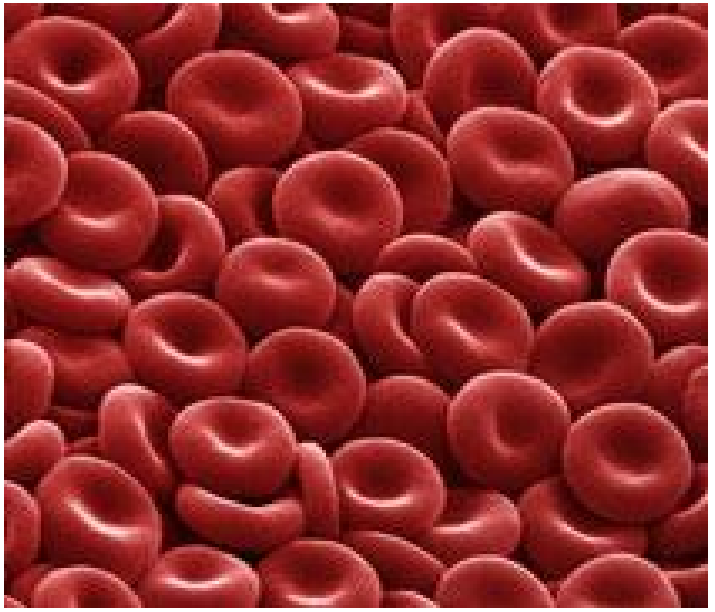
NUCLEUS

- Control center → contains DNA
- Most cells have only 1 nucleus
  - **Multinucleate**: many nuclei (muscle, some liver cells)
  - **Anucleate**: no nucleus (mature RBC)
- Three main structures:
  1. Nuclear envelope
  2. Nucleoli
  3. Chromatin

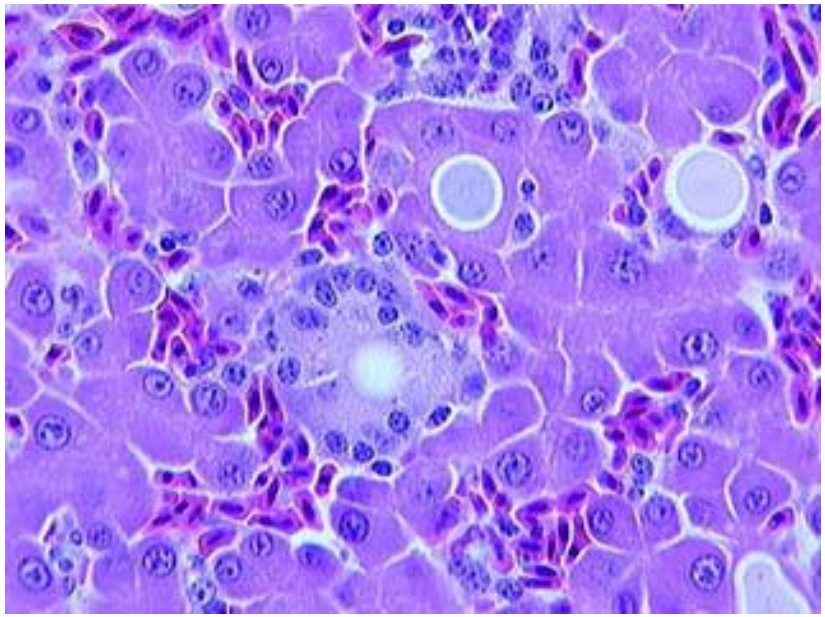




Multinucleated Muscle Cells



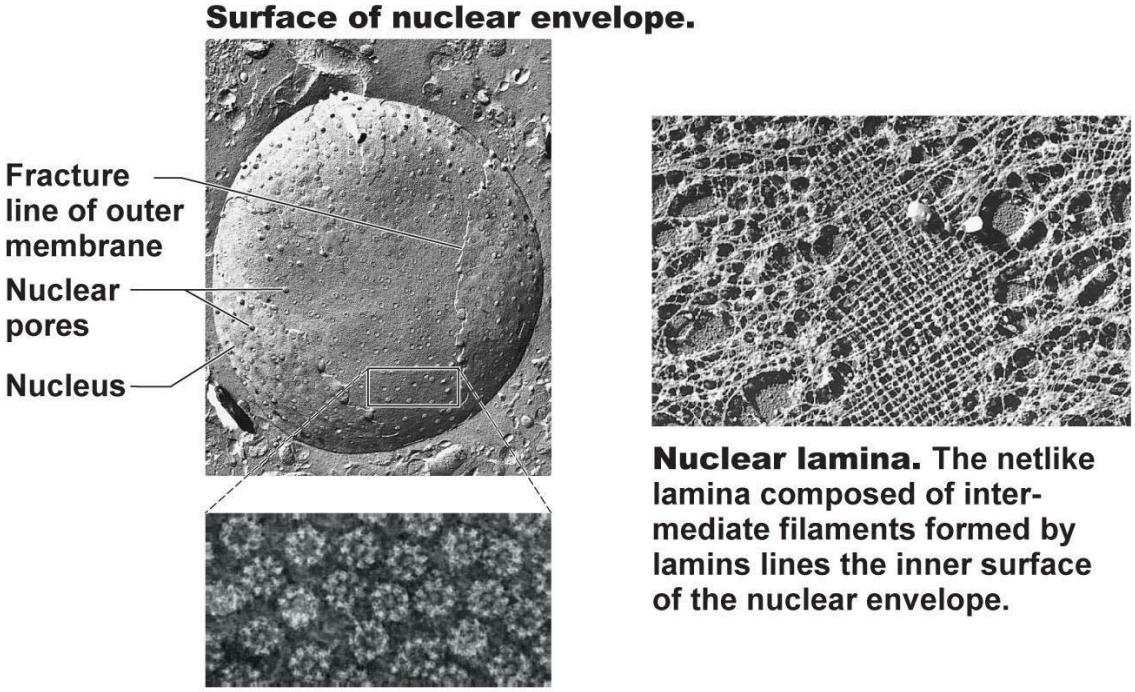
Anucleated Red Blood Cells



Multinucleated Liver Cells

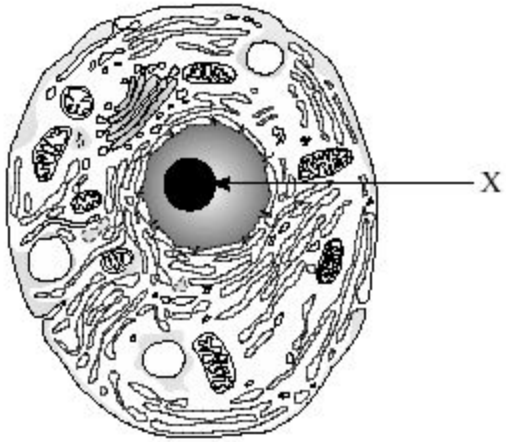
NUCLEAR ENVELOPE

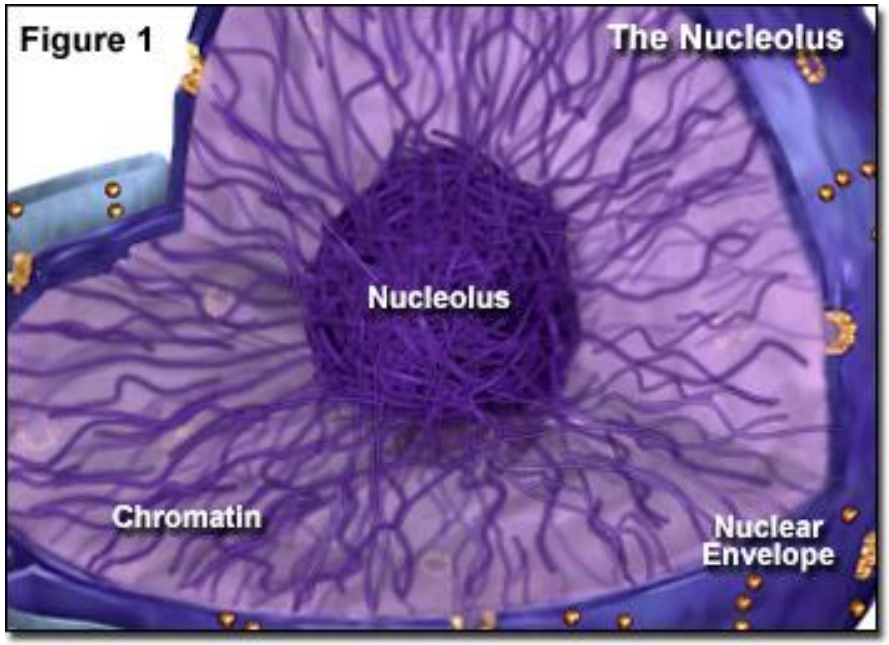
- Double membrane barrier surrounds nucleus
  - Outer part continuous with Rough ER
- **Nuclear pores**: control entry/exit of molecules



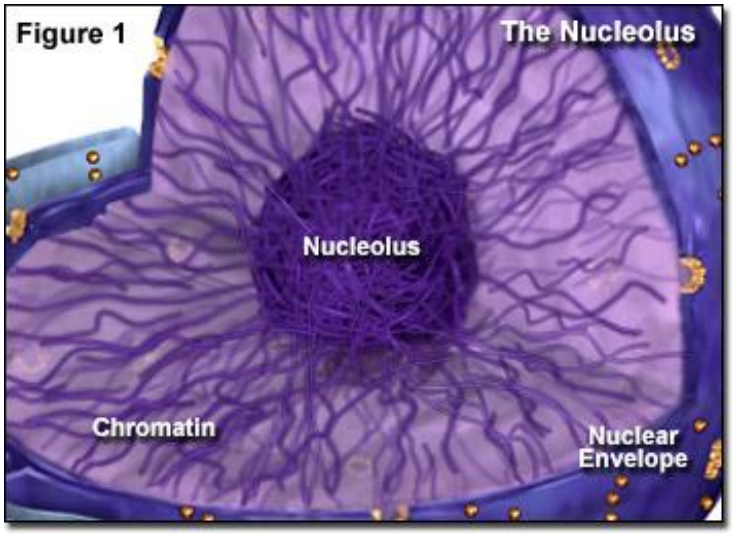
NUCLEOLUS (NUCLEOLI)

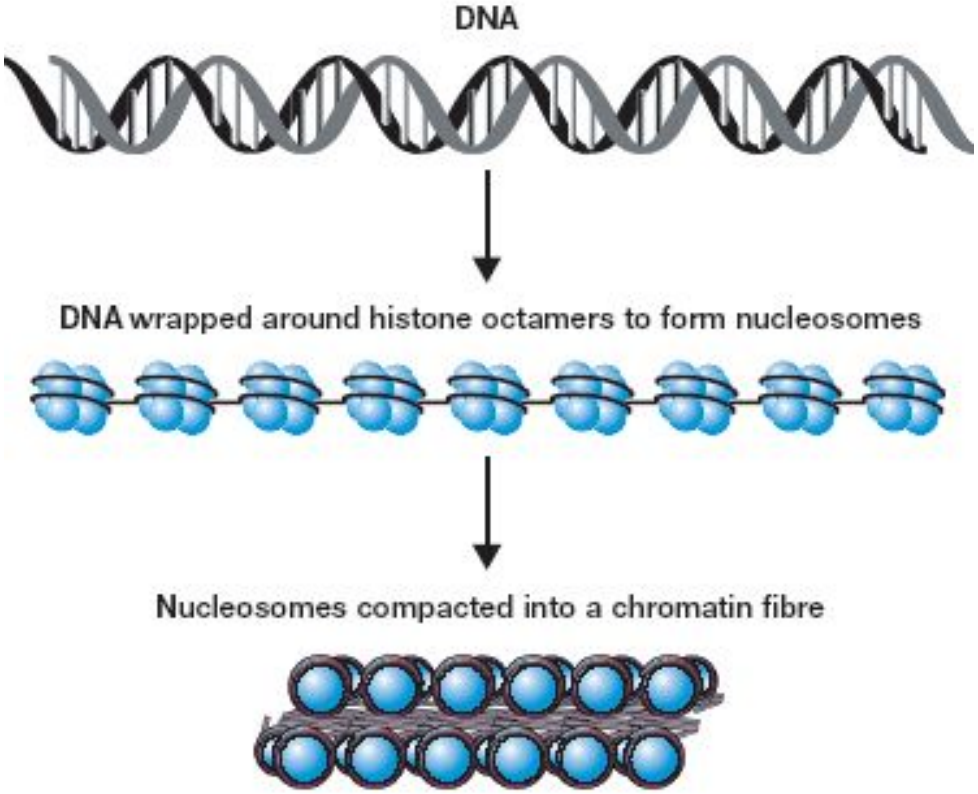
- Dark-staining bodies in nucleus
- 1-2 per cell
- Site where ribosomes are made



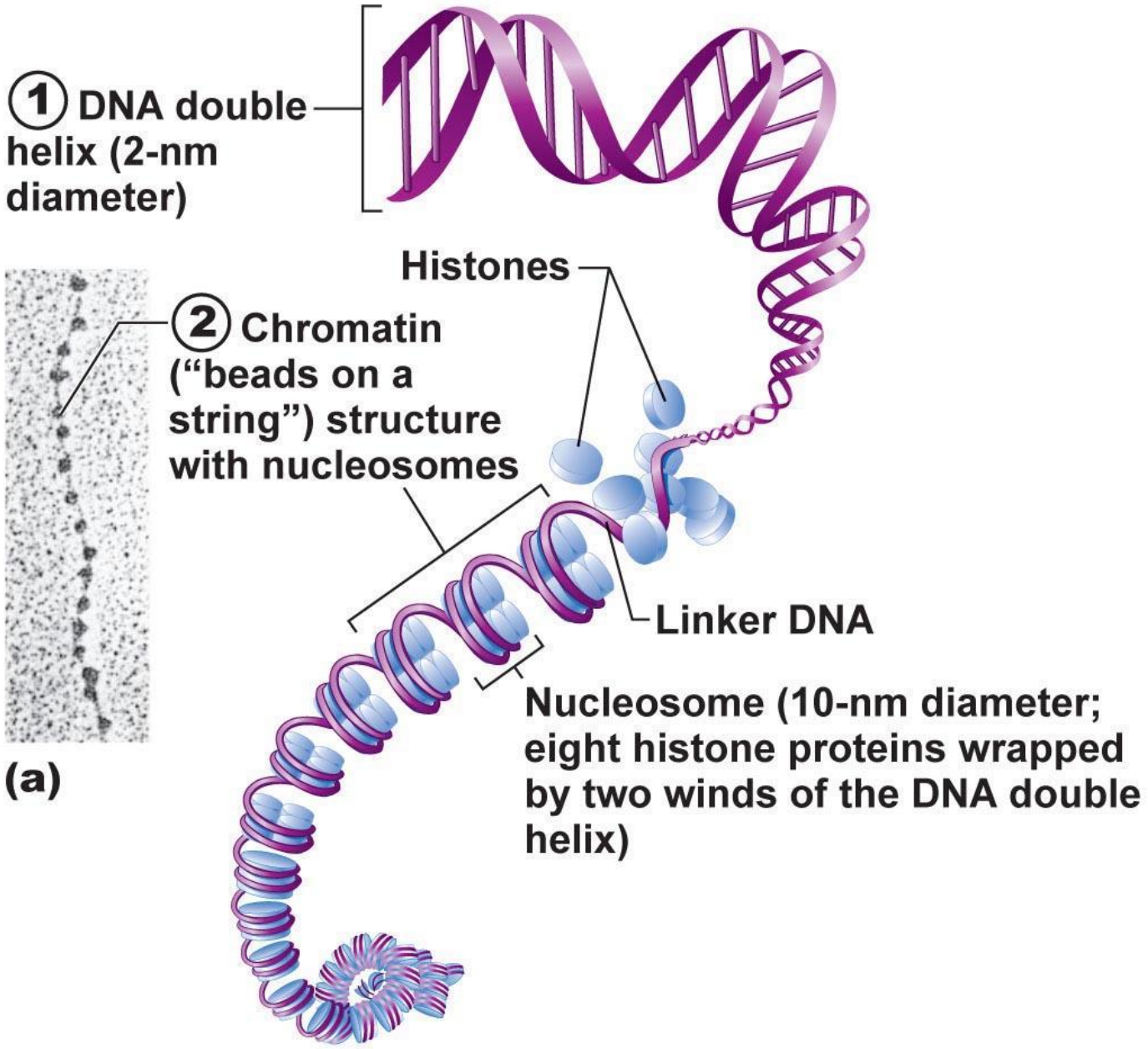


CHROMATIN





- Chromatin = DNA + Proteins
- Nucleosome = DNA wrapped around 8 histone proteins
- **Histones** allow for compact and orderly packing of long DNA molecules

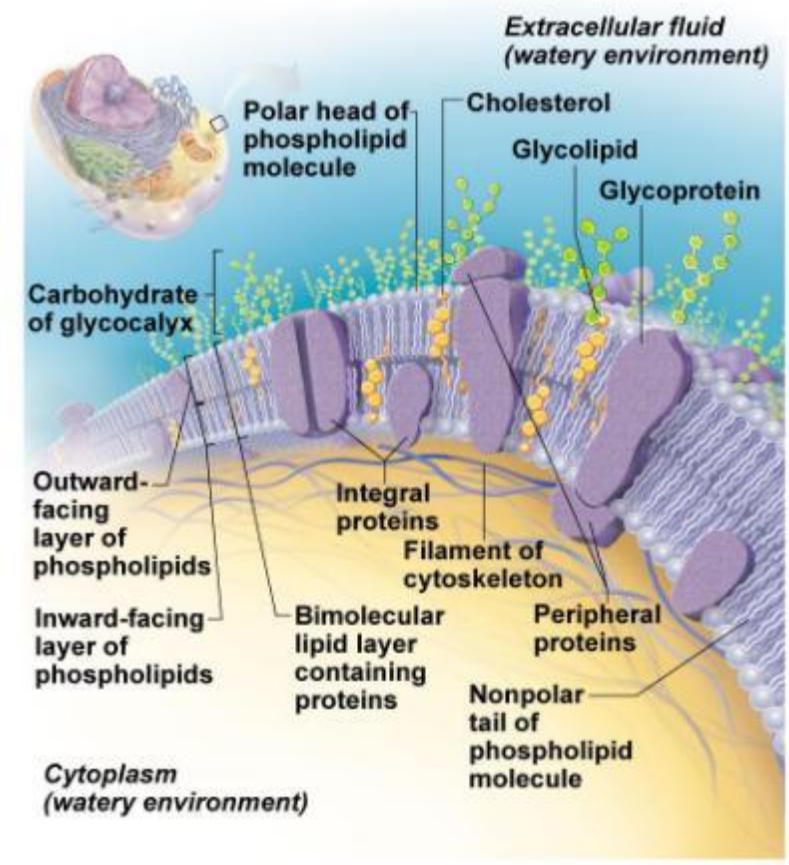


PLASMA MEMBRANE

- **Function**: enclose cell contents, control exchange of substances with environment, cell communication
- Made of:
  - Lipid bilayer
  - Cholesterol
  - Glycolipids
  - Proteins

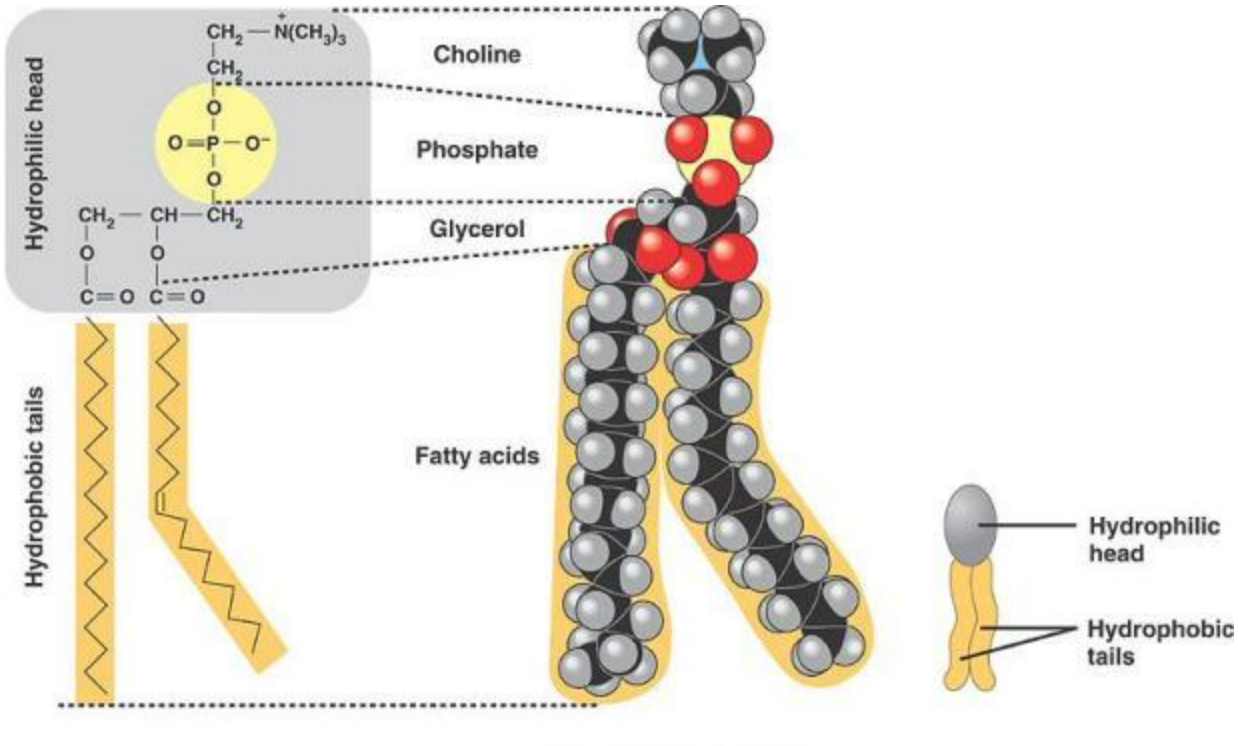
FLUID MOSAIC MODEL

- Proteins float in fluid lipid bilayer

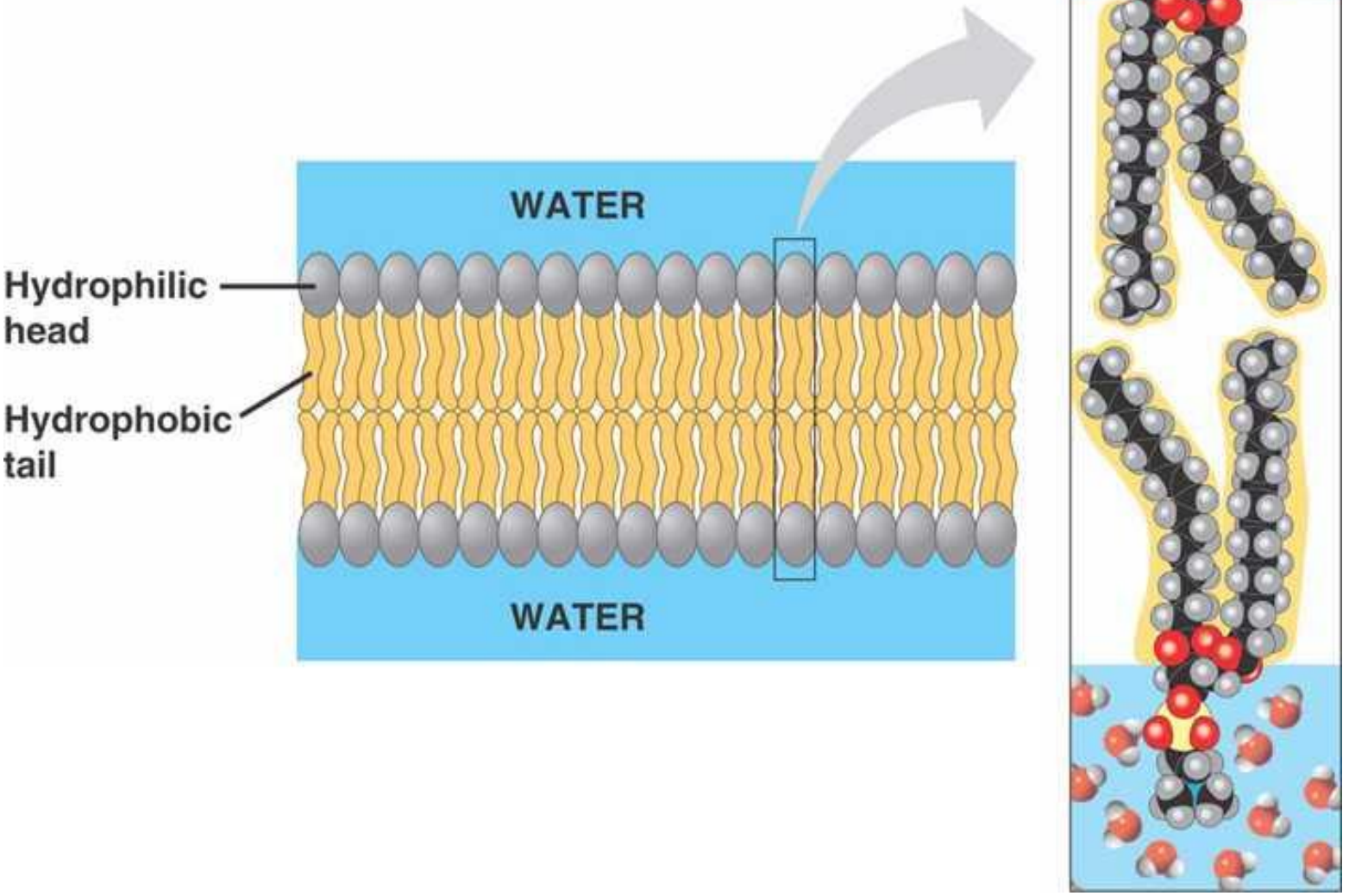


MEMBRANE LIPIDS:

1. Phospholipid:
   - Polar/hydrophilic (water-loving) “head”
   - Nonpolar/hydrophobic (water-fearing) “tail”

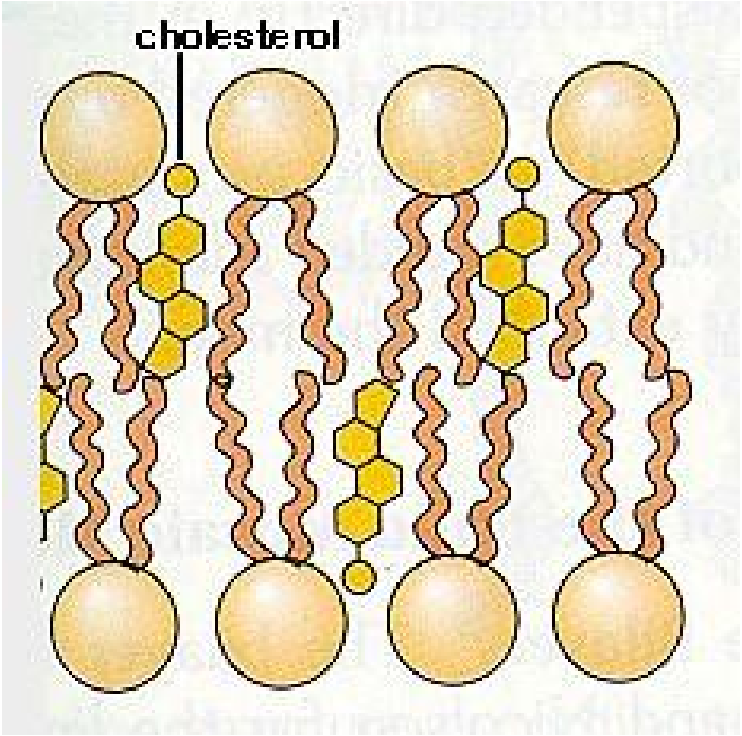


LIPID BILAYER



MEMBRANE LIPIDS

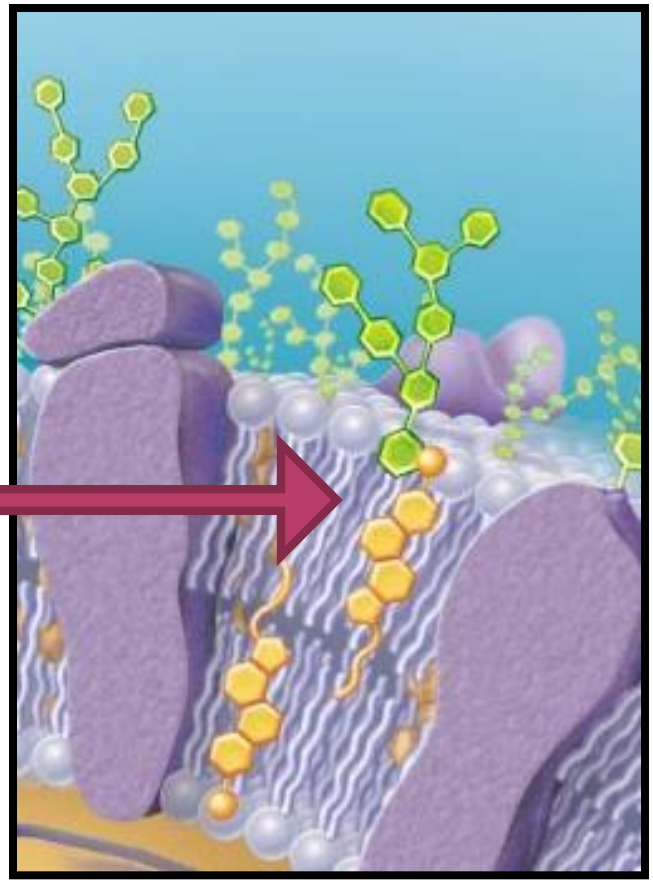
2. Cholesterol
   - 20% of membrane lipid
   - Stabilize membrane
   - Maintain fluidity



MEMBRANE LIPIDS

3. Glycolipids
   - Lipid + sugar attached
   - 5% membrane lipid
   - For cell recognition

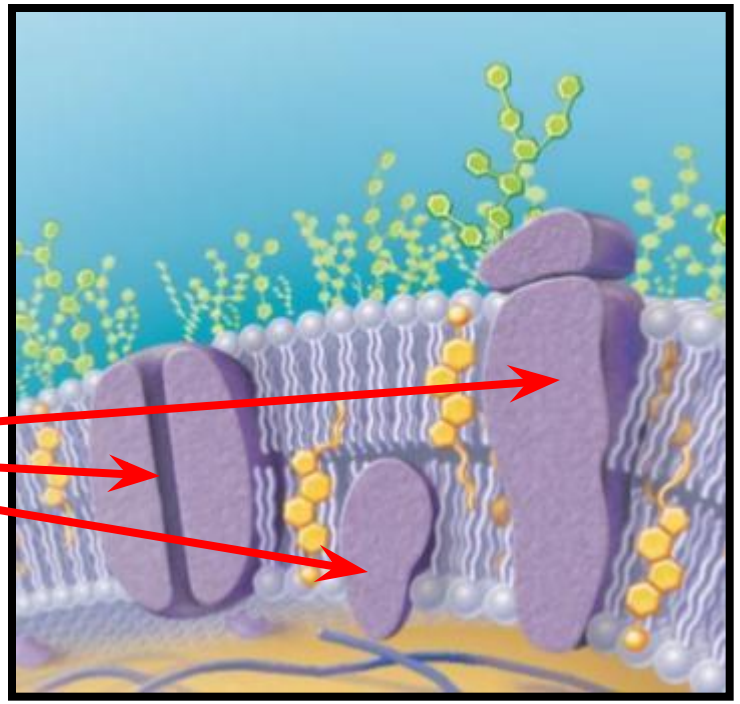
glycolipid



MEMBRANE PROTEINS

1. Integral Proteins
   - Inserted into lipid bilayer
   - Have both hydrophilic & hydrophobic regions
   - **Functions**: enzymes, transport, receptors (relay messages)

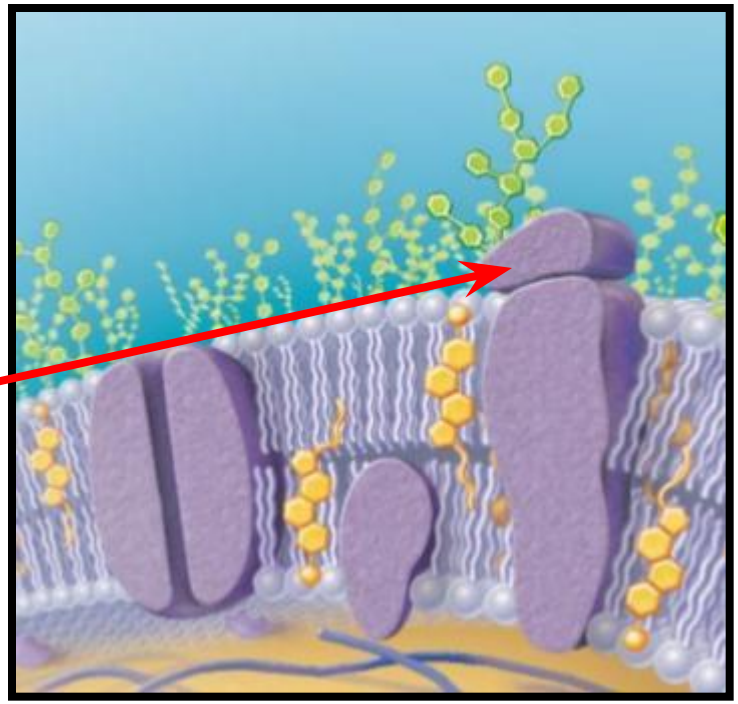
integral proteins



MEMBRANE PROTEINS

2. Peripheral Proteins
   - Attached loosely to membrane
   - **Functions**: support, enzymes, movement, linkage

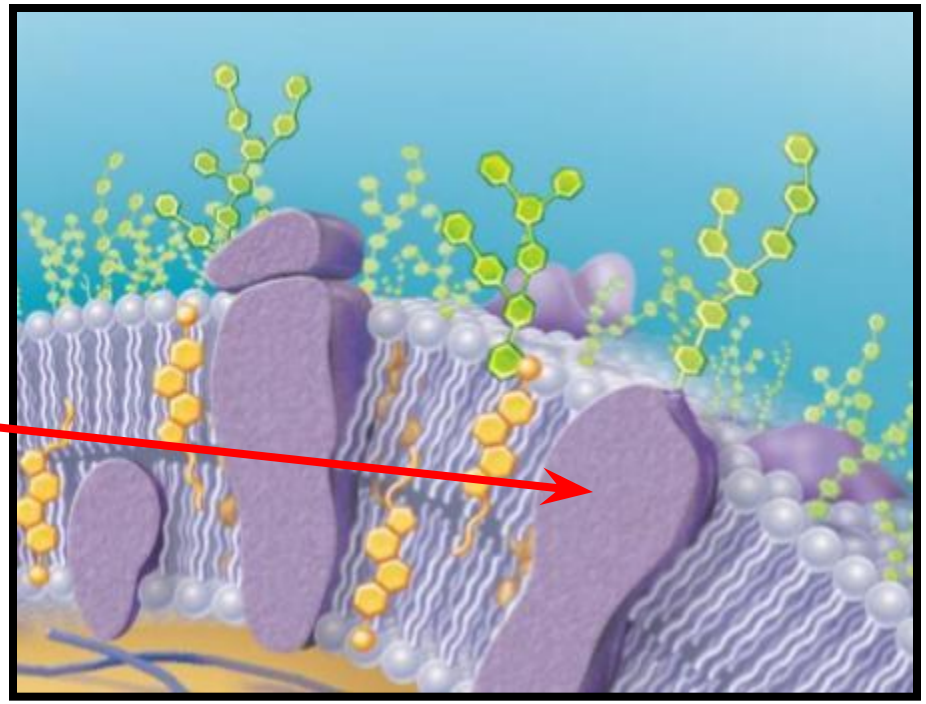
peripheral protein



GLYCOPROTEIN

- protein + sugar attached
- Serves as specific biological marker → cell recognition

glycoprotein



HAP in the News

Topic: Body's chemical calendar discovered

Essential Question: Can your cells determine what time of year it is?

Concepts: Hibernation, circadian rhythm, time, light

http://www.bbc.com/news/health-34351983

HAP in the News

- Requirements
  - URL to article
  - Topic
  - Summary of article
    - Incude:
      - New vocabulary/unfamiliar terms
      - Explanation of biological process
        - Example: How stem cells are grown
  - Two questions for the class
    - Why is this important?
    - How does this relate to HAP?
    - Do you support this study?


STEM
CELLS
Sci Show

Stem Cell Investigation

Write a report with the following elements:

1. Summarize stem cells and their research
    a. Where do we find them?
    b. Why do we have them?
    c. Why are we researching them?
2. Your opinion of stem cell research
    a. Is it an ethical practice?
    b. What are the pros/cons?
        i. Make sure to support your claim with reasoning.

        Don't just explain why you think it's wrong,

        analyze the alternative argument to give strength to your opinion

HAP in the News

Topic: Study supports cancer link with height

Essential Question: Are taller people at a higher risk for cancer?

Concepts: Skin cancer, Breast cancer, growth factor, cells, risk factors

http://www.bbc.com/news/health-34414446

Organelles

Mitochondria
Peroxisomes
Lysosomes
Rough Endoplasmic Reticulum
Smooth Endoplasmic Reticulum
Golgi Apparatus
Vesicles
Cytoskeleton
Centrioles
Ribosomes

To Know:

1. Location
2. Function

Folded double membrane

Several within cell

ATP production

Membrane bound sac

Storage and transport of substances (waste, water, food, etc.)

Mitochondria

Vesicles/Vacuoles

Single membrane surrounding nucleus

Protein synthesis and processing

Rough Endoplasmic Reticulum

SIngle membrane surrounding nucleus

Lipid synthesis

Smooth Endoplasmic Reticulum

Single membrane found folded near the ER

Packages proteins for export, forms secretory vesicles

Golgi Apparatus

Single membrane organelle

Digests macromolecules and cell debris, recycles

Lysosomes

Single membrane organelle

Oxidizes fatty acids, ethanol, and other compounds

Peroxisome

Two pairs of bunched microtubules

Anchor and assemble microtubules, assist in cell replication

Centrioles

Network of protein filaments

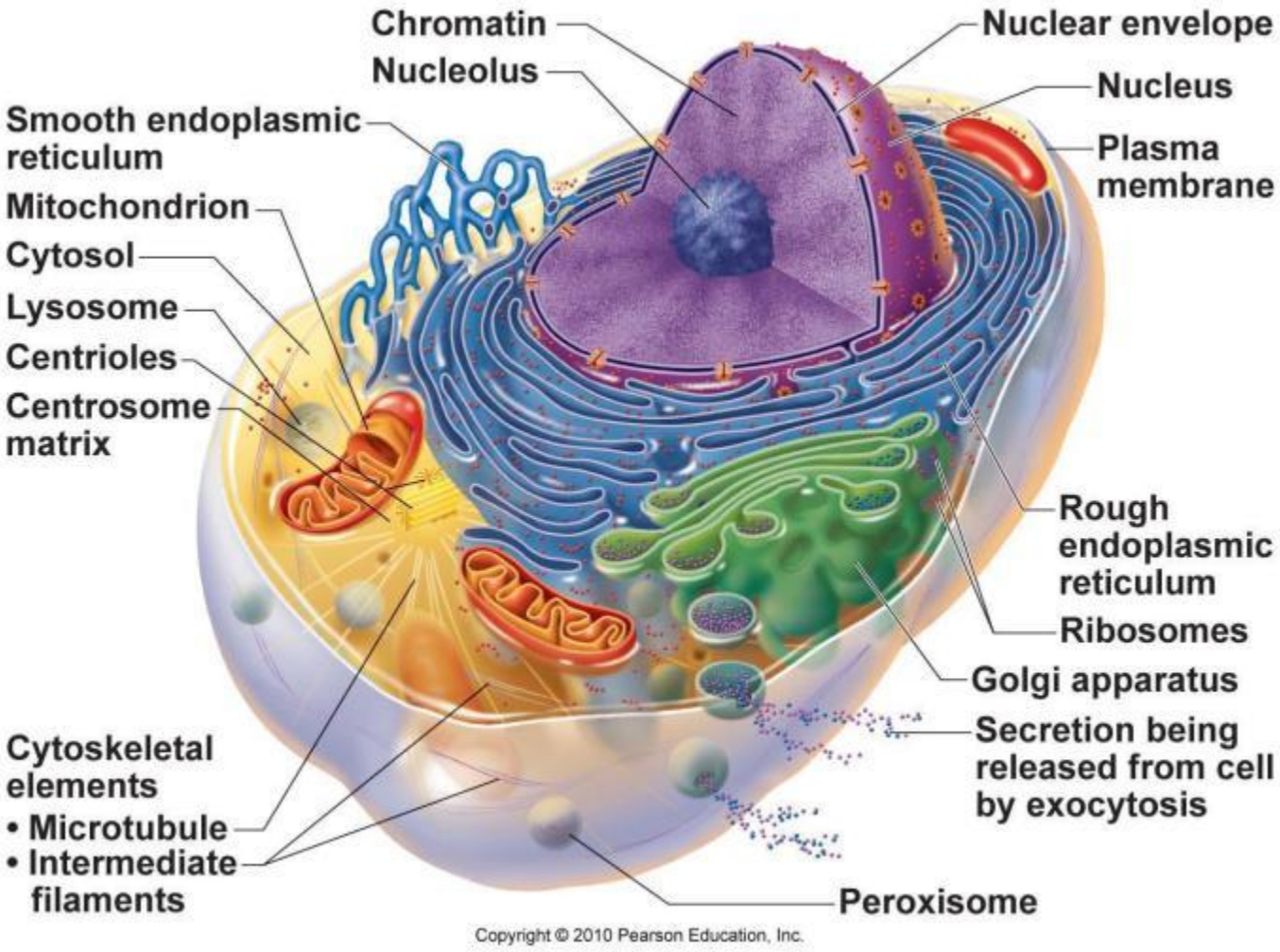
Support and give the cell structure

Small proteins embedded within cell and on rough ER

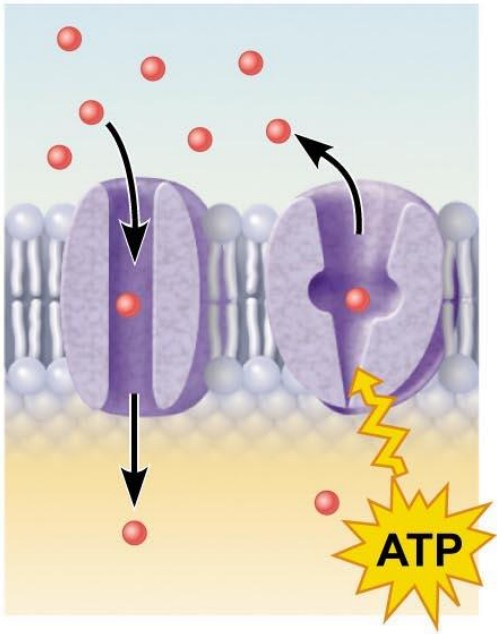
Protein synthesis

Cytoskeleton	Ribosomes

CELL STRUCTURE

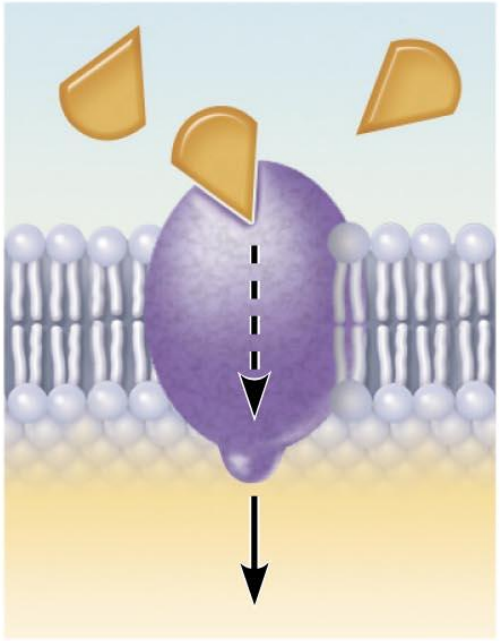


MEMBRANE PROTEIN FUNCTIONS



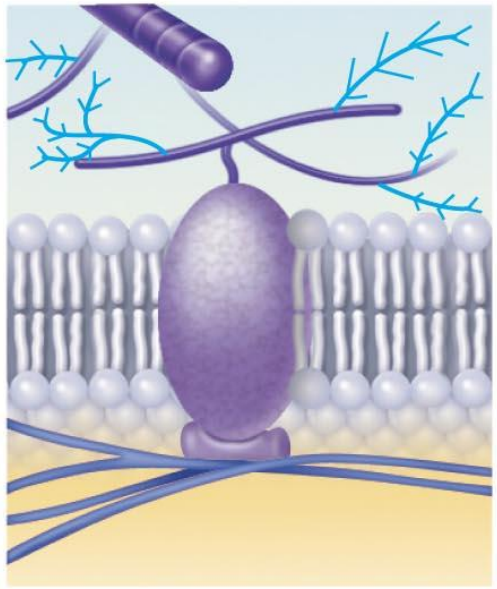
(a) **Transport**

MEMBRANE PROTEIN FUNCTIONS



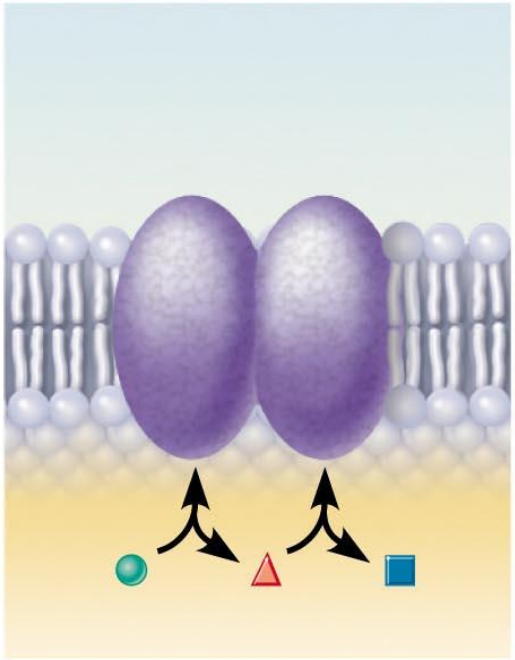
(b) **Receive chemical messages**

MEMBRANE PROTEIN FUNCTIONS



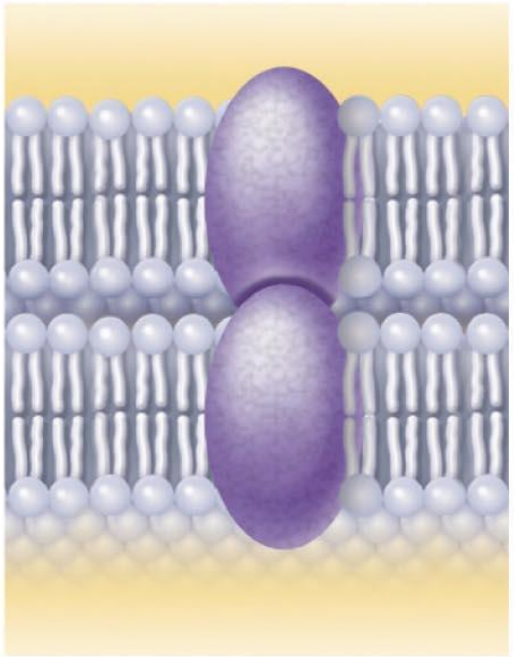
(c) **Maintain cell shape**

MEMBRANE PROTEIN FUNCTIONS



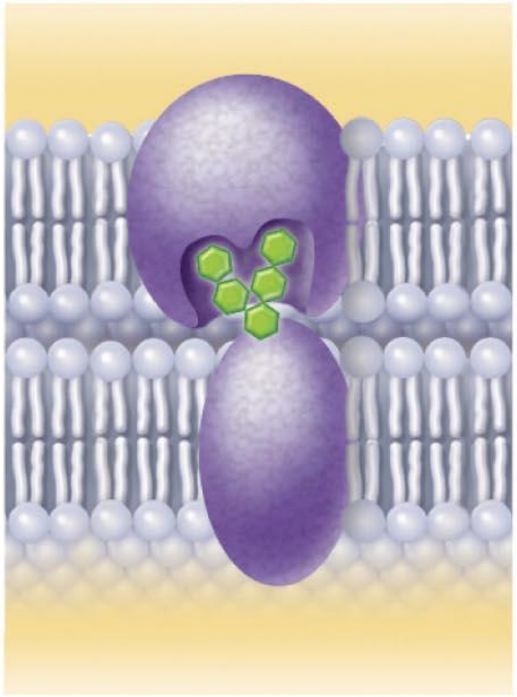
(d) **Enzyme activity**

MEMBRANE PROTEIN FUNCTIONS



(e) **Intercellular joining**

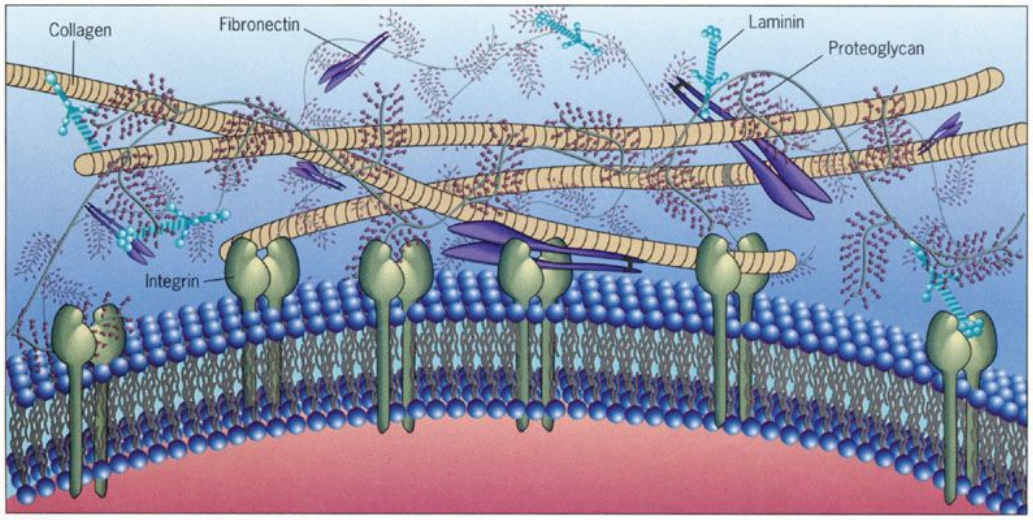
MEMBRANE PROTEIN FUNCTIONS



(f) Cell-cell recognition
"ID tags"

EXTRACELLULAR MATERIALS

- Any substances outside cells
  1. Body fluids (blood plasma, interstitial fluid)
  2. Cellular secretions (saliva, mucus, gastric fluids)
  3. **Extracellular matrix (ECM)**: "glue" that holds cells together; jelly-like substance made of proteins (like collagen) and carbs



MEMBRANE TRANSPORT

Interstitial fluid:

- Fluid outside cells
- Rich, nutritious "soup" – amino acids, sugars, fatty acids, vitamins, hormones, salts, wastes

Selective Permeability:

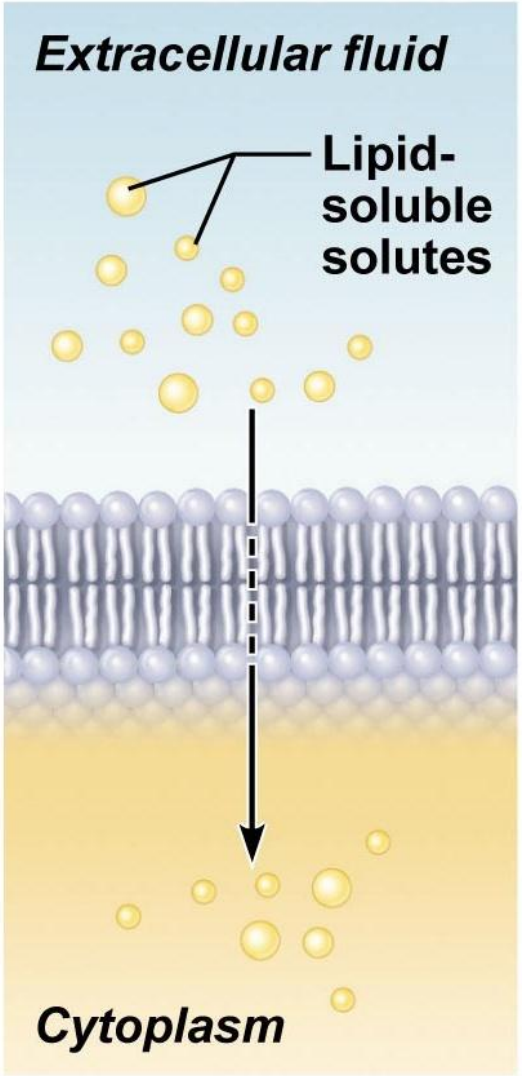
- Plasma membrane only allows some substances to enter cell
- Nutrients in, wastes out
- By passive or active transport

PASSIVE TRANSPORT

- No energy (ATP) needed
- Molecules move *down concentration gradient* from HIGH → LOW concentration
- Types: diffusion, filtration

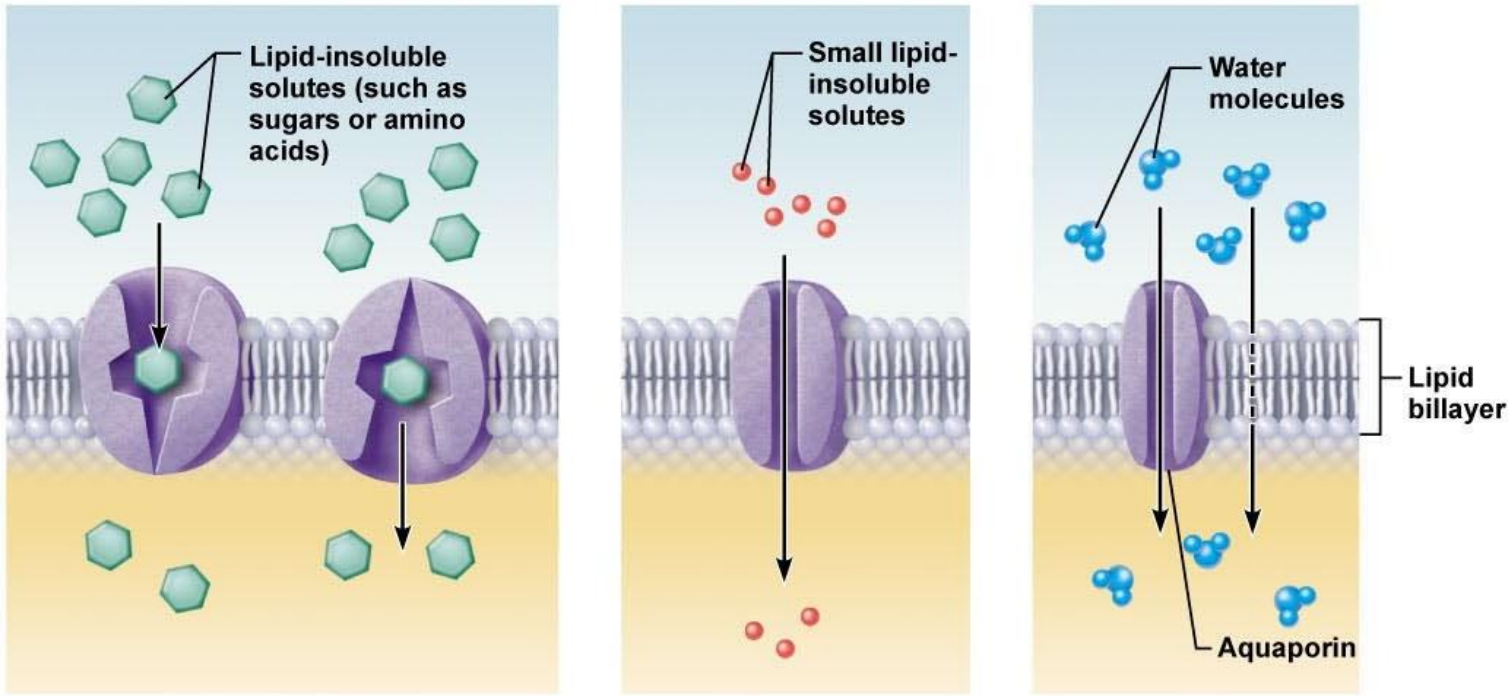
SIMPLE DIFFUSION

- Nonpolar & lipid-soluble substances diffuse directly through lipid bilayer
- Eg. O_2, CO_2, fat-soluble vitamins



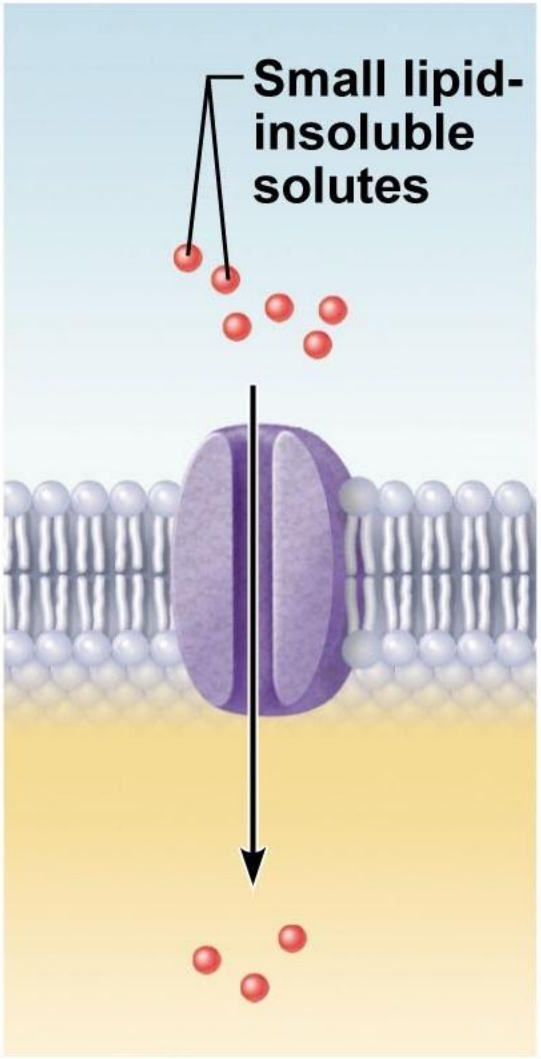
FACILITATED DIFFUSION

- Transport proteins (carrier or channel proteins) assist molecules across membrane
- Eg. glucose, amino acids, H_2O, ions



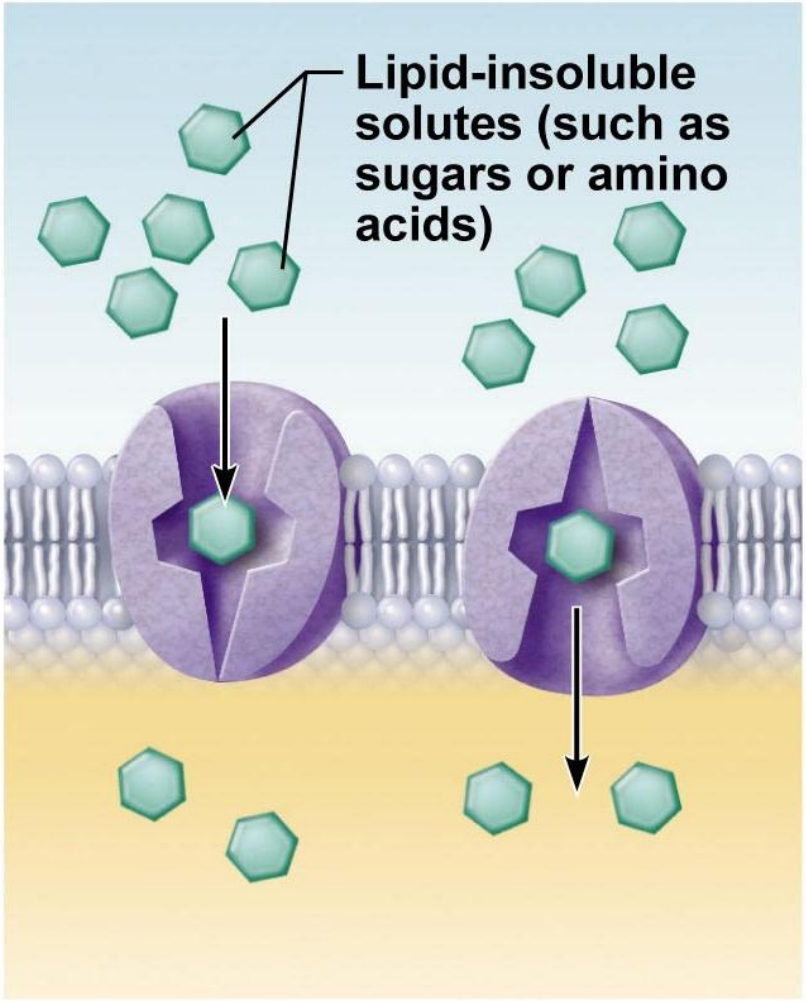
CHANNEL PROTEINS

- Water-filled channels
- Eg. ions



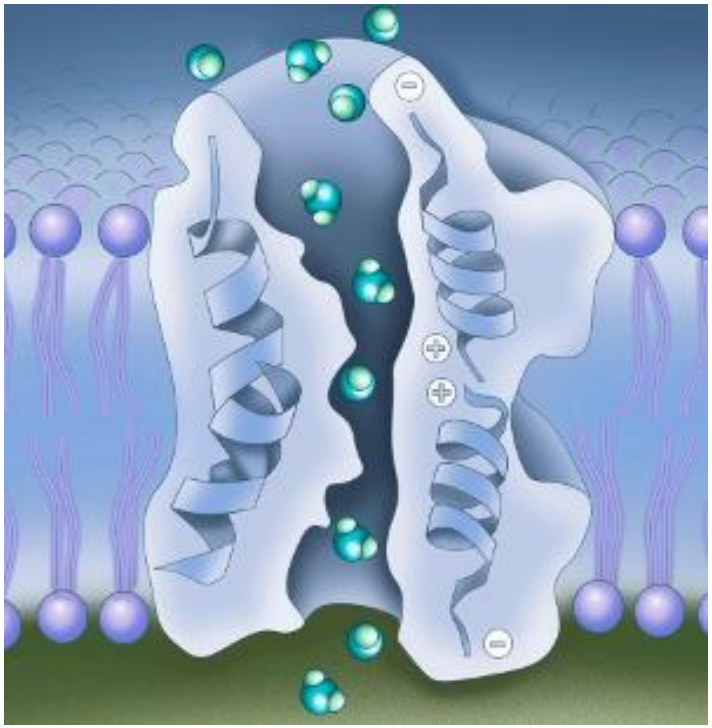
CARRIER PROTEINS

- Binds to molecule, changes shape, ferries it across membrane
- Eg. glucose transporter



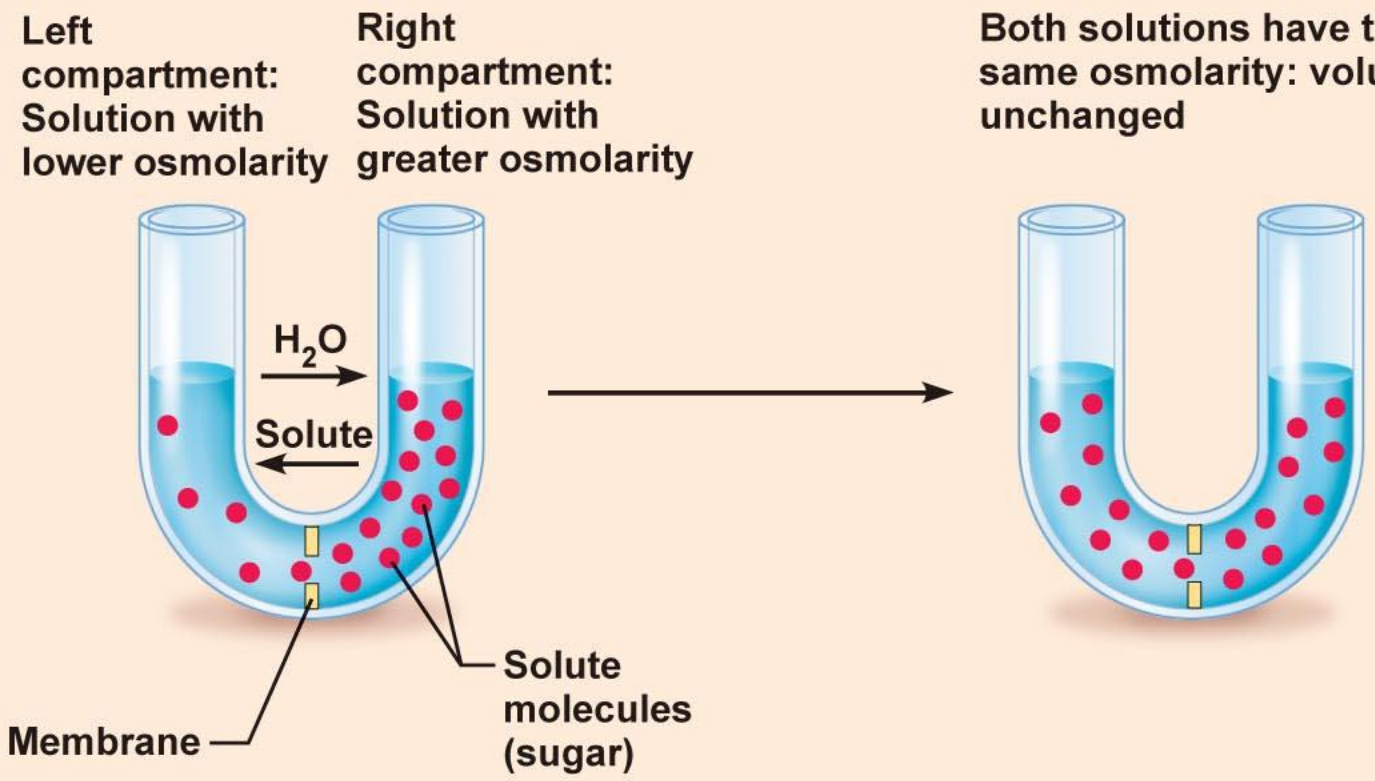
OSMOSIS

- Diffusion of H_2O
- **Aquaporins:** channel proteins for H_2O passage



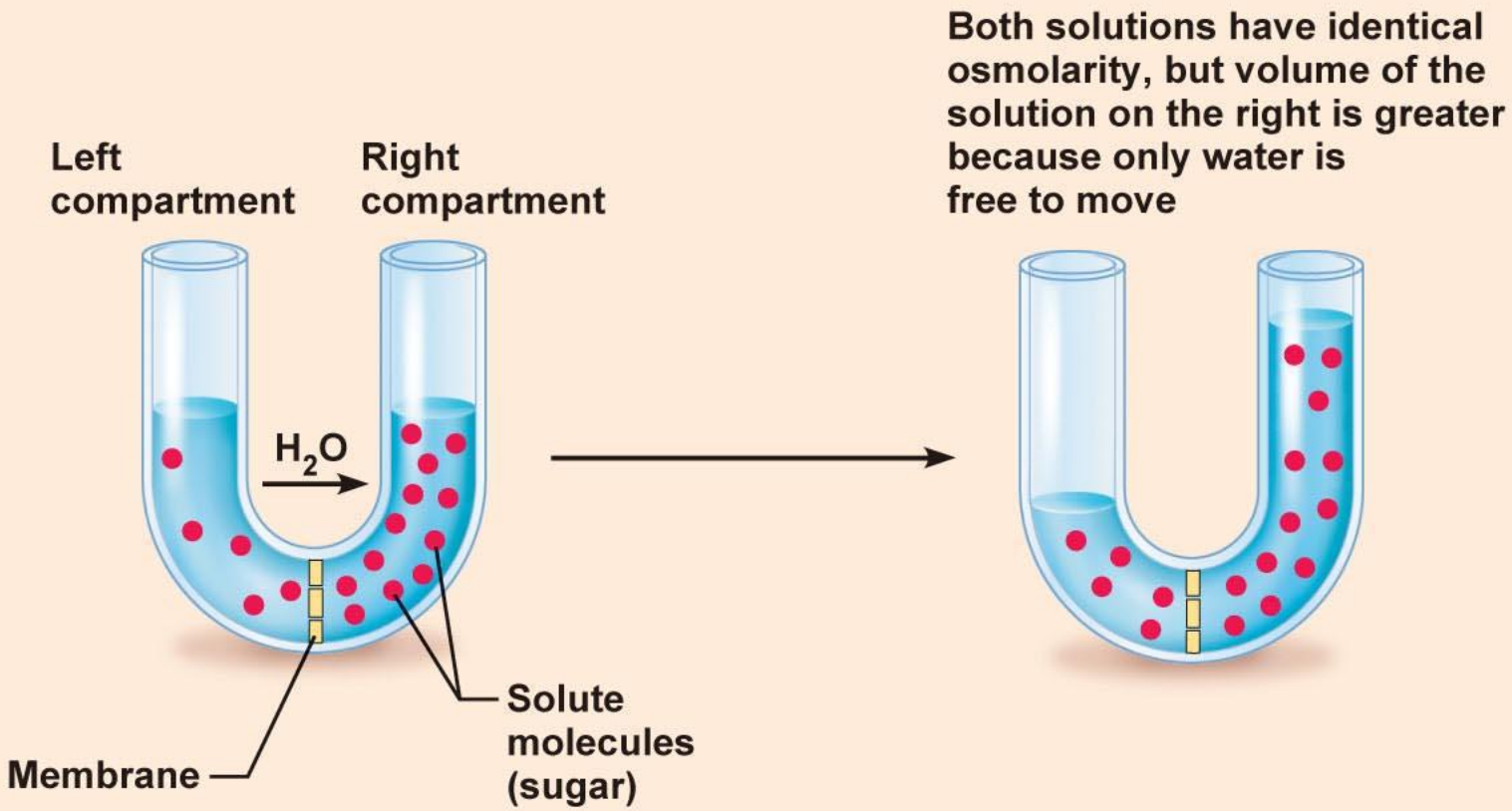
(a) Membrane permeable to both solutes and water

Solute and water molecules move down their concentration gradients in opposite directions. Fluid volume remains the same in both compartments.



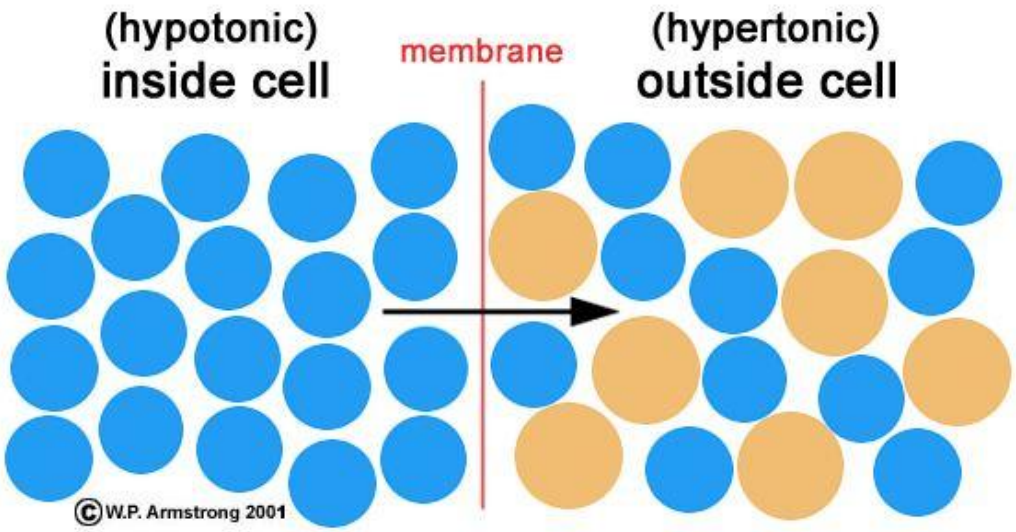
(b) Membrane permeable to water, impermeable to solutes

Solute molecules are prevented from moving but water moves by osmosis. Volume increases in the compartment with the higher osmolarity.

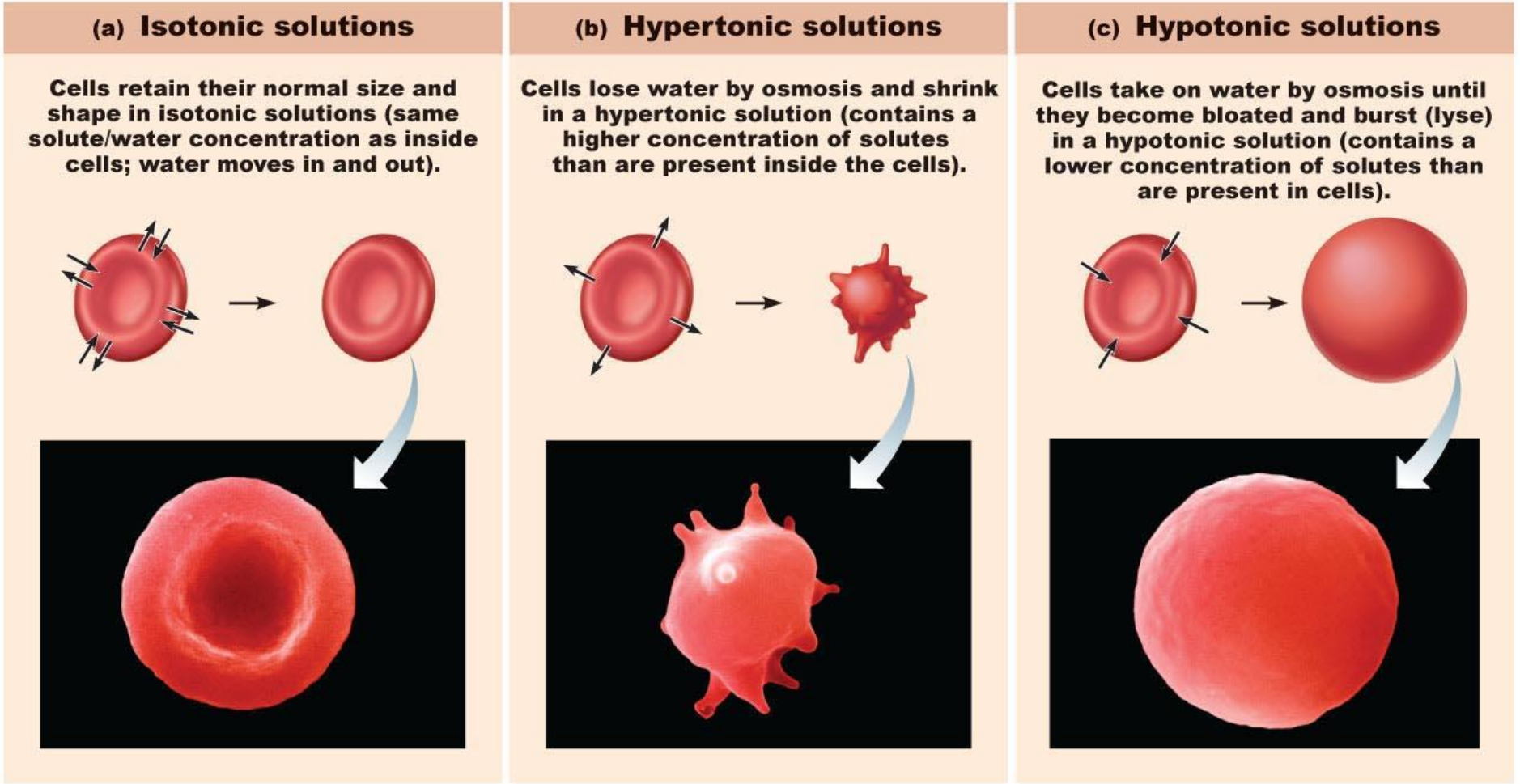


TONICITY

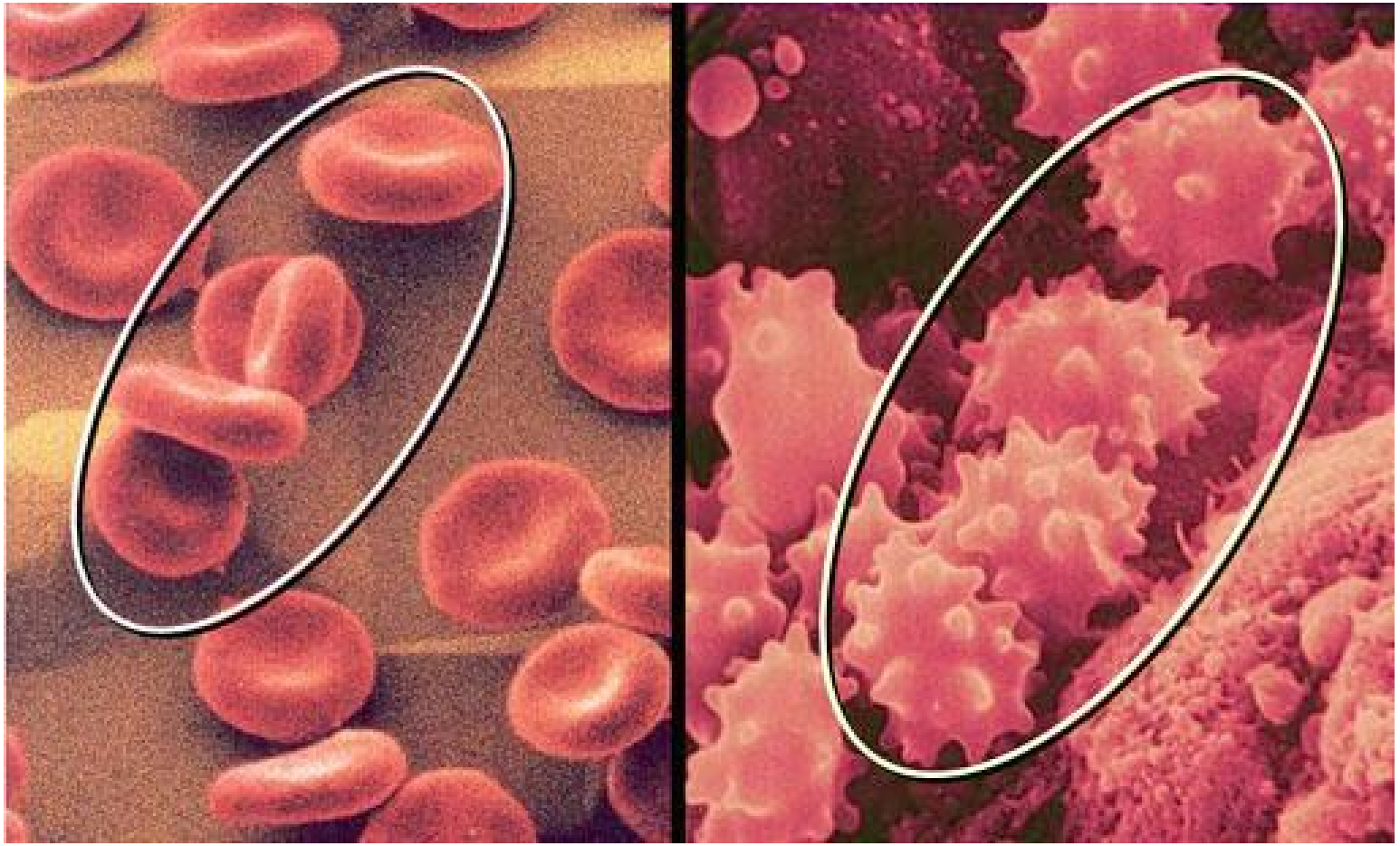
- Ability of solution to change shape or tone of cells by changing water volume
- Isotonic = equal concentration solutes
- Hypertonic = higher conc. of solutes
- Hypotonic = lower conc. of solutes



EFFECT OF SOLUTIONS ON RED BLOOD CELLS



RBC'S IN **ISOTONIC** & **HYPERTONIC** SOLUTIONS



When you are done:

- Complete the Nerve Transmission worksheet that is on your table.
  - Questions 1-8 due on Friday
  - Separate sheet of paper preferred
  - You may work with a partner and turn in one sheet

HAP in the News

Title: **Freezing ovaries 'safe option' for cancer sufferers**

Topic: Ovarian transplants that can result in pregnancy

Concepts: Hormones, organ regeneration, cancer, cells, ovaries

http://www.bbc.com/news/health-34453230

RETEST

- Human Chemistry
  - Topics
    - Acids/bases
    - Energy types
    - Macromolecules
- Options:
  - Acidosis/Alkalosis Case Study
  - ATP Report
  - Enzyme Exploration

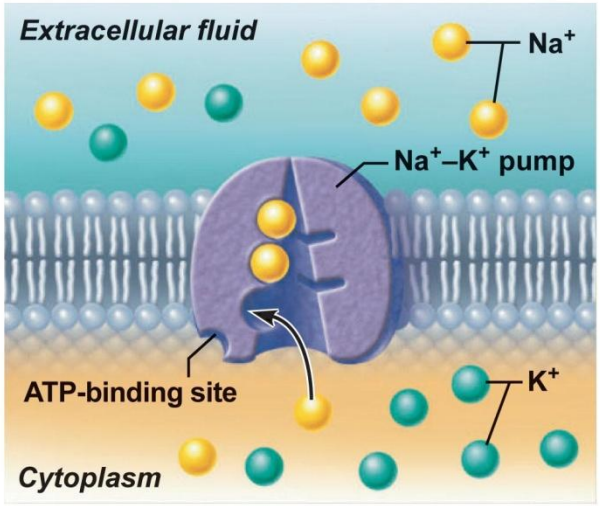
ACTIVE TRANSPORT

- Energy (ATP) is needed!!
- Move molecules *against concentration gradient* from LOW → HIGH concentration
- Types: Primary and Secondary

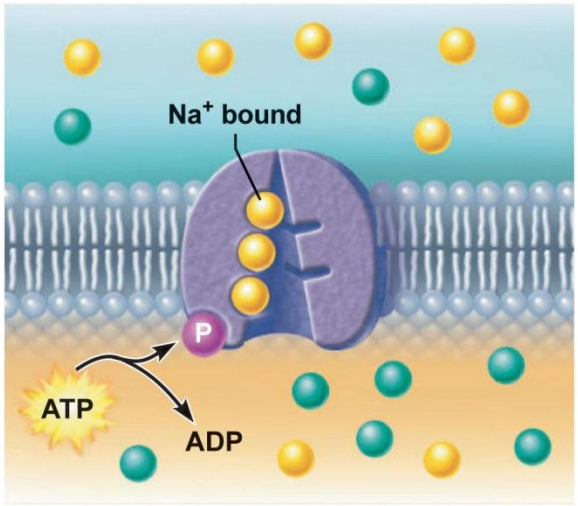
PRIMARY ACTIVE TRANPORT

- Directly uses ATP to drive transport
- Eg. Ca^{2+} pump, H^{+} pump, Na^{+}-K^{+} pump

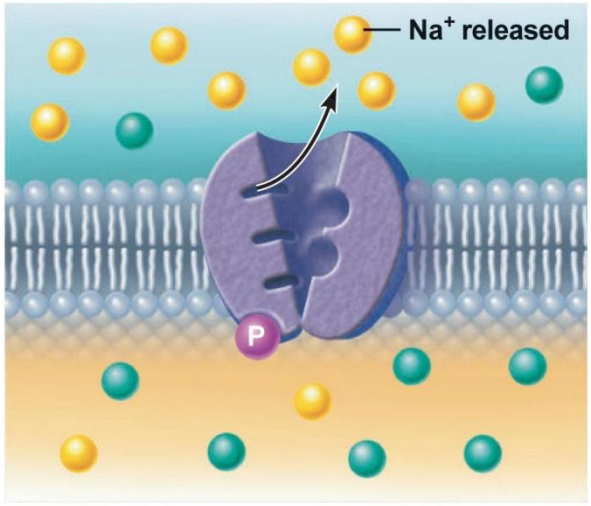
Sodium-Potassium Pump



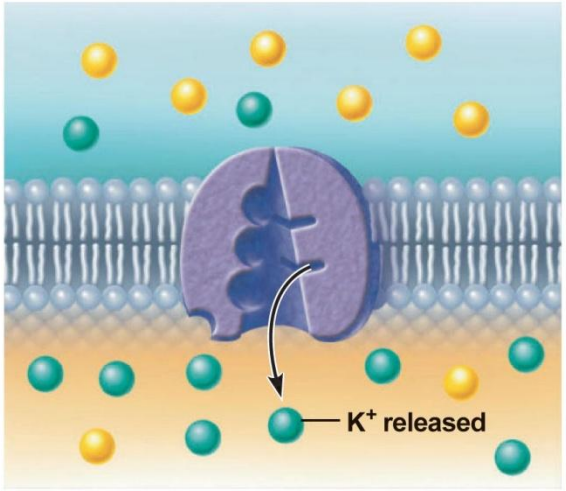
1 Cytoplasmic Na^+ binds to pump protein.



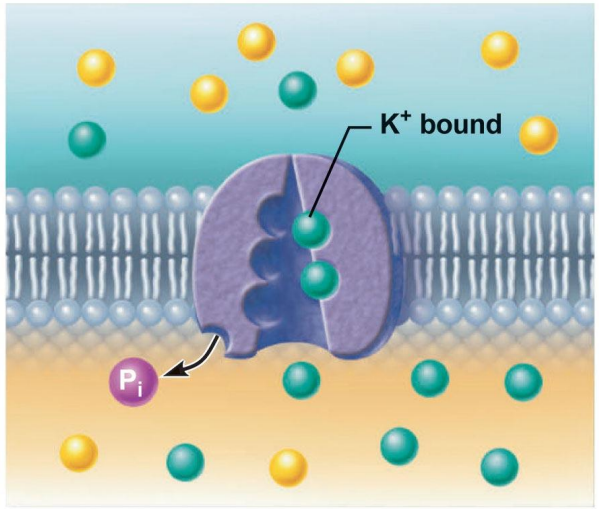
2 Binding of Na^+ promotes phosphorylation of the protein by ATP.



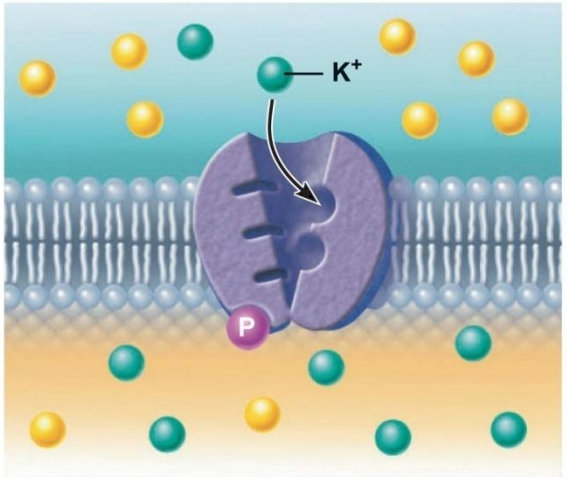
3 Phosphorylation causes the protein to change shape, expelling Na^+ to the outside.



6 K^+ is released from the pump protein and Na^+ sites are ready to bind Na^+ again. The cycle repeats.



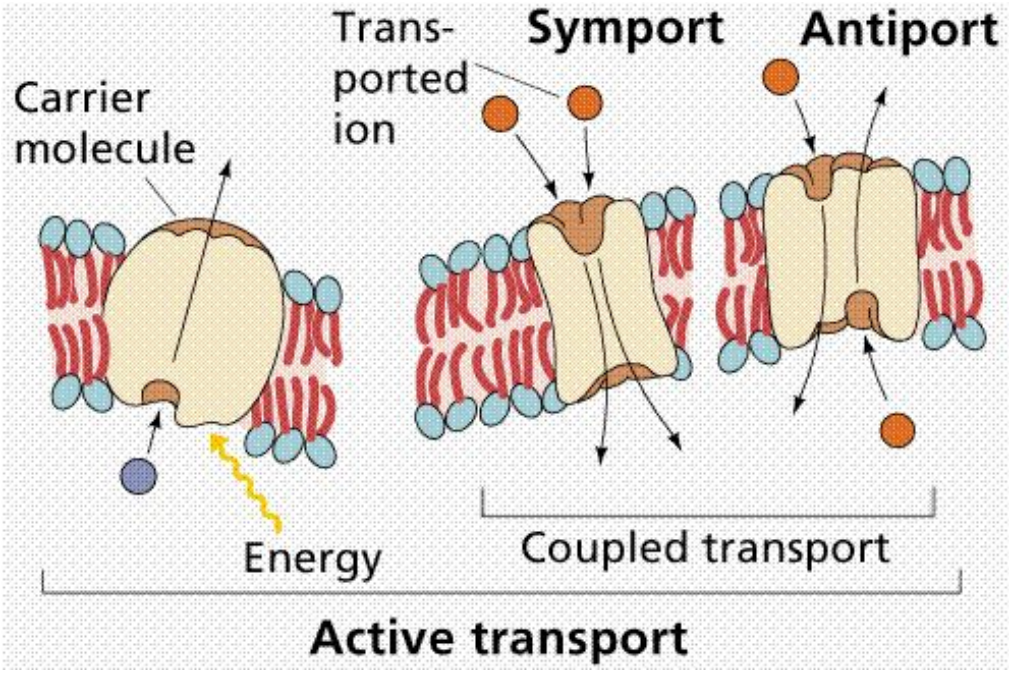
5 K^+ binding triggers release of the phosphate. Pump protein returns to its original conformation.



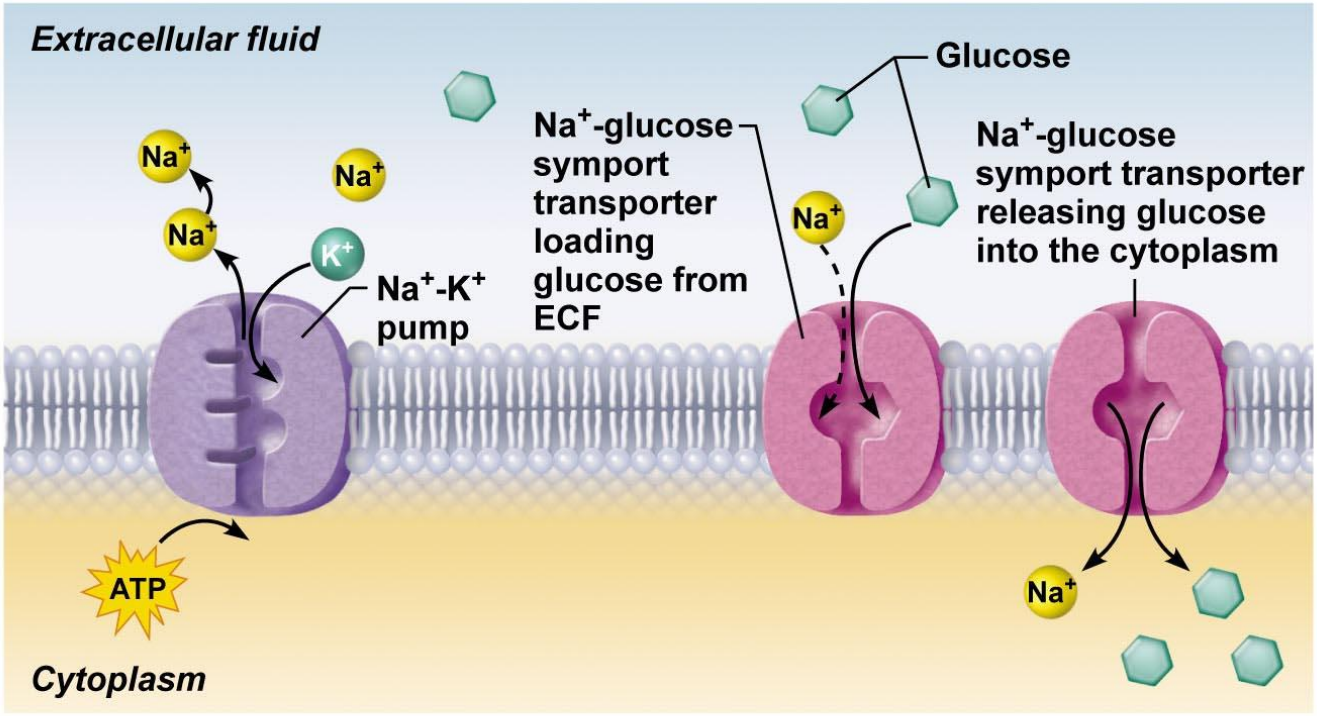
4 Extracellular K^+ binds to pump protein.

SECONDARY ACTIVE TRANSPORT

- Move more than 1 substance at a time
- Symport: 2 substances moved in same direction
- Antiport: 2 substances cross in opposite directions
- Eg. cotransport of sugars, animo acids, ions



SECONDARY ACTIVE TRANSPORT:
Na^+/Glucose Cotransport

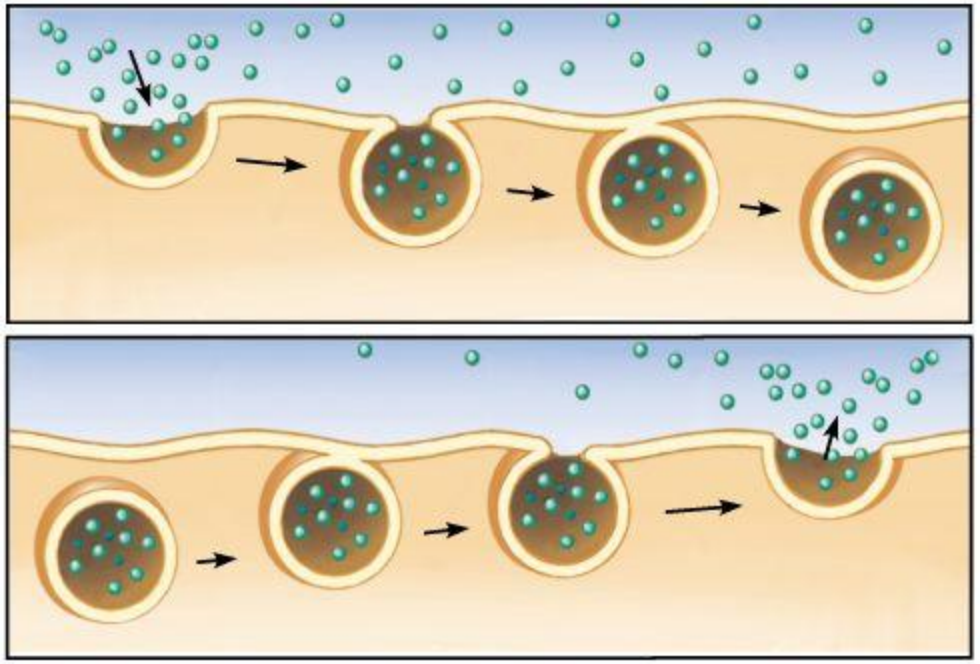


① The ATP-driven Na^+-K^+ pump stores energy by creating a steep concentration gradient for Na^+ entry into the cell.

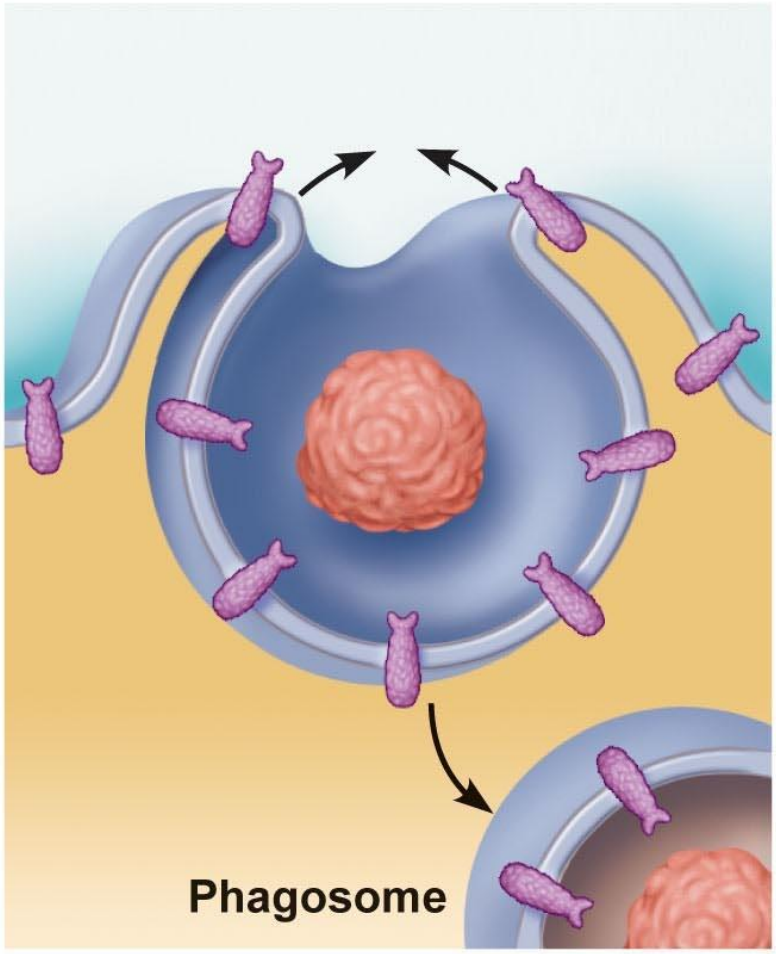
② As Na^+ diffuses back across the membrane through a membrane cotransporter protein, it drives glucose against its concentration gradient into the cell. (ECF = extracellular fluid)

VESICULAR TRANSPORT

- Fluid & large particles transported across membranes in **vesicles** (sacs)
- Exocytosis: “out of cell” – eject substances
- Endocytosis: “within the cell”- ingest substances

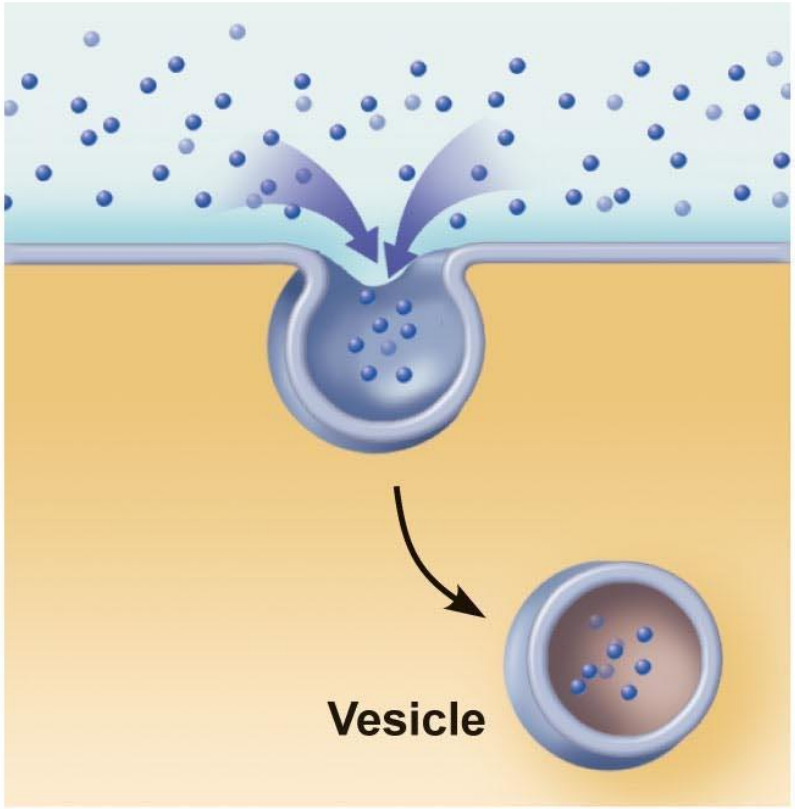


TYPES OF ENDOCYTOSIS



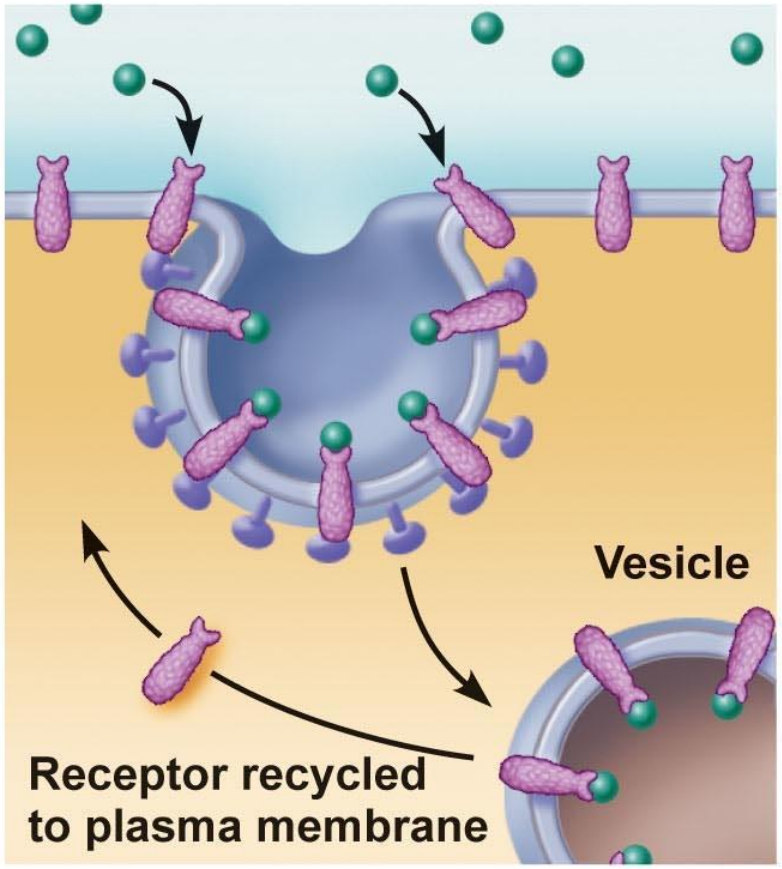
- Phagocytosis: (cell eating) – engulf large or solid material
  - eg. WBC engulf bacteria

TYPES OF ENDOCYTOSIS



- Pinocytosis: (cell drinking) – fluid w/dissolved molecules
  - Eg. intestinal cells

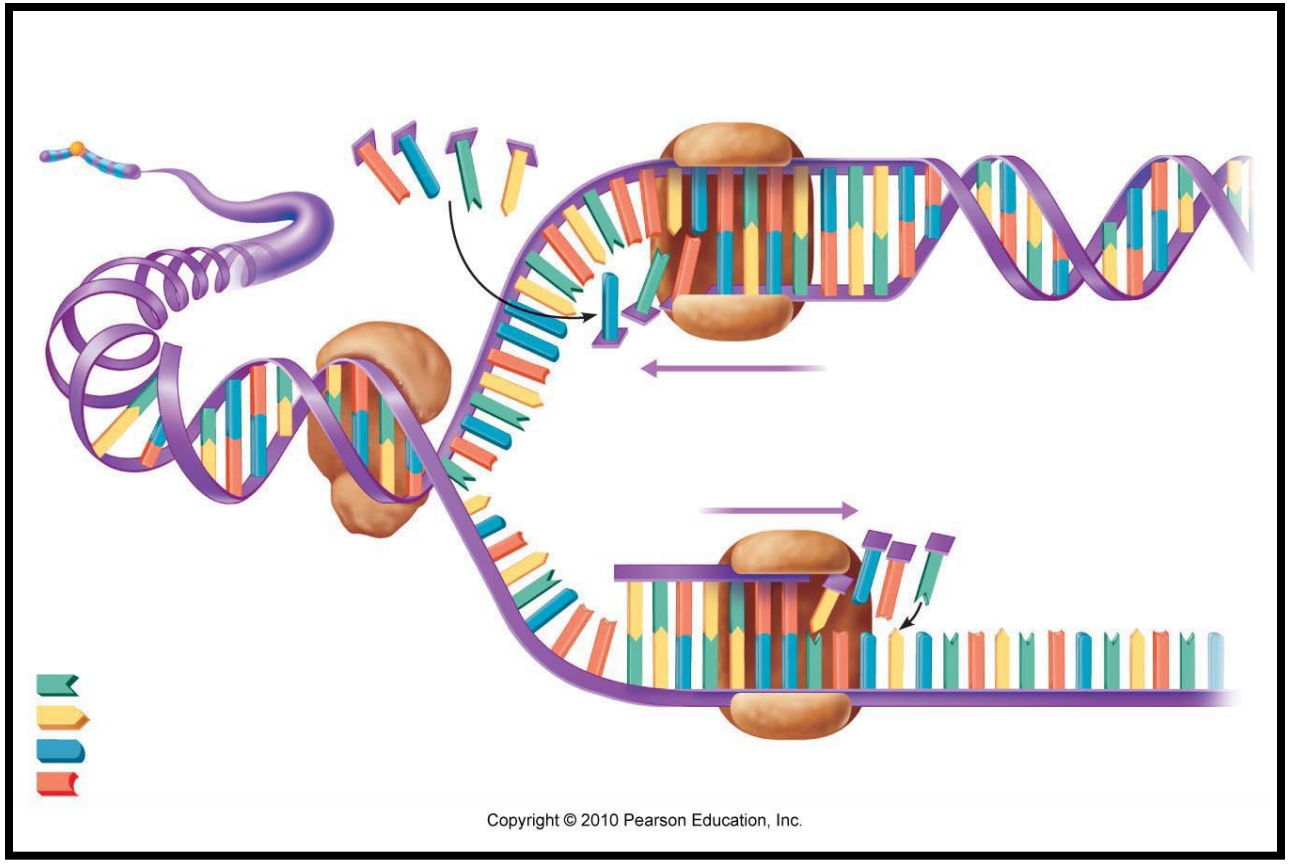
TYPES OF ENDOCYTOSIS



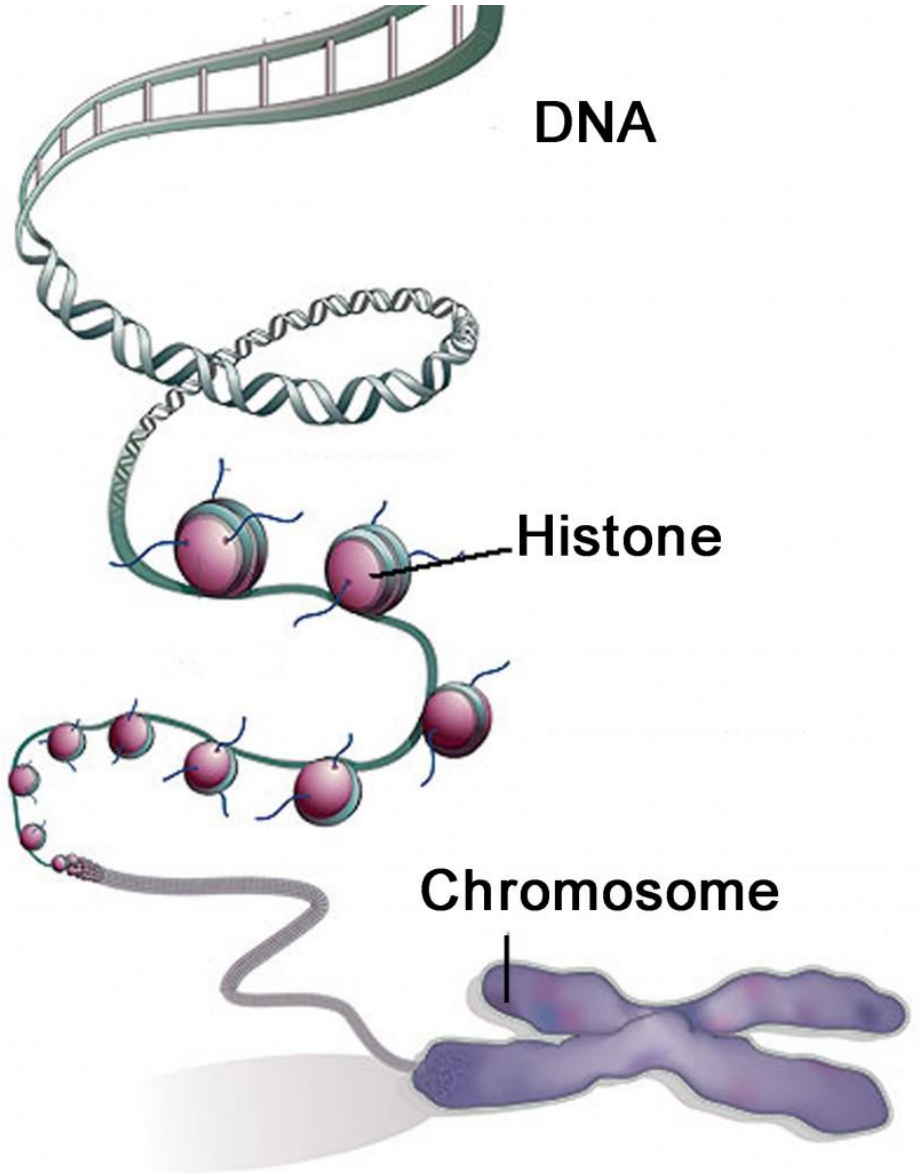
- Receptor-mediated endocytosis: concentrate specific substances (*ligands*) that bind to *receptor proteins*
  - Eg. insulin, iron, cholesterol

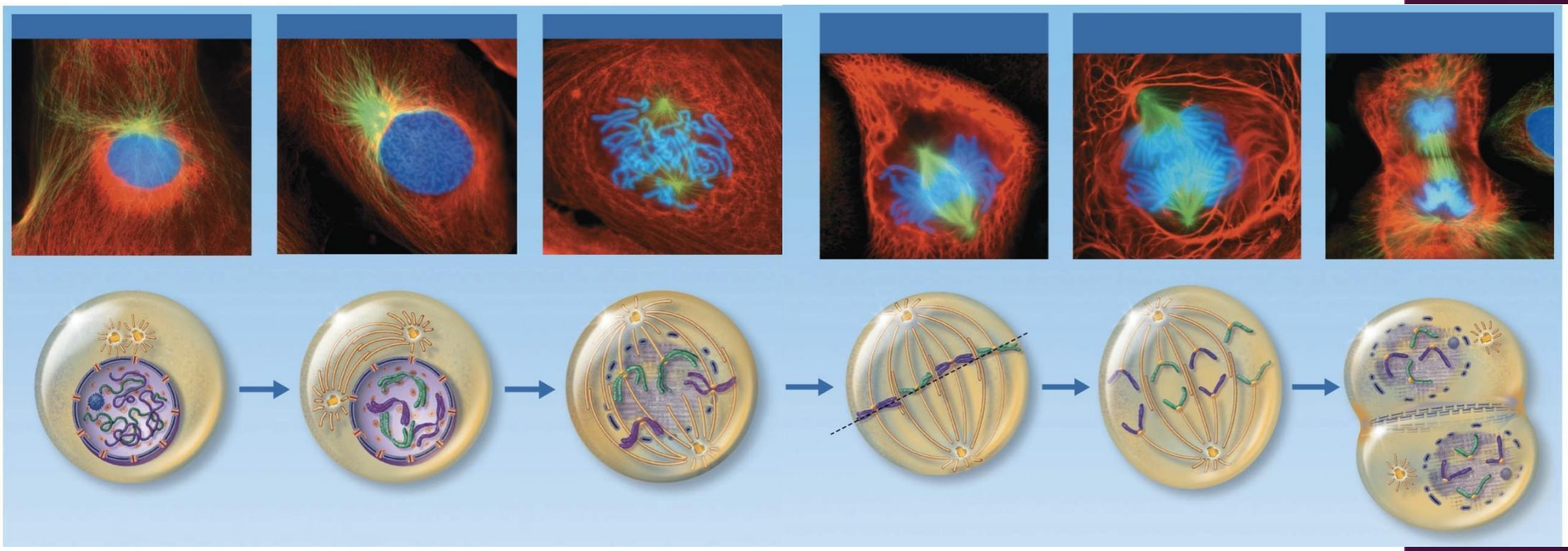
REPLICATION

- Make identical copies of DNA before a cell divides



During cell division, chromatin condenses to form ***chromosomes***.





MITOSIS

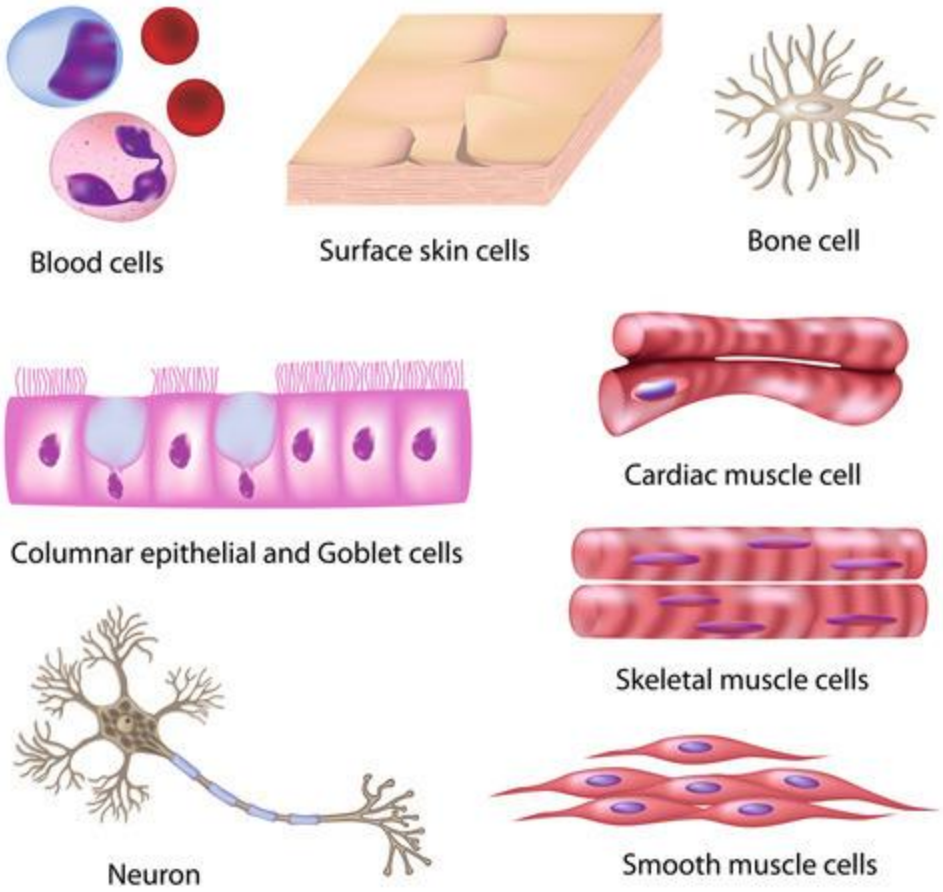
- Part of cell division
- Replicated DNA divided into 2 daughter cells
- Usually lasts about an hour
- Interphase → prophase → metaphase → anaphase → telophase & cytokinesis

Cheek Cell Lab

- Must observe 3 different cells:
  - Your cheek cells
  - 2 prepared microscope slides
- Need the following on your paper:
  - Cell Type
  - Drawing under low magnification
  - Drawing under high magnification
    - Label Cell Parts/Organelles if you can
- Answer the following:
  - List 2 organelles that were NOT visible but should have been in the cheek cell.
  - Keeping in mind that the mouth is the first site of chemical digestion in a human.Your saliva starts the provss of breaking down the food you eat. Keeping this in mind, what organelle do you think would be numerous inside the cells of your mouth?

WHAT CELL IS THIS?

This activity will be due next class period!

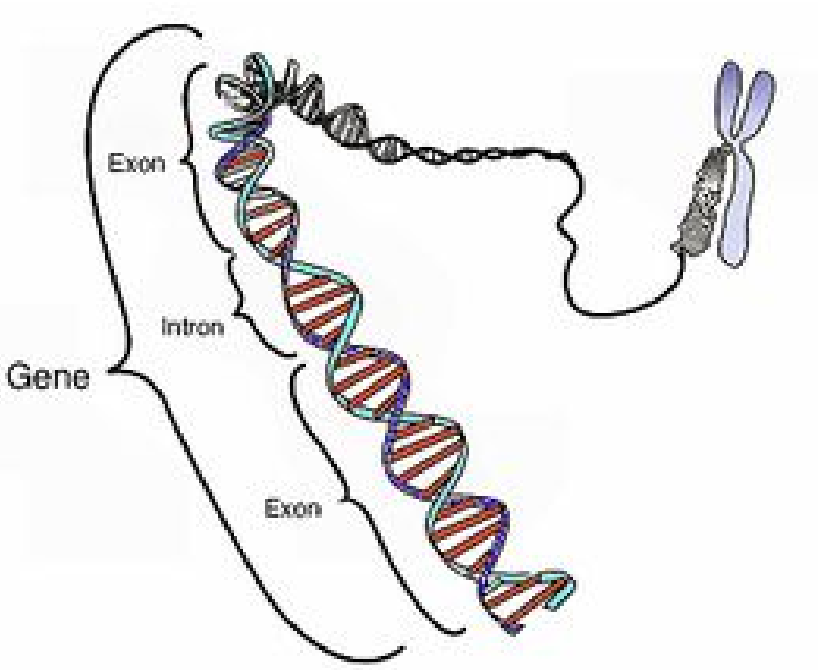


HAP IN THE NEWS

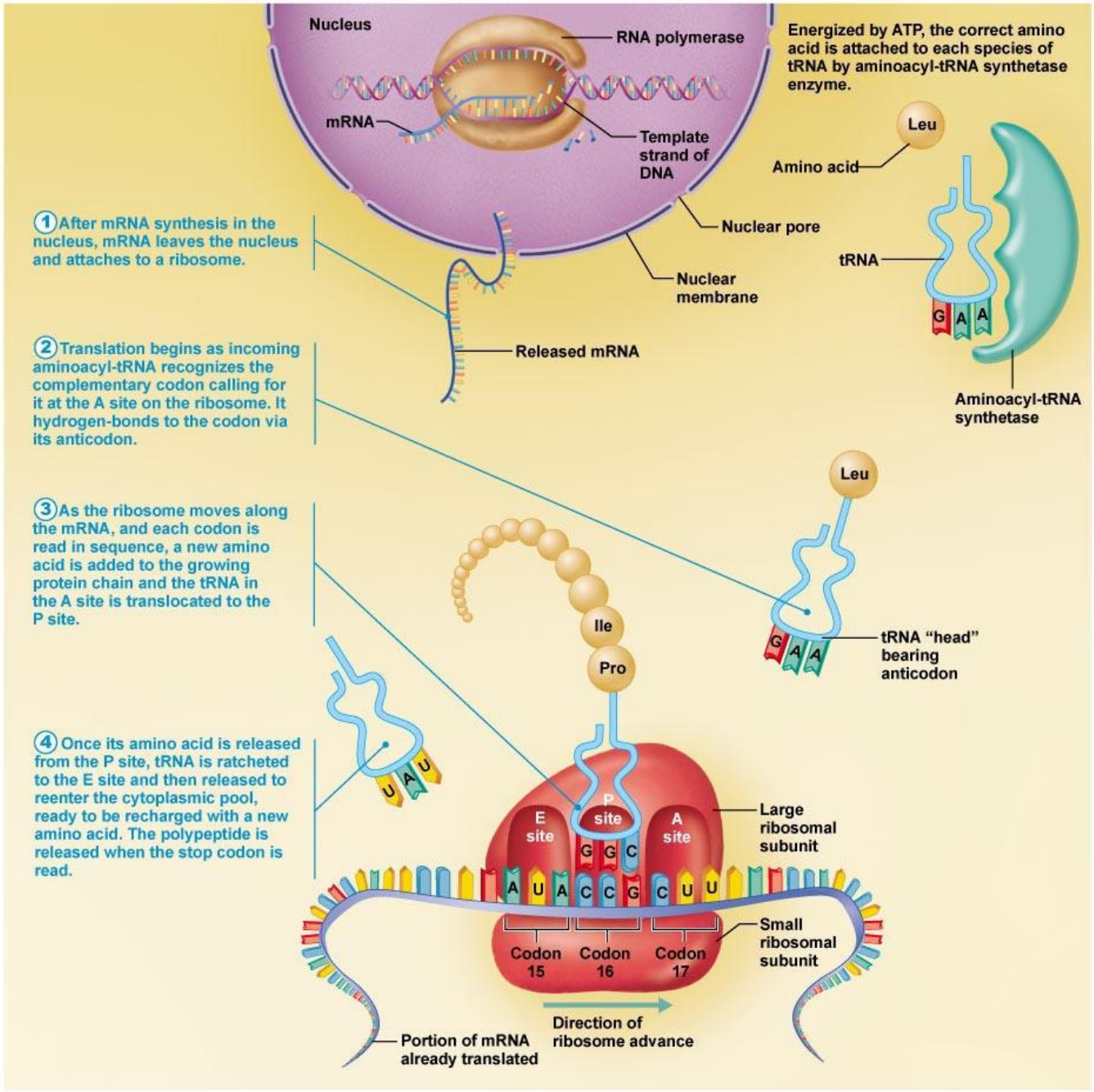
- **Protein that helps cancer cells source food may offer new treatment target**
- Topic: Cancer, proteins, tumors, relapse, cell nutrition, aspirin
- Essential Question: Does protein PAT4 fuel cancer cells?

http://www.medicalnewstoday.com/articles/300490.php

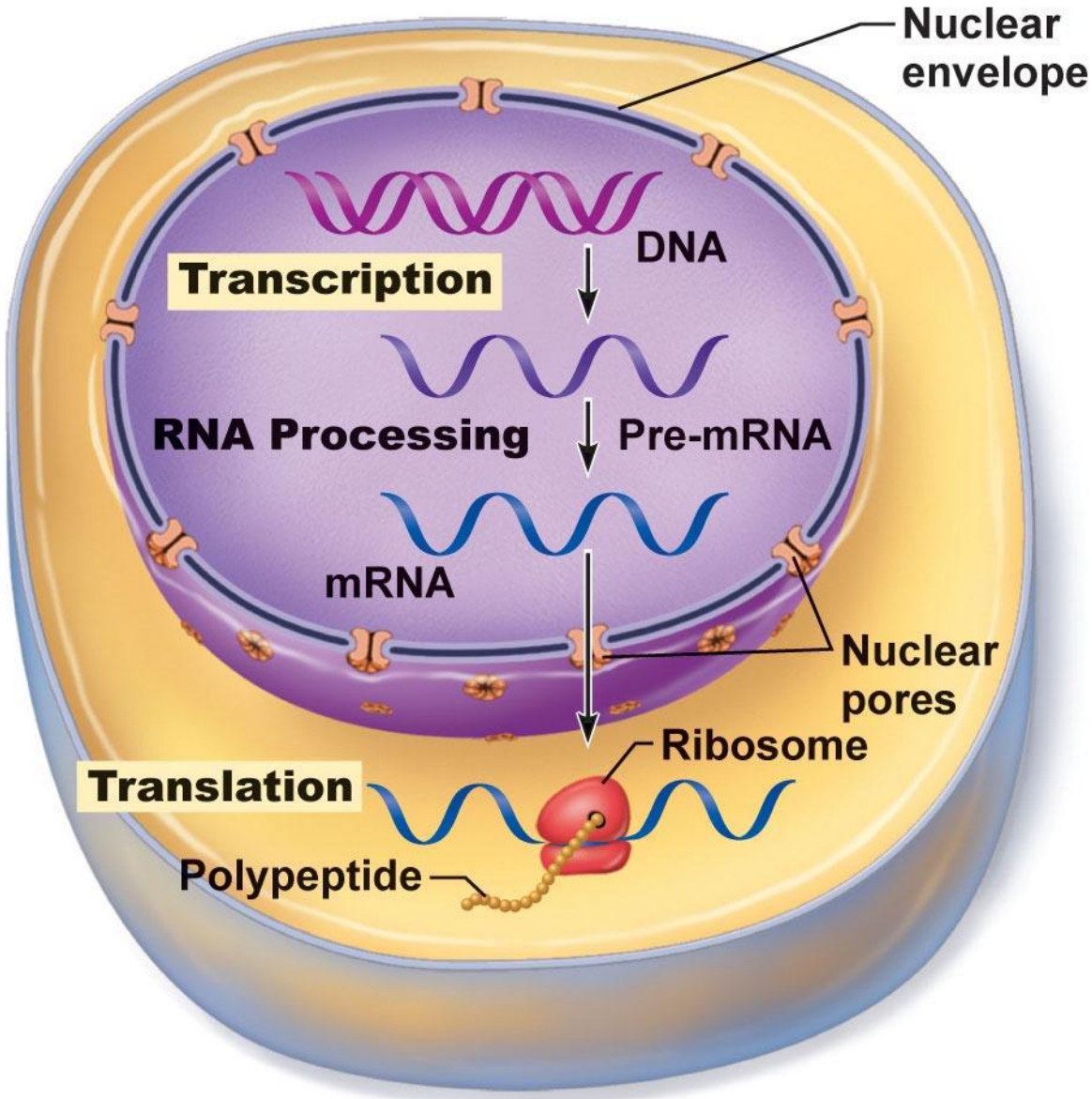
DNA = BLUEPRINT FOR PROTEIN SYNTHESIS



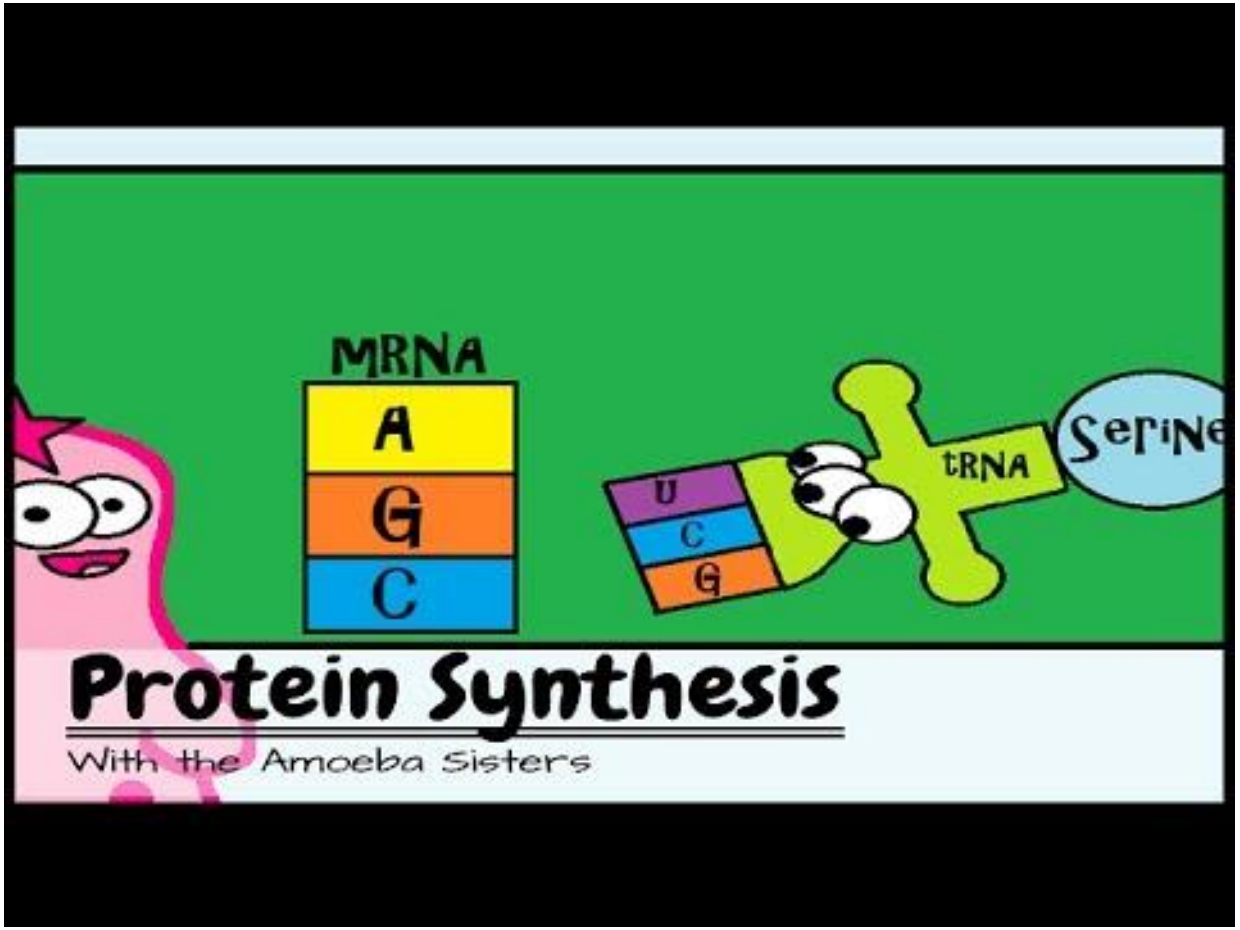
- **Gene**: segment of DNA that codes for 1 polypeptide
- **Exon**: part of DNA that codes for polypeptides
- **Intron**: part of DNA that is noncoding (not "junk"!)



INFORMATION FLOW: DNA → RNA → PROTEINS



How do we make proteins?

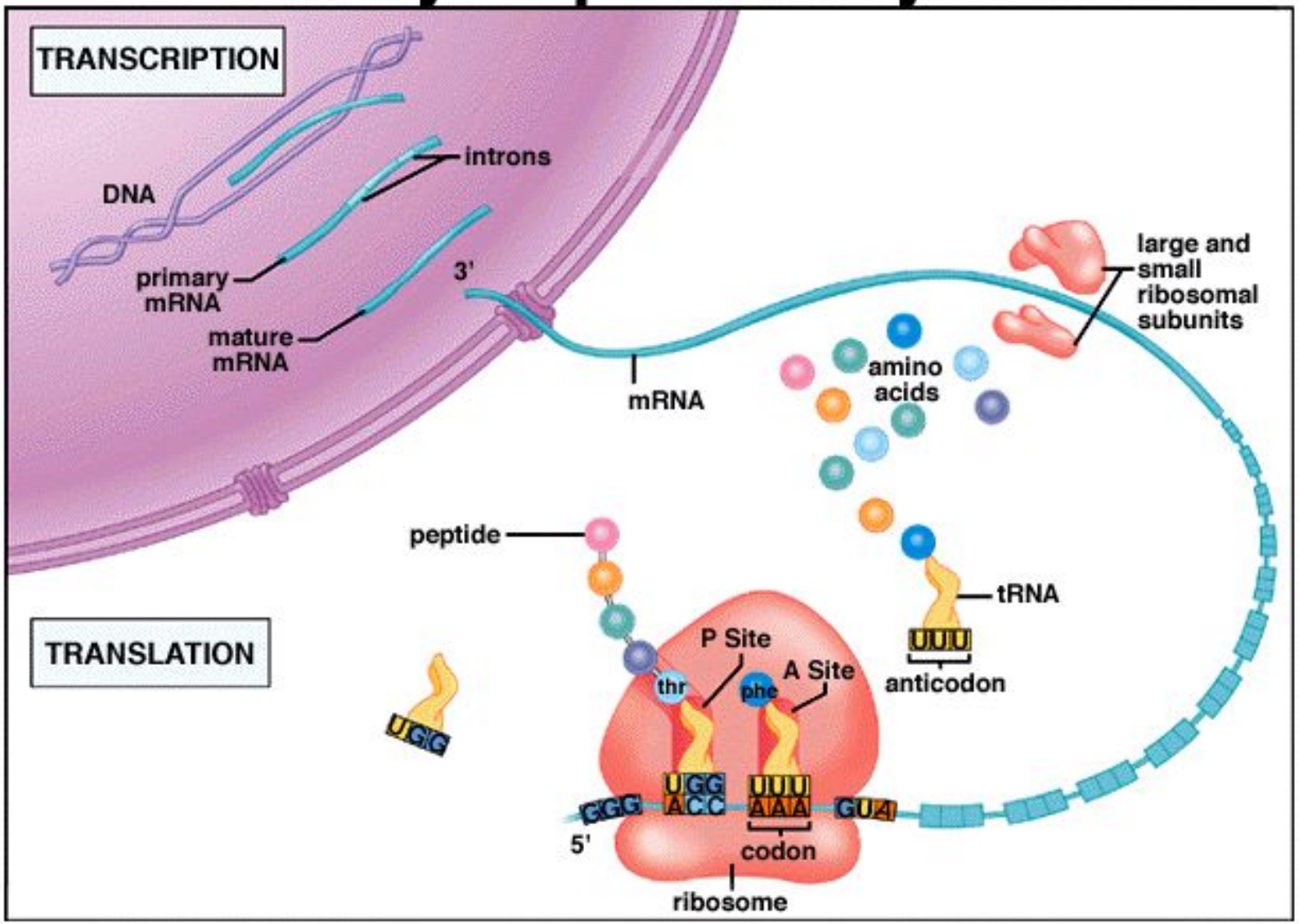


PROTEIN SYNTHESIS

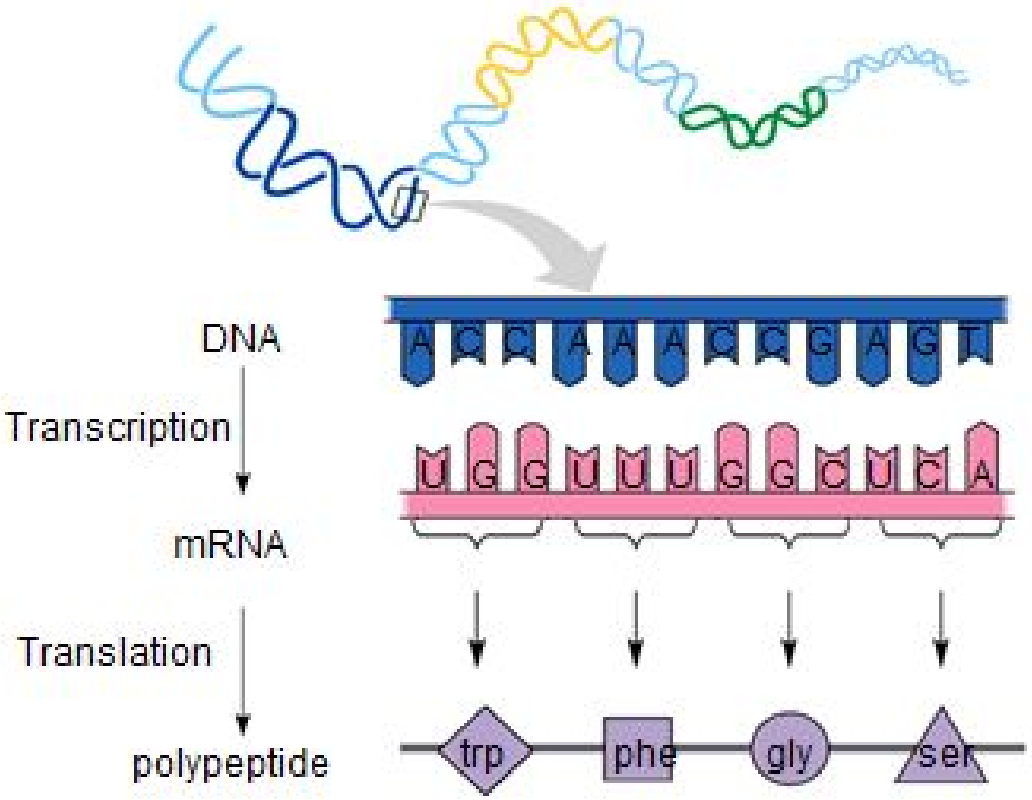
- **Transcription**: RNA formed from DNA
  - Occurs in nucleus
  - Types: mRNA, tRNA, rRNA
- **Translation**: protein synthesis
  - polypeptide formed from mRNA
  - Occurs in cytoplasm
  - By **ribosomes**

GENE → PROTEIN

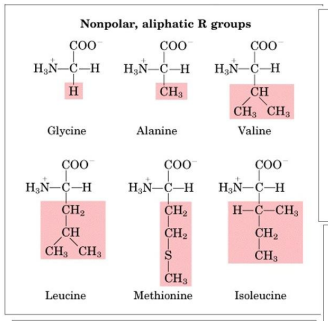
Summary of protein synthesis

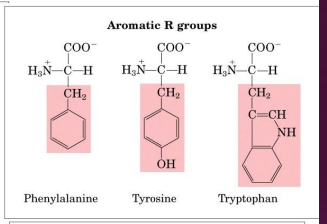


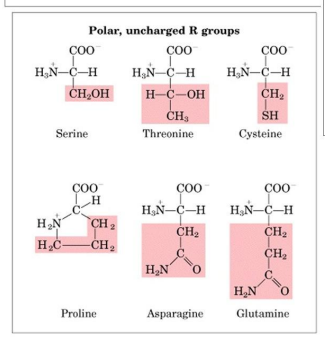
Triplet-code Instructions for a polypeptide

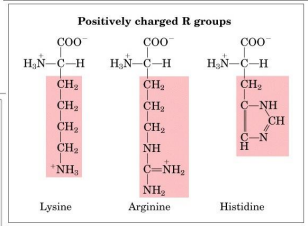


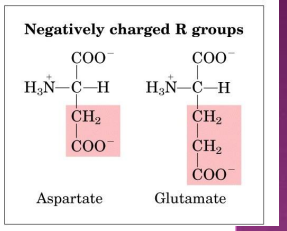
First Base in Codon	Second Base in Codon: U	C	A	G
U	UUU Phe UUC Phe UUA Leu UUG Leu	UCU Ser UCC Ser UCA Ser UCG Ser	UAU Tyr UAC Tyr UAA TERM UAG TERM	UGU Cys UGC Cys UGA TERM UGG Trp
C	CUU Leu CUC Leu CUA Leu CUG Leu	CCU Pro CCC Pro CCA Pro CCG Pro	CAU His CAC His CAA Gln CAG Gln	CGU Arg CGC Arg CGA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











Practice Problem!

GGGATCGATGCCCCTTAAAGAGTTTACATATTG

1. Translate into mRNA
2. Bind to tRNA and rRNA
3. Read the codon and bind the corresponding polypeptide
4. Results in an polypeptide composed of 11 amino acids

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

Try for yourself!

DNA: GCTATCGATCCTAGCATTGCCTGACTGGATCGA

RNA:

CGAUAGCUAGGAUCGUAACGGACUGACCUAGCU

tRNA:

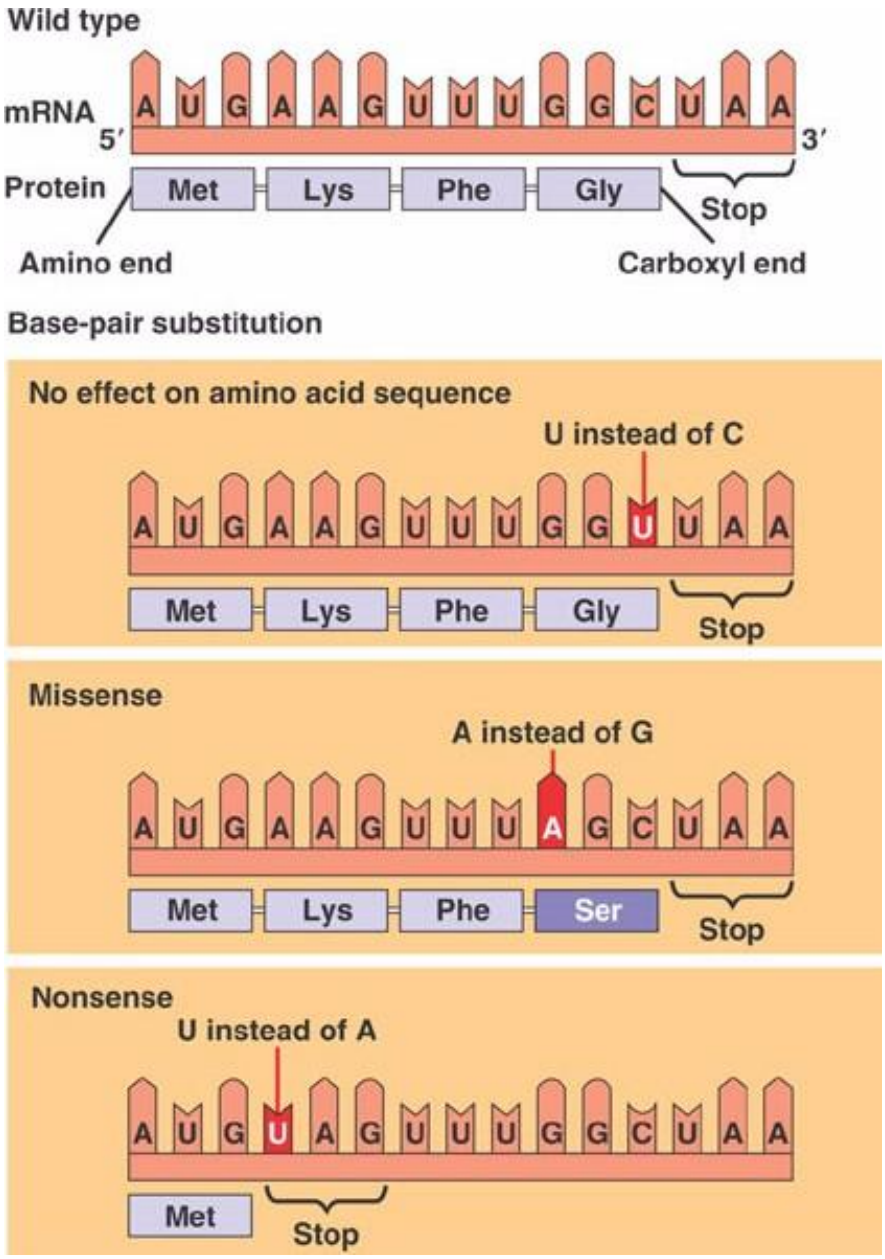
CGA UAG CUA GGA UCG UAA CGG ACU GAC CUA GCU

Polypeptide:

Arg STOP Leu Gly Ser STOP Arg Thr Asp Leu Ala

Everyone makes mistakes

What physiological effects might a mutation have on the body?



Frameshift Mutation: Insertion or Deletion

- Cancer
- Crohn's Disease
- Cystic Fibrosis
- Tay-Sach's

Missense Mutation: Swapping a base, change an amino acid

- Cancer

Nonsense Mutation: Swapping a base, creating a stop codon

- Cystic fibrosis
- Duchenne muscular dystrophy
- Hurler's syndrome

Alien Encounters!

1. You need to have the following:
   a. Blue sheet- DIRECTIONS. READ THEM.
   b. Yellow code sheet
   c. White data sheet
   d. Your personal Alien gene codes

Why might we want to determine the *traits* a **gene** will code for?

Reminder:

***Put up Alien Encounter Gene/Amino Acid Sequencing Codes

Alien Encounters!

After you have completed the data table, switch with a partner/friend and have them confirm your results. Have them sign off on your data table!

Then ask Ms. S for the final check!

Make sure you answer the questions and include a drawing of your alien!

Due next class

When you are done: page 74 in your textbook

- Read section about Mitosis, draw the steps, write a description for each

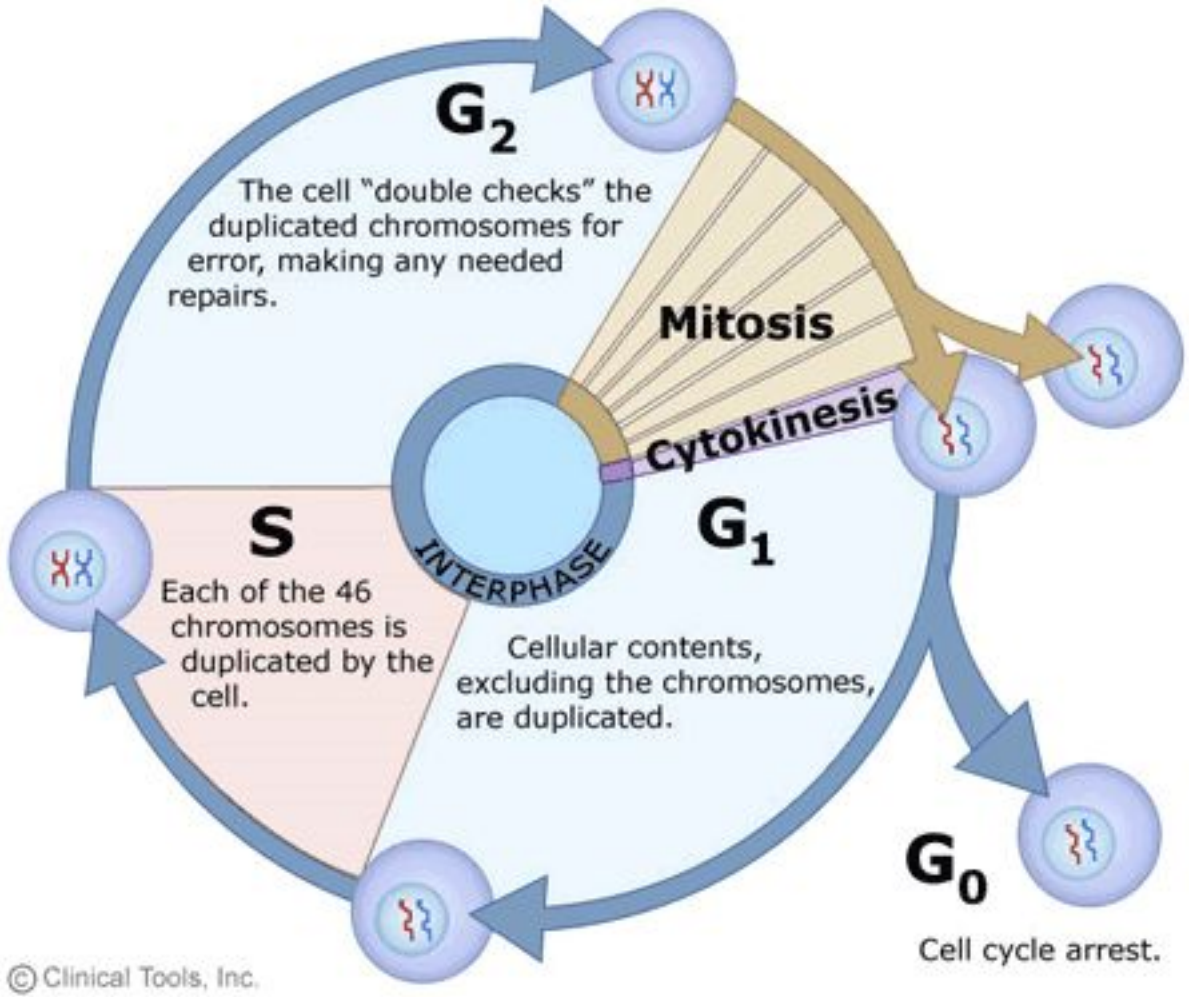
HAP in the News

- **Woman Has a Rare Condition That Allows Her to Remember Every Single Moment of Her Life**
- Topic: Highly Superior Autobiographic Memory/Hypermnesia- abnormally vivid or complete memory or recall of the past

Liz Renegar

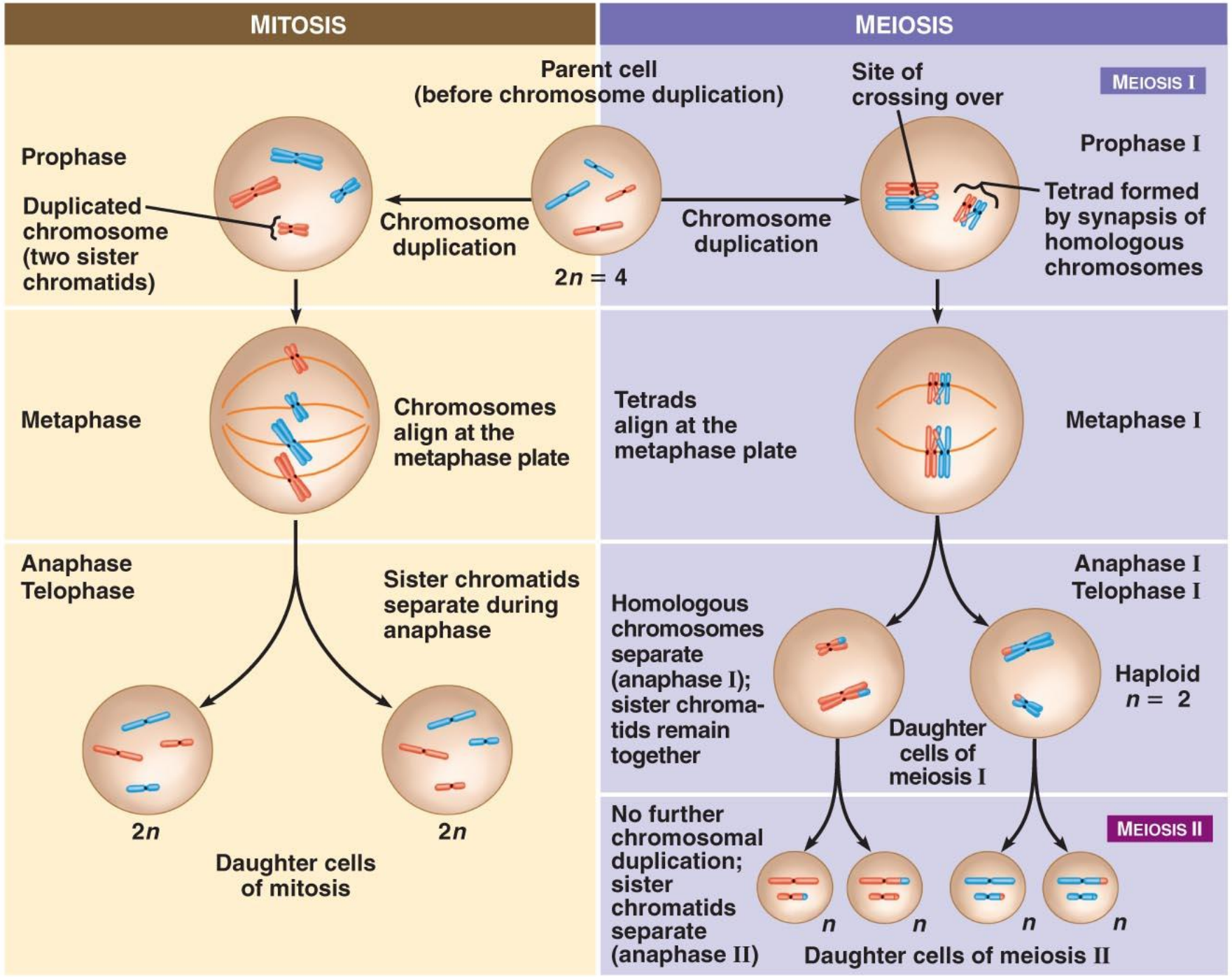
http://www.womansday.com/life/real-women/a52209/this-womans-rare-condition-means-that-she-can-recall-every-single-moment-of-her-life/

Cell Cycle


G2
The cell "double checks" the duplicated chromosomes for error, making any needed repairs.
Mitosis
Cytokinesis
S
Each of the 46 chromosomes is duplicated by the cell.
INTERPHASE
G1
Cellular contents, excluding the chromosomes, are duplicated.
G0
Cell cycle arrest.
© Clinical Tools, Inc.

Cell Division

- Mitosis
  - Eukaryotes
  - One cell replicates to create 2 identical copies
- Meiosis
  - Eukaryotes
  - Gametogenesis
  - One cell replicates twice to create 4 copies
- Binary Fission
  - Prokaryotes
  - One cell replicates to create 2 identical copies



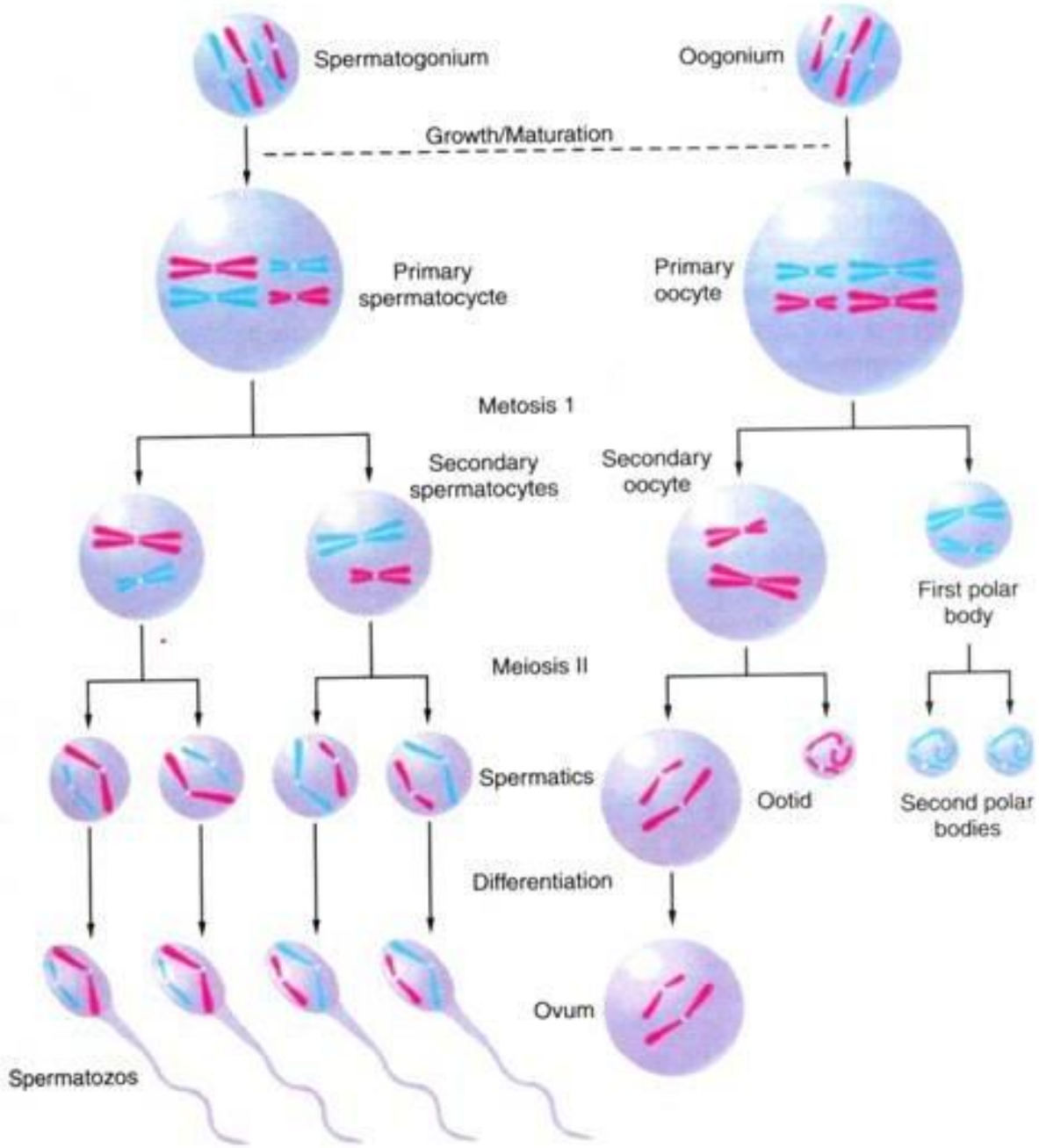
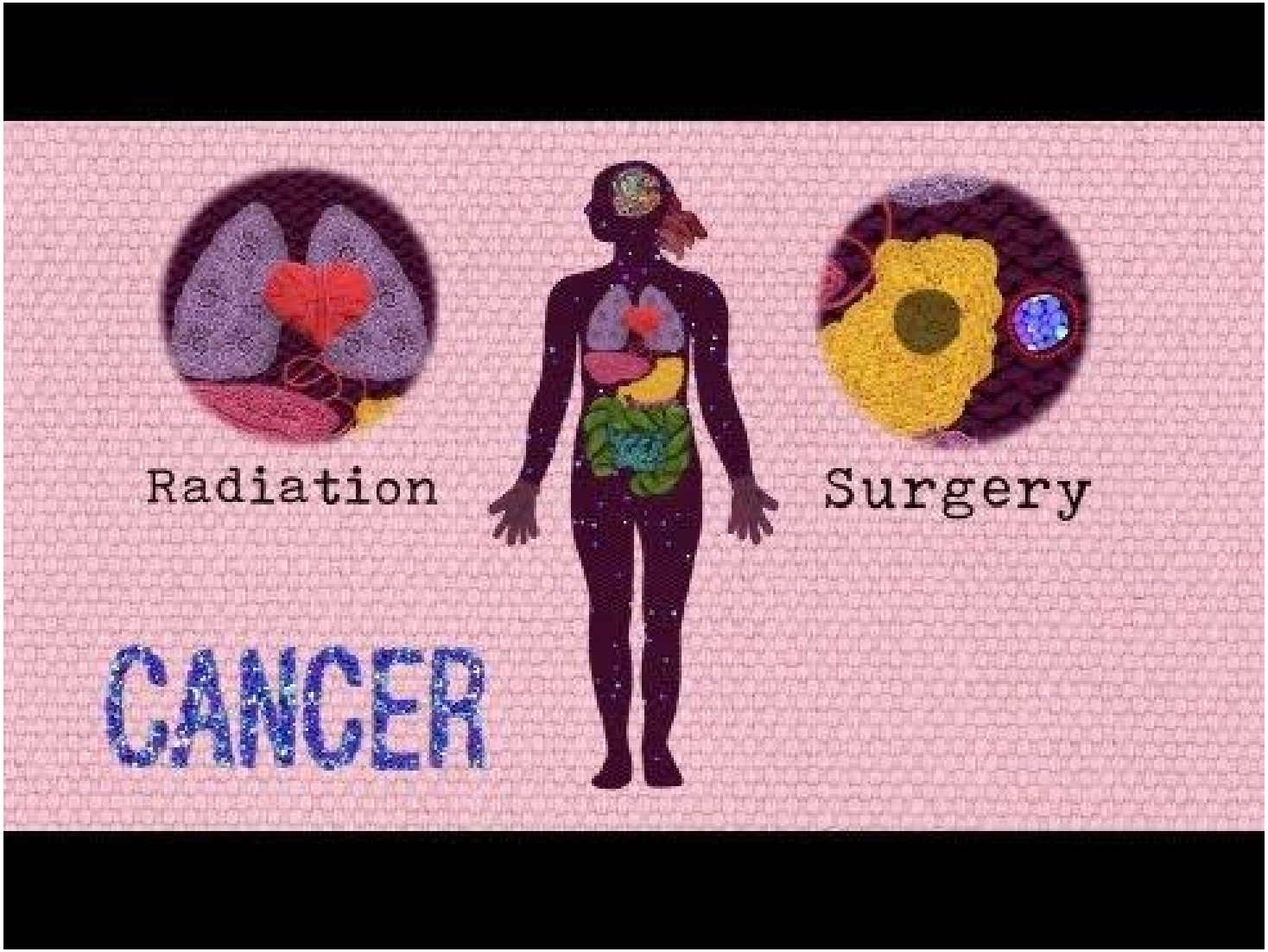


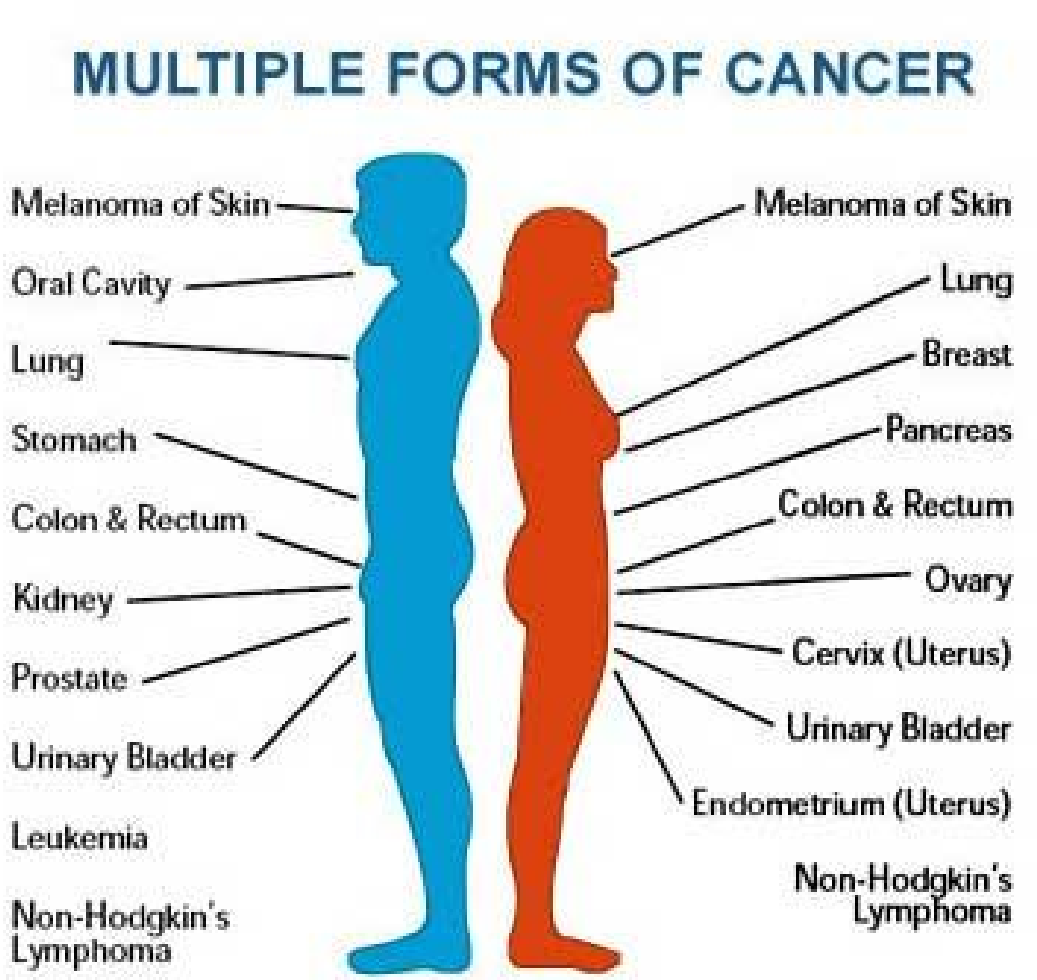
Image 9.5. Production of human sex cells ovum and spermatozoa.

Telomeres & Aging

http://learn.genetics.utah.edu/content/chromosomes/telomeres/


Radiation
Surgery
CANCER

Cancer Study



Review Day!

1. What Cell Am I?
2. Cheek Cell Lab
3. Looking forward...
4. Test/Midterm Review

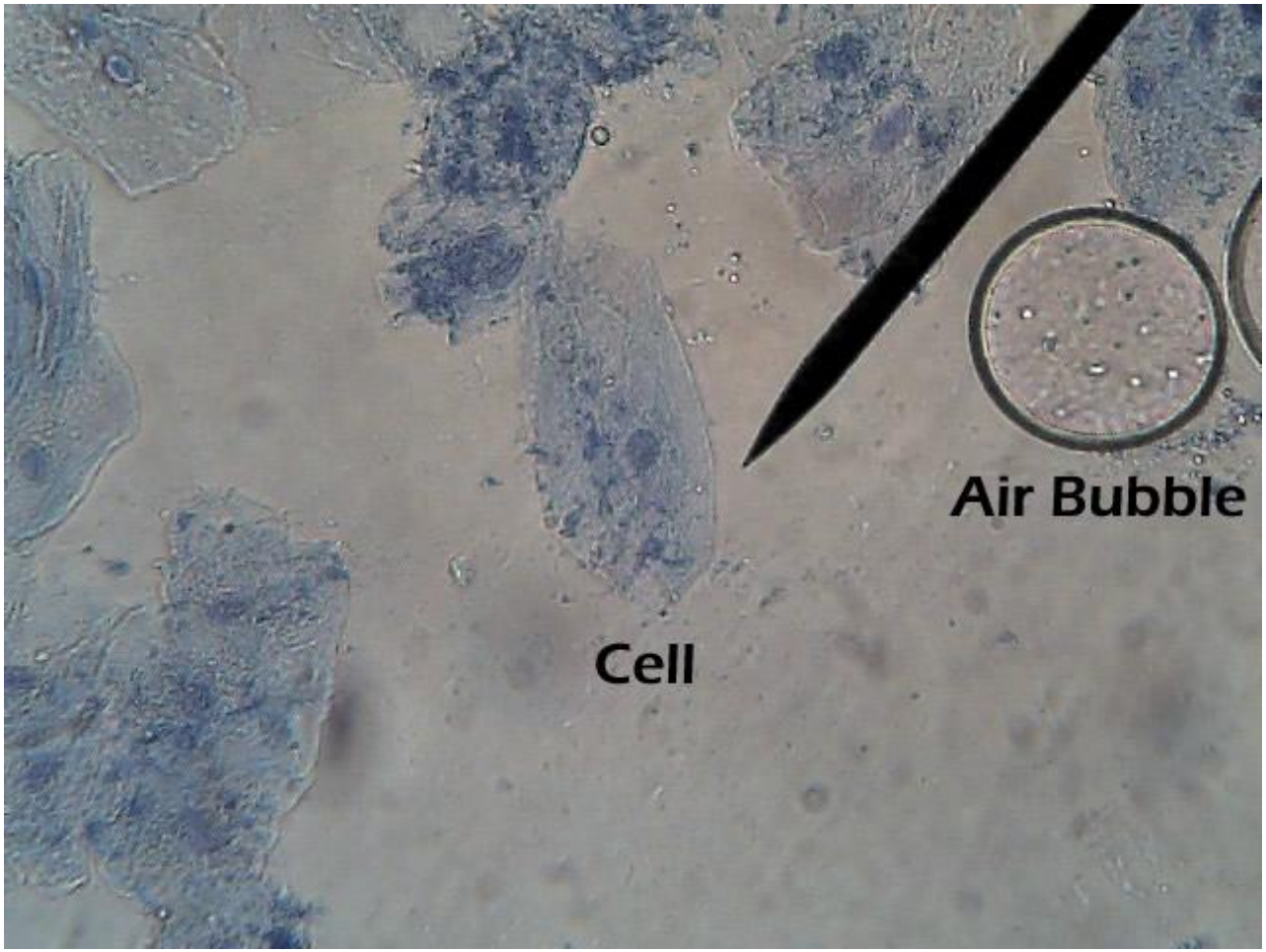
What Cell Am I?

You will find 3 cell types that interest you (must be different than the cell type you examined!)

On a piece of scratch paper, I need the following:

1. Location of the cell
2. Function of the cell
3. A question you have about that cell type

Cheek Cell Lab



x400

Looking Forward

- Next Unit: Tissues/Histology
  - Short, quick unit
  - Last of the “intro” units
  - Test = Lab Practical
    - Identify tissue types and their locations
- Midterm?
  - Nah.
- Integumentary System
  - More Labs!
  - More Activities!
- We’re getting cats, hearts, and kidneys to dissect
  - Oh my.

Cell Test

50 questions

- True/false
- Multiple choice
- Protein synthesis problem
- Short answer
  - 3 prompts
- Bonus questions
  - 5 points possible

Topics

- Cells
  - Organelles & Functions
  - Plasma Membrane
  - Nucleus
  - Extracellular Matrix
- Cell Transport
- Protein synthesis
- DNA replication
- Cell division
- Stem Cells
- HAP in the News
  - Anthony Atala
  - PAT4

Cell Review

- Kahoot
- Bluff
- White Boards
- CELL VIDEOS =)