BIOL 1107
Endomembrane System and Membrane Transport

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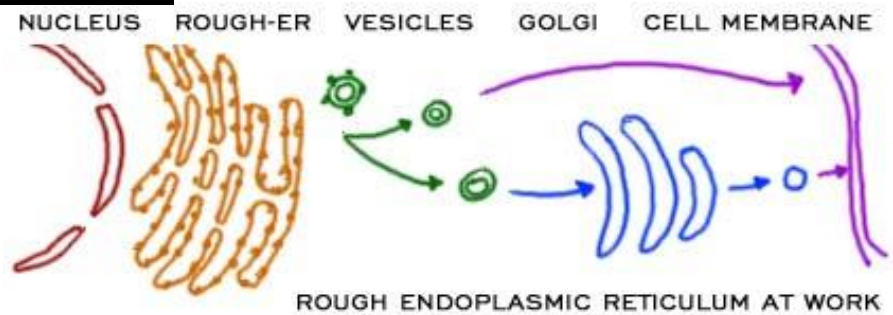
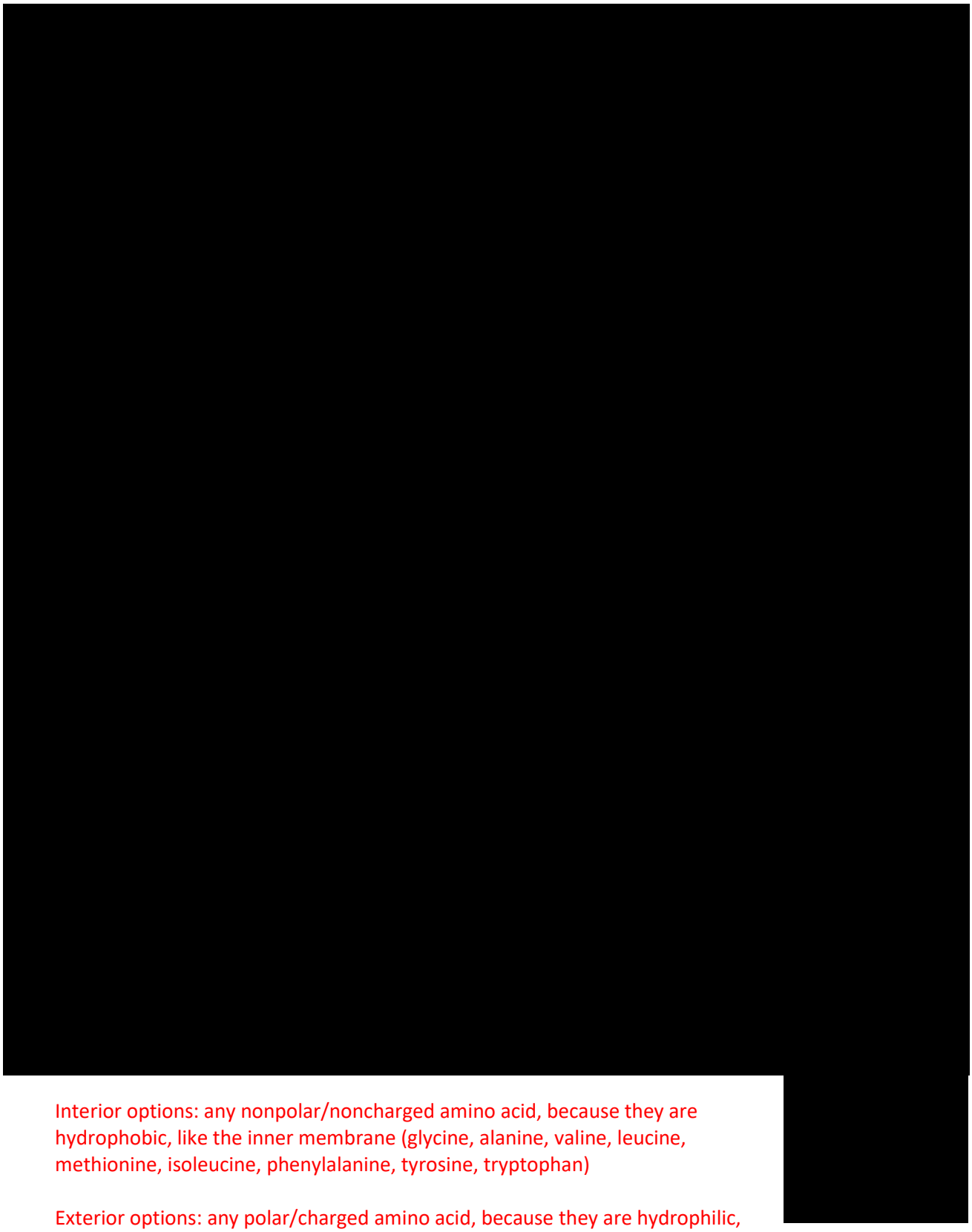
Both types of ER are part of the endomembrane system, and both synthesize molecules and then send them to the Golgi for further processing. The rough ER contains ribosomes, whereas the smooth ER doesn't. The two types of ER synthesize different types of molecules, rough ER being primarily involved with proteins. The smooth ER also performs detoxification, which the rough ER does not.

Synthesis occurs in the smooth ER. Early forms of carbs are then sent to the Golgi via secretory vesicles, where they are received by the cis face of the Golgi and further refined. Once fully assembled, carbs are transported out of the Golgi in vesicles thru the trans face of the organelle, to their ultimate destination inside or outside of the cell. The refinements made in the Golgi include "tags" to ensure that the molecules are recognized and reach the correct destination.

[redacted]



Great diagrams will label/describe: DNA initially codes for RNA, RNA travels to rough ER where it's made into a protein via ribosome action, protein is transported by vesicle to Golgi and refined, and then released in a vesicle into or out of the cell for its intended use.



Interior options: any nonpolar/noncharged amino acid, because they are hydrophobic, like the inner membrane (glycine, alanine, valine, leucine, methionine, isoleucine, phenylalanine, tyrosine, tryptophan)

Exterior options: any polar/charged amino acid, because they are hydrophilic, like the inside and outside of the cell membrane (serine, threonine, cysteine, proline, asparagine, glutamine, lysine, arginine, histidine, aspartate, glutamate)

[redacted]

Because they are attached to the outside of the cell membrane, exposed to the water-based environment of the extracellular fluid. Glycoproteins and glycolipids must be able to interact with this environment, therefore they must be hydrophilic.

[redacted]

[redacted]

The fluidity of the membrane allows phospholipids and other membrane components to flow as needed. When the membrane is punctured, it doesn't burst. Instead, membrane components immediately flow to seal the breach in the membrane. When this occurs, there will be a shift in the composition of the membrane in the section being viewed, changing the viewed image.

Correct options: increase concentration of phospholipids (denser arrangement); increase presence of long-tailed phospholipids to increase “sticking”; increase presence of saturated phospholipids (tighter packing); decrease presence of cholesterol (specify only in cold conditions)

Passive transport, because energy is <u>not</u> required to move solute down its concentration gradient (from high to low concentration, as in <u>*down*</u> a slide). Looking forward, we must also consider whether the molecule can cross the membrane without facilitation, despite the concentration gradient…

[redacted]

Solute moves down its concentration gradient (ask yourself: is energy required for this? No, it's passive). It starts at high concentration outside of the cell (extracellular fluid), and begins moving into the cell (cytoplasm) towards low concentration. As the concentration increases inside the cell, some solute begins moving out of the cell, as well. Eventually, as the concentrations of the solute become equal, the rate of solute moving in equals the rate moving out, and equilibrium is reached. Solute movement continues, but there is no net change in concentration.

[redacted]

Assuming nothing disturbs the equilibrium, the solute will move into and out of the cell, at roughly equal rates, such that the concentrations inside and outside of the cell will remain roughly equal. This is the nature of equilibrium.

[redacted]

Possible answers: increase or decrease of water in the environment inside or outside of the cell, which would change solute concentration on one side of the cell membrane, creating a new concentration gradient that would require a new equilibrium; change in solute concentration inside of the cell due to a change in what is being synthesized inside the cell (solute being used up rapidly); change in nutrition that affects the availability of the solute and therefore its concentration in the extracellular fluid; *anything that would change the concentration of solute* ***on one side*** *of the cell membrane, creating a* ***new concentration gradient***

[redacted]

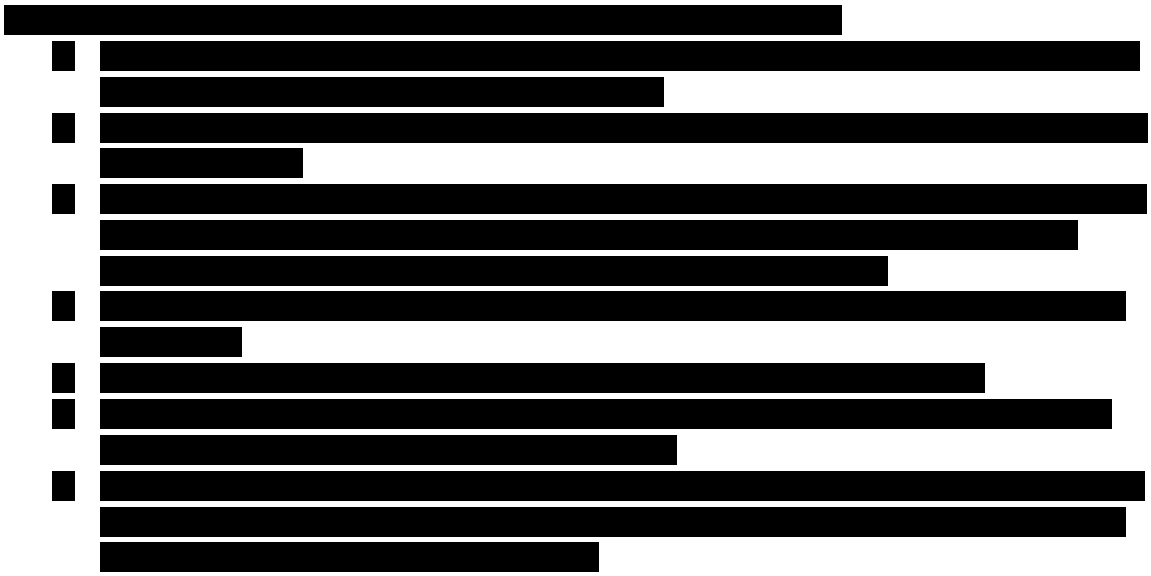
Both are passive, so solute is moving down its concentration gradient in both cases. However, simple diffusion involves nonpolar particles that can cross through the hydrophobic inner membrane without assistance, whereas facilitated diffusion employs proteins to move polar or charged substances that cannot encounter the inner membrane on their own.

When dehydration occurs, not enough water is in bodily circulation. This raises solute concentrations of bodily fluids, because the volume of bodily fluids is reduced while solute count remains the same (concentration = mass solute / volume solution). This leads to extracellular fluids becoming **hypertonic** relative to cells, or having a lower concentration of water relative to the cytoplasm inside the cell. Water will then flow from high water concentration to low, so water leaves the cell via aquaporin channels out into the extracellular fluid. If this persists, cells lose too much water, and essentially wither and die.

We know that the extracellular environment is generally positive in charge relative to the cytoplasm in the cell. This is important, because maintaining an electrical gradient is necessary to control the uptake of many important charged particles needed by the cell.

We know that cells are safe and healthy in isotonic environments, so that osmosis is not impacted detrimentally. This requires the combined concentration of all solute in and out of the cell to be roughly even. So, we can infer that overall concentrations of solute are the same on both sides of the cell membrane.

Maintenance of a concentration gradient requires avoiding equilibrium, though equilibrium is the natural outcome of passive diffusion. So, active transport must be used to pump solute against (up) its concentration gradient, from low concentration to high (as in up a slide, requiring energy). This continued, net movement of solute towards the already higher concentration maintains concentration gradients, and requires substantial energy inputs from the cell.



[redacted]

The NCX pump can only move Ca^{2+} out of the cell if it simultaneously diffuses three sodium ions into the cell. Diffusion involves the passive movement of solute down a concentration gradient, so an existing gradient of Na^{+} must exist for NCX pump operation, with higher concentration outside of the cell. The sodium-potassium pump is responsible for creating such an Na^{+} gradient. Ouabain prevents the sodium potassium pump from functioning, depleting the Na^{+} gradient, preventing the NCX pump from removing Ca^{2+} from the cell, all leading to cardiac arrest.

[redacted]

Transport Method	Active or Passive?	What is Transported?	How's it work?
[redacted]	Passive	Small, nonpolar particles	Nonpolar, non-charged small particles passively move down their concentration gradients, across the cell membrane
	Passive	Water	The diffusion of water, based on the same concentration gradient dynamics as diffusion
	Passive	Small, polar or charged particles	Same as simple diffusion, but with the use of membrane proteins to allow the passage of charged or polar molecules across the hydrophobic inner membrane
	Active	Smaller particles that need to be moved against their gradient, such as sodium, potassium and calcium	Active transport mechanisms such as pumps use ATP-derived energy to send particles across the membrane, against (up) their electrochemical gradient

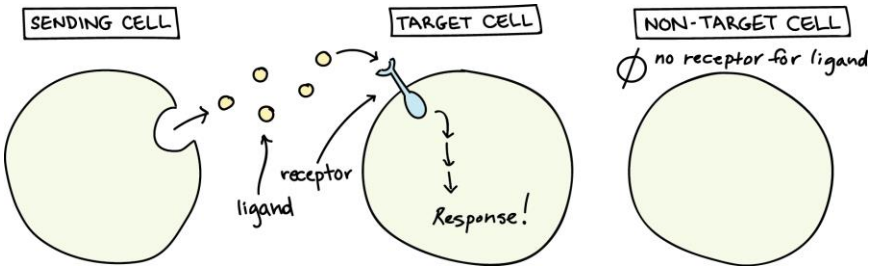
[redacted]	Active	Large molecules such as amino acids and sugars, often in conjunction with sodium ions	A result of primary active transport: the gradient created and maintained by primary active transport leads to diffusion of a substance back into the cell, sometimes in conjunction with other molecules needed by the cell (e.g. glucose, amino acids)
	Active	Large particles, such macromolecules, parts of cells, and even whole cells	The plasma membrane of the cell collapses inward, forming a pocket around the target particle, which may include the fluid around it. The pocket pinches off, resulting in the particle being contained in a newly created intracellular vesicle formed from the plasma membrane
	Active	A variety of things that need to be released from the cell: degraded cell components, secretions, digested waste, etc.	Waste material is enveloped and fuses with the interior of the plasma membrane. This fusion opens the membranous envelope on the exterior of the cell, and the waste material is expelled into the extracellular space

Larger cells have a smaller surface area to volume ratio, so they must “work harder” to bring the necessary substances into the cell. Regarding simple diffusion, few differences may be necessary, because no special membrane components are needed to accomplish it. However, regarding facilitated diffusion and non-bulk active transport, we may expect to see a larger concentration of membrane proteins. The reasoning for this inference is that a higher rate of transport per surface area would be needed for a large cell, which for most cell-types would require more protein “infrastructure” to bring in many types of substances.

[redacted]

[redacted]

Generally:



BEST DIAGRAMS CLEARLY SHOW: charged ligand (signal molecule) travels to target cell > binds to surface receptor bc it can't cross hydrophobic inner membrane due to its polarity > either the ligand-receptor complex travels to the nucleus, or another molecule is sent there *by* the action of the receptor molecule upon the ligand reaching it > the second messenger (see section above) reaches the DNA in the nucleus, and a response begins in the form of protein production or some other action

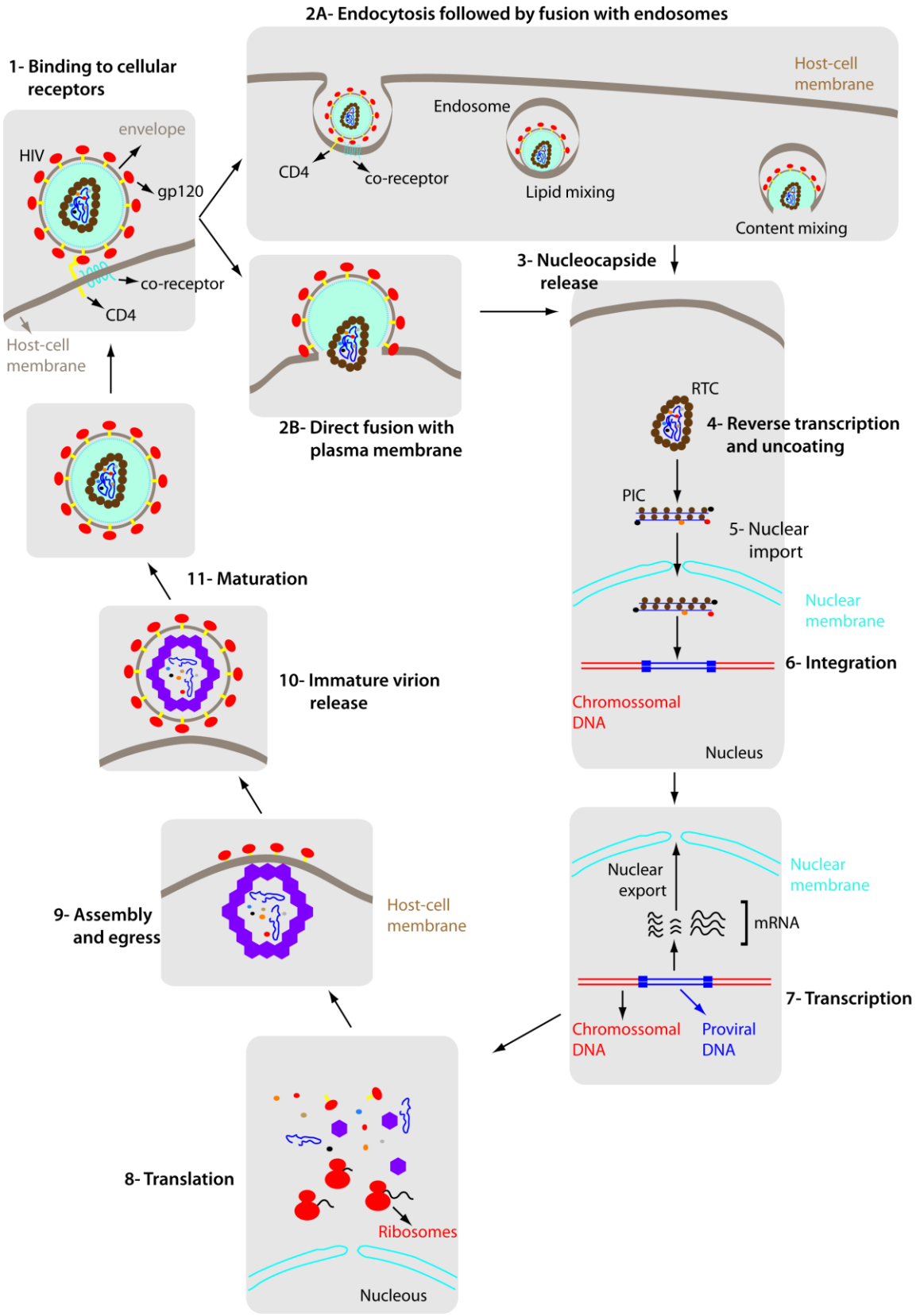
[redacted]

Everything would have the same range of mechanisms and outcomes, except that initially, the ligand would easily pass through the plasma membrane and meet a receptor molecule inside of the cell.

Viruses are receptor-specific, and only certain types of cells will have on their outer membrane the receptors needed by a specific virus.

An exemplary diagram is on the next page.

Yours should at least include the binding of the virus molecule to a receptor on the outer host cell membrane, the virus entering into the cell, release of virus DNA, integration virus DNA into host DNA, production of virus proteins, assembly of new virus molecules, and migration of new virus molecules out of the cell


1- Binding to cellular receptors
envelope
HIV
gp120
co-receptor
CD4
Host-cell membrane
2A- Endocytosis followed by fusion with endosomes
Host-cell membrane
Endosome
CD4
co-receptor
Lipid mixing
Content mixing
2B- Direct fusion with plasma membrane
3- Nucleocapside release
RTC
4- Reverse transcription and uncoating
PIC
5- Nuclear import
Nuclear membrane
6- Integration
Chromossomal DNA
Nucleus
7- Transcription
Nuclear export
mRNA
Nuclear membrane
Chromossomal DNA
Proviral DNA
8- Translation
Ribosomes
Nucleous
9- Assembly and egress
Host-cell membrane
10- Immature virion release
11- Maturation

[redacted]

First, we understand that water will move from regions of low solute concentration (and high water concentration) to regions of high solute concentration (and low water concentration). By observing changes in mass to the celery when placed in the four solutions of different NaCl concentrations, we can determine if the celery has a higher or lower solute concentration relative to the four solutions. If the celery concentration proves to be somewhere between the range of concentrations found in the solutions, then we should be able to estimate it.

For example, if the celery absorbs water mass in the .5 molar concentration solution but loses water mass in the .75 molar concentration solution, then we can deduce that the solute concentration of the celery is more than .5 molar and less than .75 molar.

[redacted]

I. 30 molecules of fructose ($C_6H_{12}O_6$) in 1 liter of water
II. 10 molecules of beryllium chloride ($BeCl_2$) in 1 liter of water
III. 12 molecules of sodium chloride (NaCl) in 1 liter of water

UNDERSTAND THE FOLLOWING:

- Solutions have more osmotic pressure as they increase in solute concentration.
- Options I, II and III all have the same volume, so we are only concerned with the quantity of solute particles in each.
- When ionic solutes such as NaCl and $BeCl_2$ are place in water, they split up into their ions. The more ions the compound has when whole, the more overall concentration they will impart upon the solution.
- Fructose is not an ionic compound, because it is not a combination of a positively charged metal and a negatively charged nonmetal. The other two compounds are ionic.
- NaCl splits into 2 ions, Na+ and Cl-, adding 24 mols of solute to the solution (12 X 4). $BeCl_2$ splits into 3 ions (one Be+ and two Cl-), adding 30 mols of solute to the solution.
- So, option II will be the most concentrated and possess the most osmotic pressure.

[redacted]

[redacted]

a. Desmosomal adhesion
b. Intercalated discs
c. Tight junctions
d. Gap junctions

Diffusion occurs across the plasma membrane of cells, as opposed to through the gaps between cells. To make sure that the substance is crossing the layer of cells via diffusion, they will be best served by using cells with tight junctions between them that will prevent the passing of any substances between the individual cell boundaries.

[redacted]