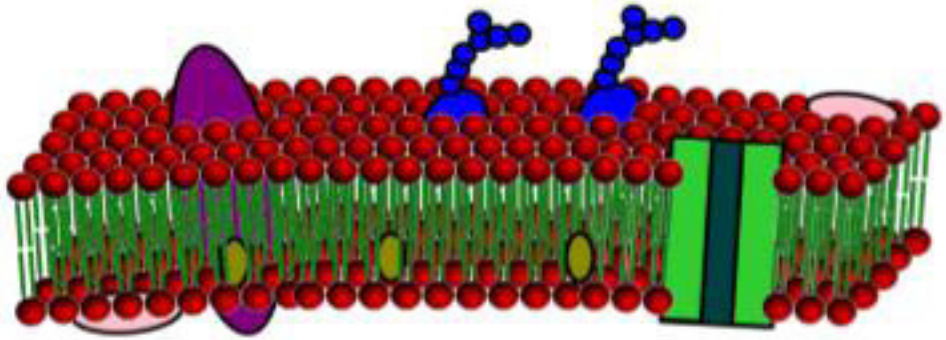


Membranes

Functions of a plasma membrane

1. Hold the cell together

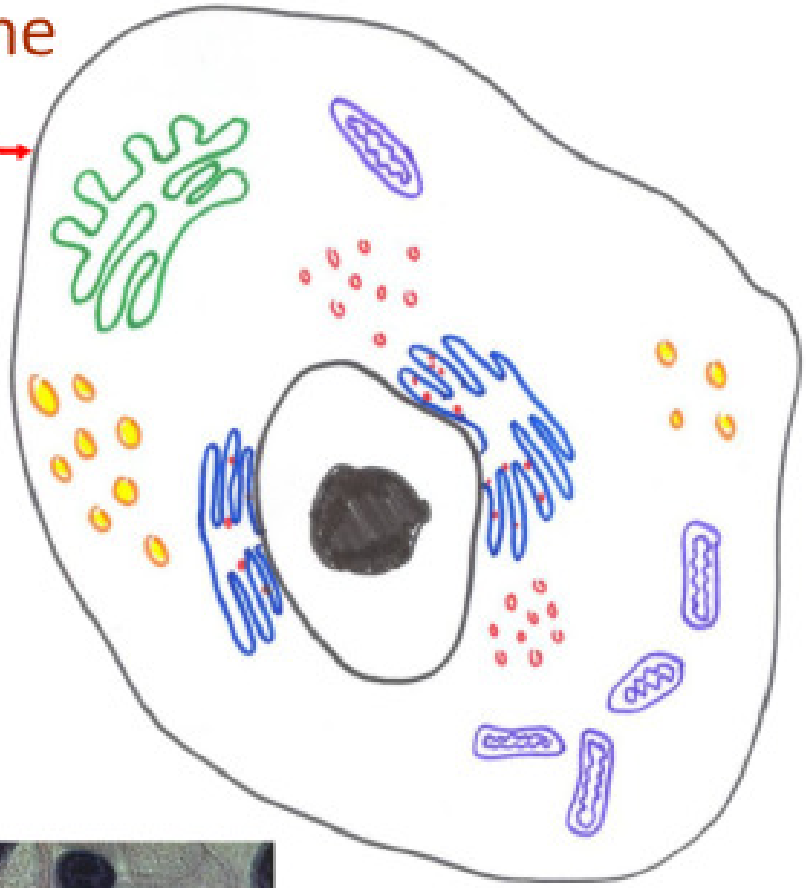
2. Control what goes in and out
   (diffusion, osmosis, active transport)

3. Protect the cell

4. Allow the cell to recognise and be recognised
   (cell signalling and immunity)

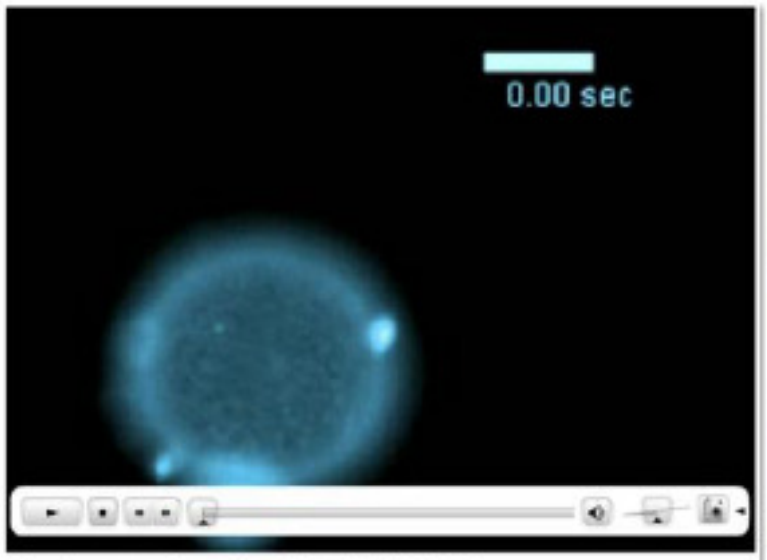
5. Bind to other cells and molecules

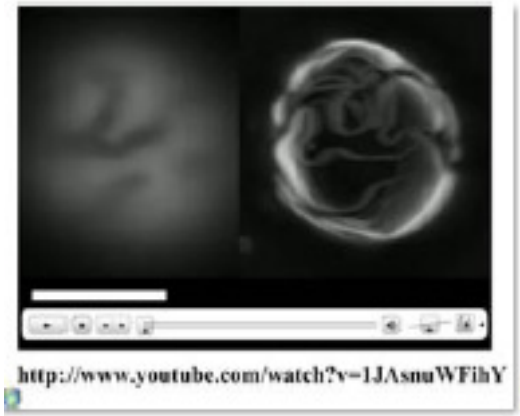
6. A site for biochemical reactions
   (enzymes, areas for reactions)



Liver cells binding to one another
http://hplusclub.com/hblog/files/2008/04/liver-cells.JPG

Lipids (fats) do not mix with water





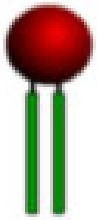
Try the oil-on-water calming effect in the lab!

http://www.youtube.com/watch?v=00PPPt7EJqo

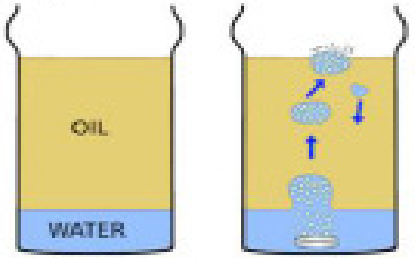
The phospholipid bilayer

phosphates fats 2 layers

A single phospholipid



Try this:



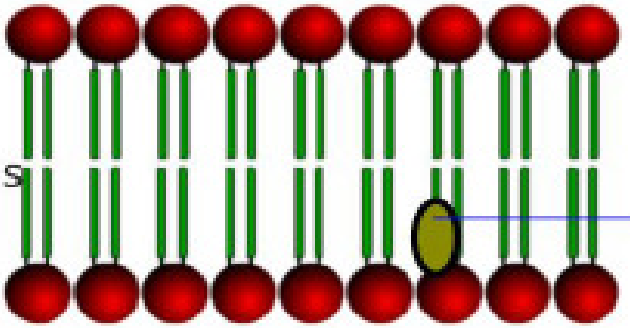
http://www.planet-science.com/newsletters/planetscience/issue_1901/images/lavalamp.gif

hydrophilic phosphate heads

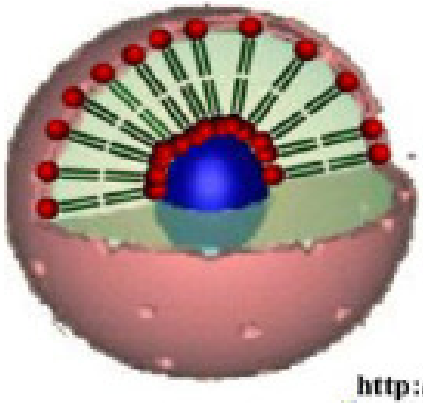
water attracted

hydrophobic hydrocarbon tails

water repelled

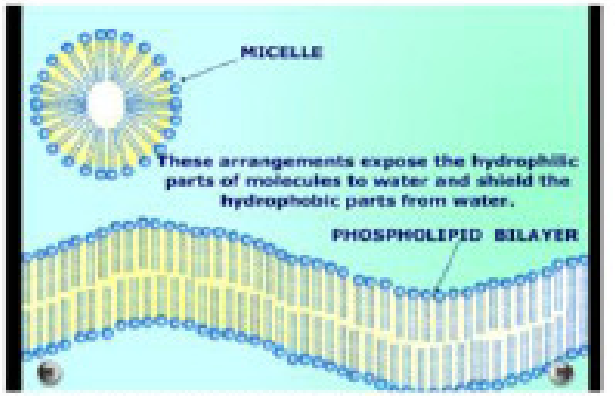


cholesterol strengthens the membrane

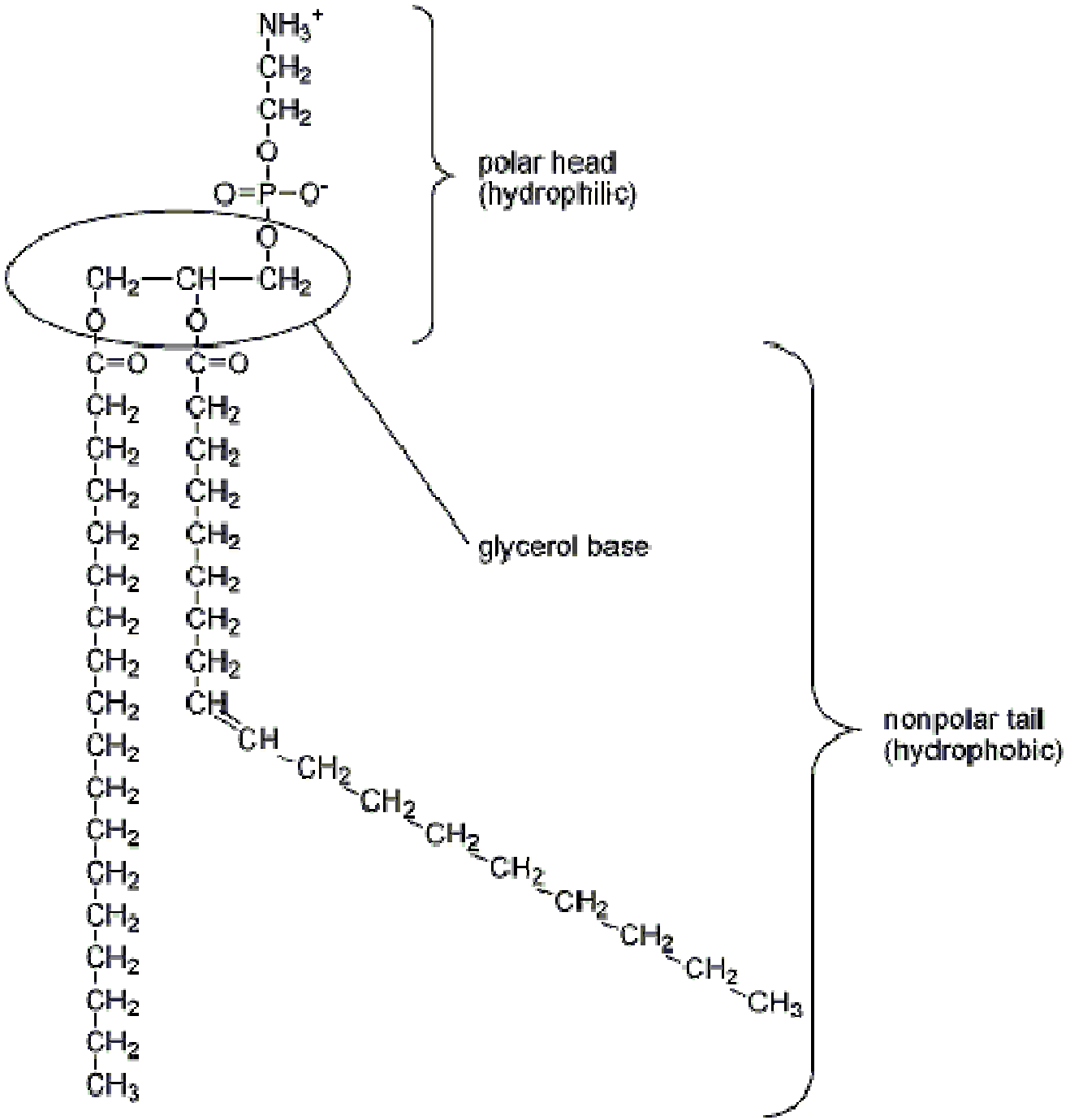


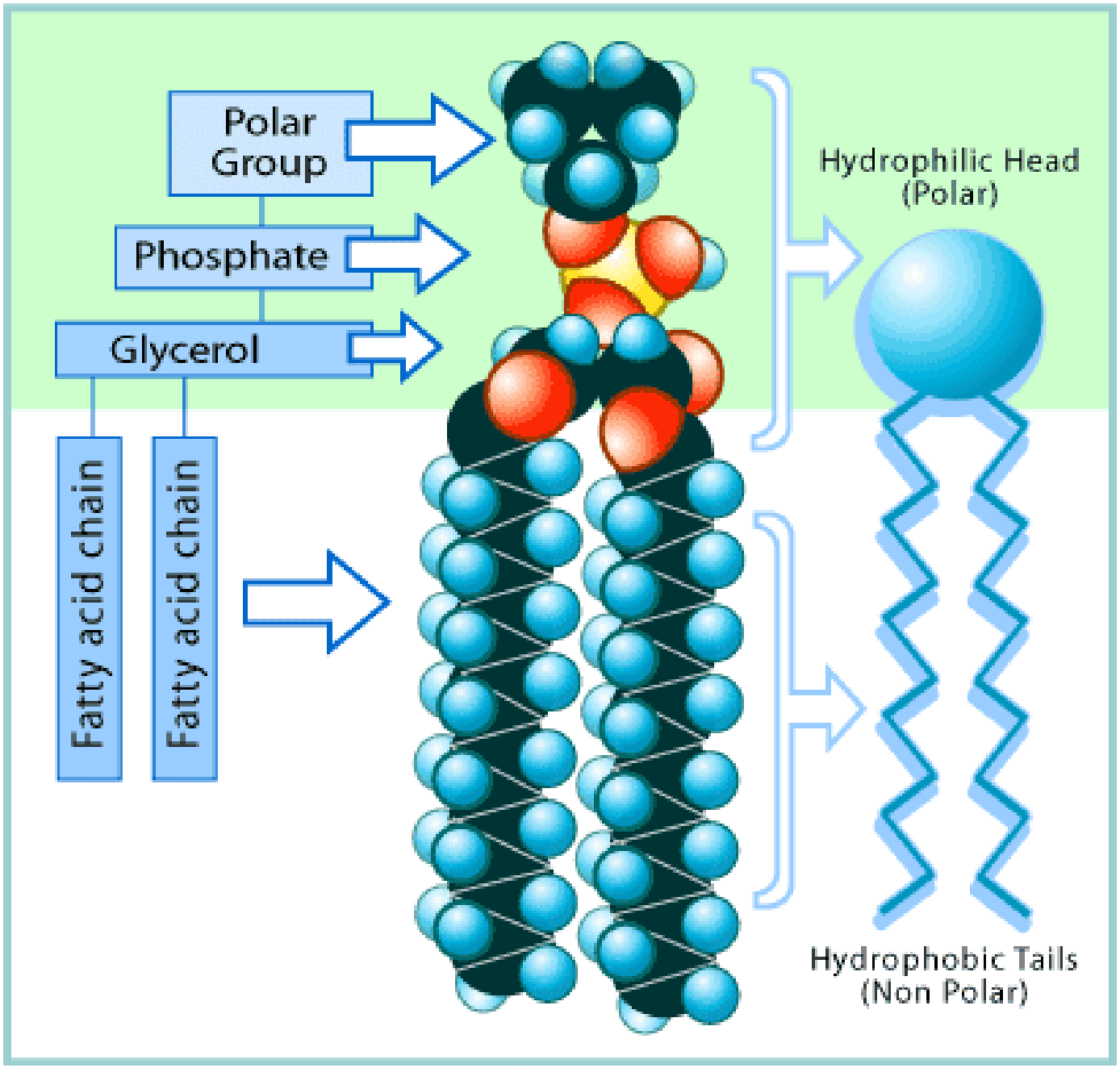
When surrounded by water, phospholipids will automatically form a liposome - an enclosed sphere. In this structure, none of the lipid tails are in contact with water.

http://www.abdn.ac.uk/~clt011/flash/samples/liposomes.swf



http://www.esnips.com/doc/45c10ddf-96a4-4731-a4d5-7455ff682054/Phospholipid-Bilayer

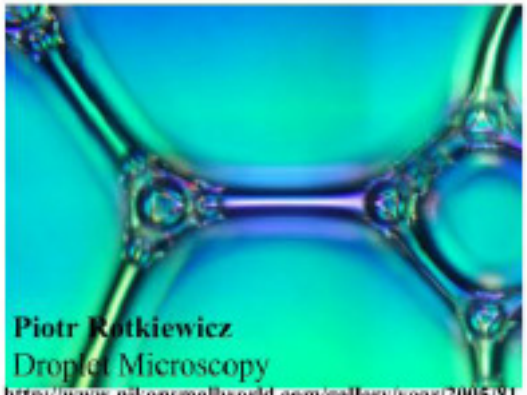

polar head
(hydrophilic)
glycerol base
nonpolar tail
(hydrophobic)


Polar Group
Phosphate
Glycerol
Fatty acid chain
Fatty acid chain
Hydrophilic Head (Polar)
Hydrophobic Tails (Non Polar)

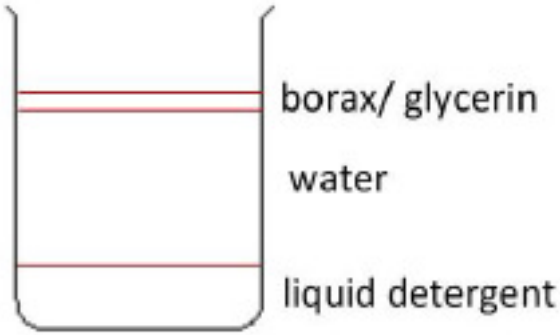
Modeling Membranes: Bubble Magic

Tasks to try:

- Observe the fluid lateral movement in the membrane.
- Make a model prokaryote (a bubble).
- Make an opening in a flat membrane without breaking it.
- Make a model eukaryote (bubble inside a bubble).
- Demonstrate membrane fusion by joining two bubbles into one.



Bubble mix:



Use wire loops, string and straws to complete the challenges.

More bubble model ideas from:
http://www.accessexcellence.org/AE/AEC/AEF/1995/wardell_membranes.php

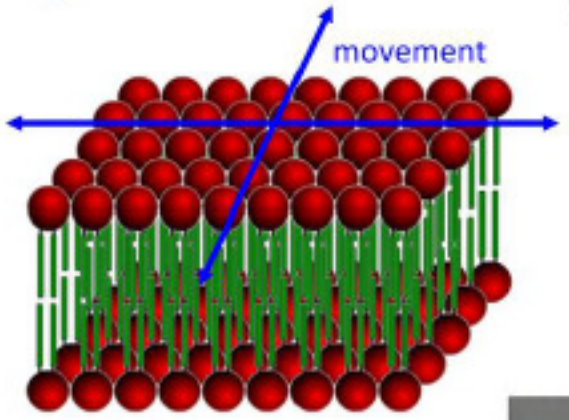
The Fluid Mosaic Model

Fluid: always moving, not solid

Mosaic: collection of things stuck together

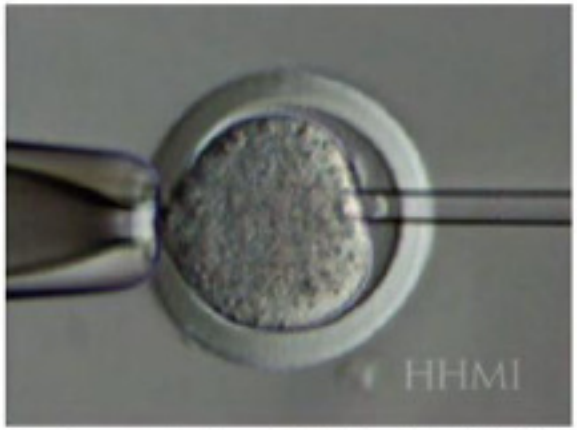
Model: representation of real life

The fluid mosaic model tells us that the structure of the membrane is flexible, adaptable and in motion. It is not solid, or fragile like the skin of a balloon.



The individual phospholipids are attached to each other by weak attractions, the cumulative effect of which is a very strong membrane.

Why doesn't this egg cell rupture when the pipette drills in through the membrane?



http://www.youtube.com/watch?v=hepoJgGJtNc

The phospholipids have freedom of movement in the 'horizontal' plane: they can move around each other, and can flow with pressure, yet do not allow the membrane to break.

It is actually pretty difficult to 'burst' or 'tear' a plasma membrane as the fluid properties of the phospholipid bilayer allow the membrane to reform very easily!

http://www.youtube.com/watch?v=hepoJgGJtNc

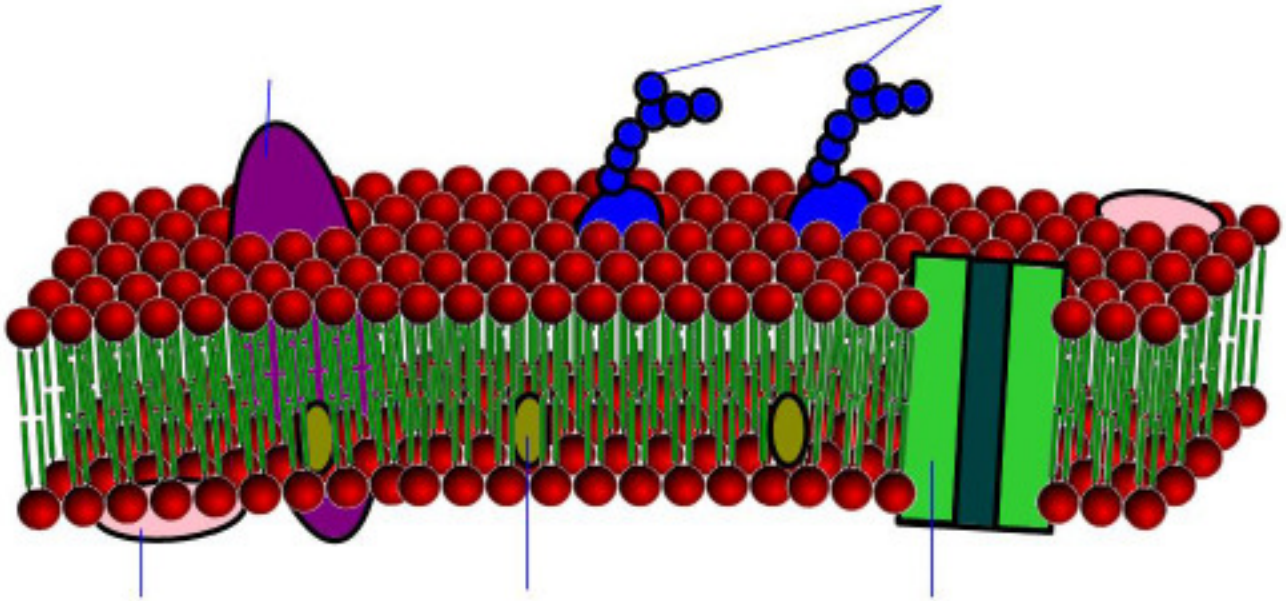
The Fluid Mosaic Model

always moving, not solid

collection of things stuck together

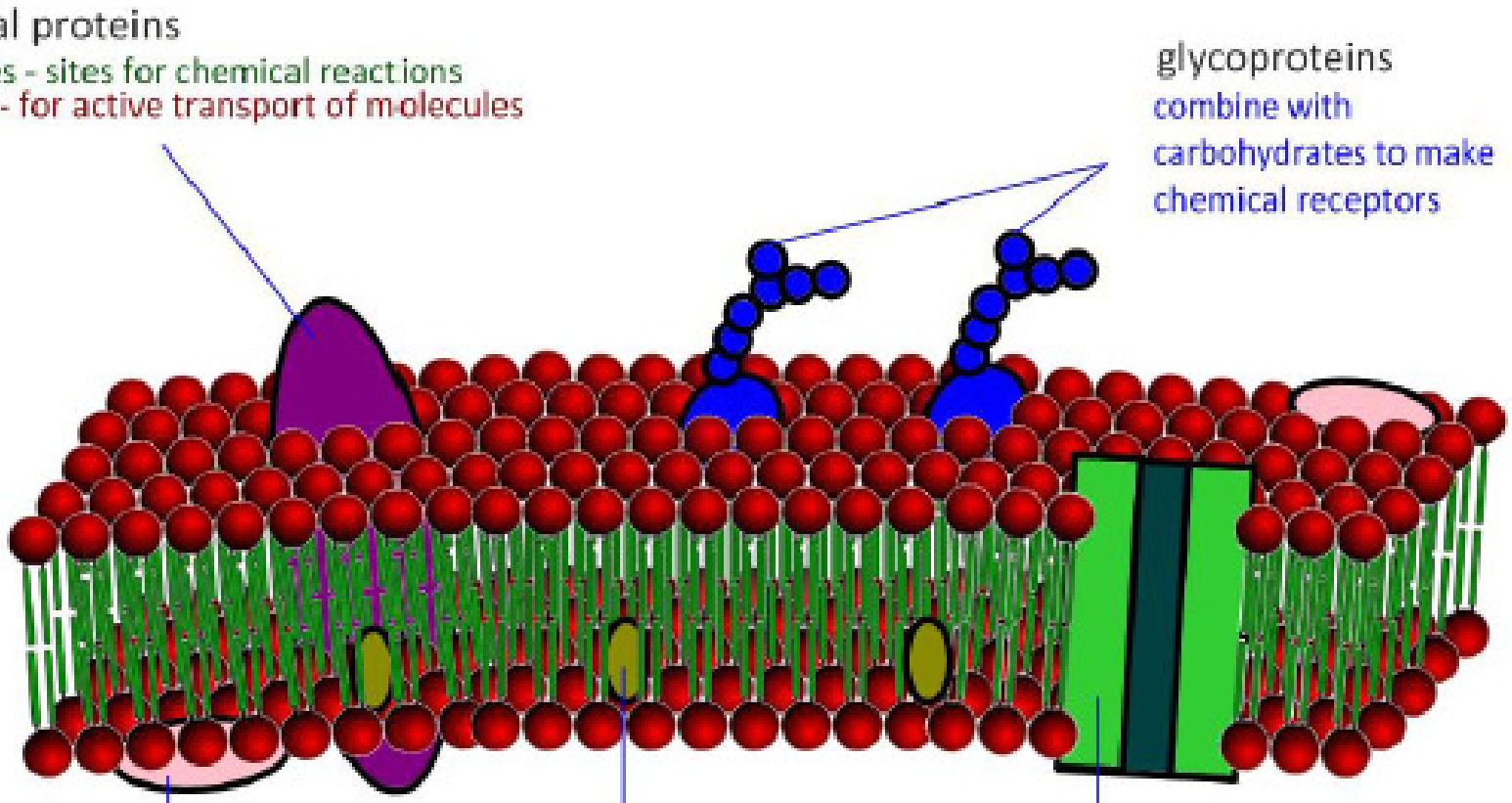
representation of real life

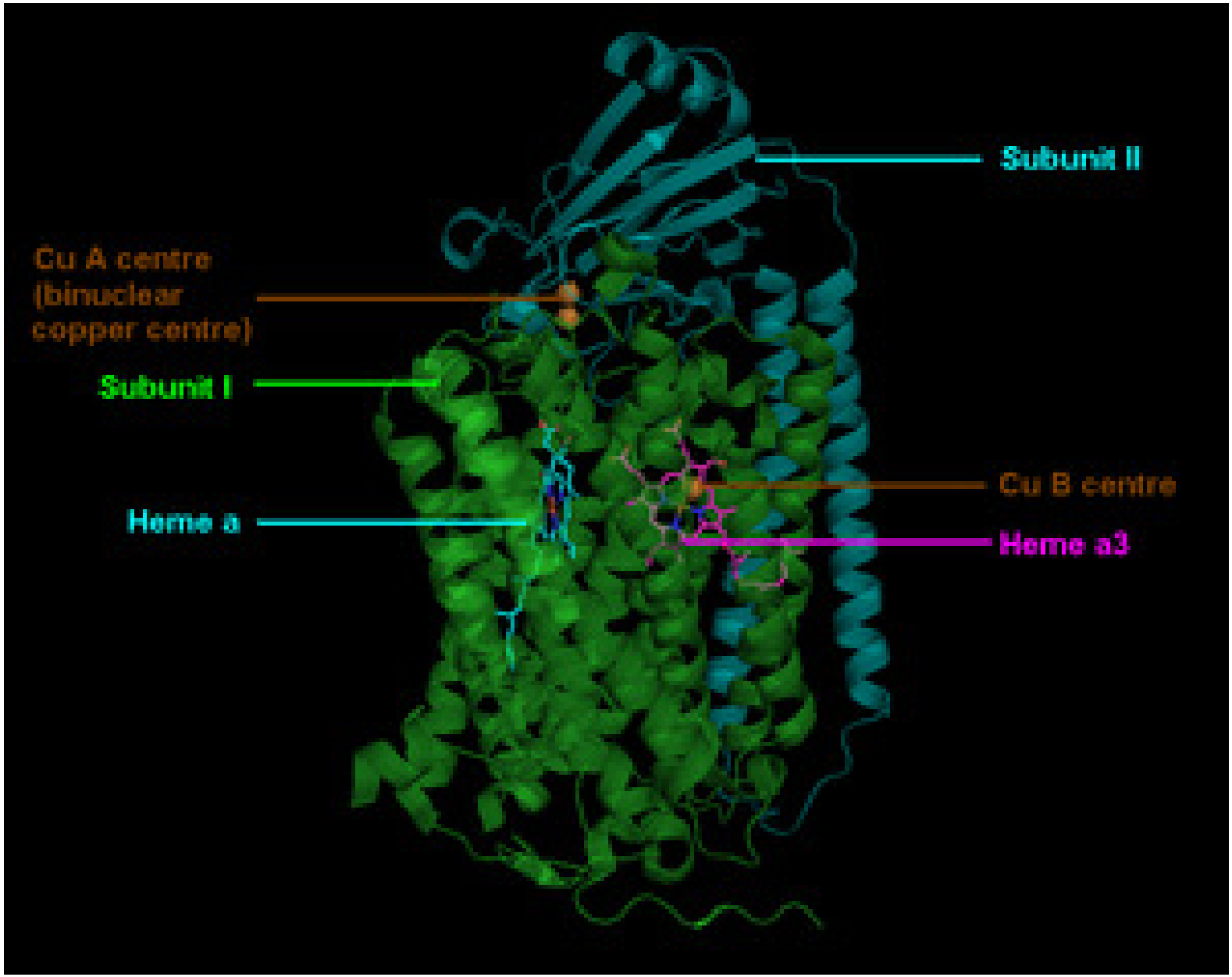
What are the names and functions of these parts of the plasma membrane?



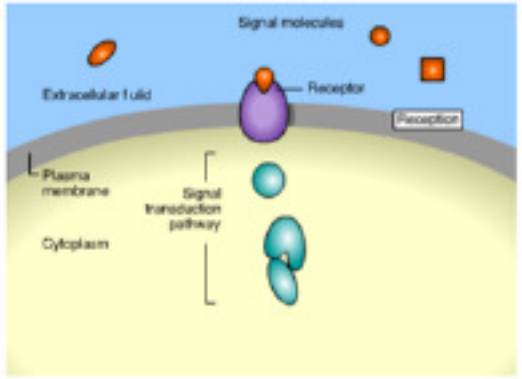
The Mosaic:

What are the names and functions of these parts of the plasma membrane?



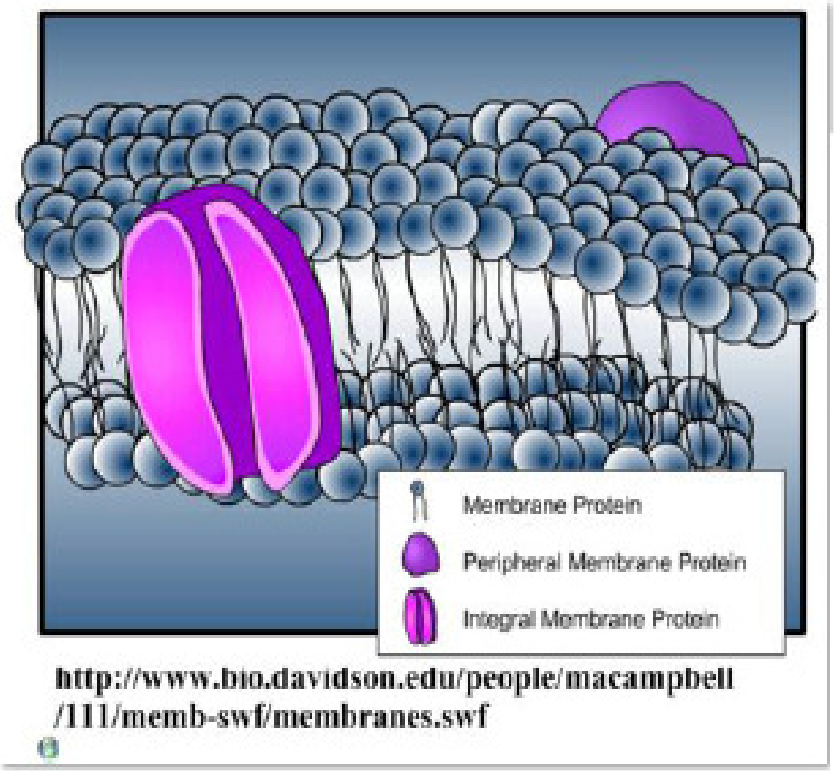

Subunit II
Cu A centre
(binuclear
copper centre)
Subunit I
Cu B centre
Heme a
Heme a3

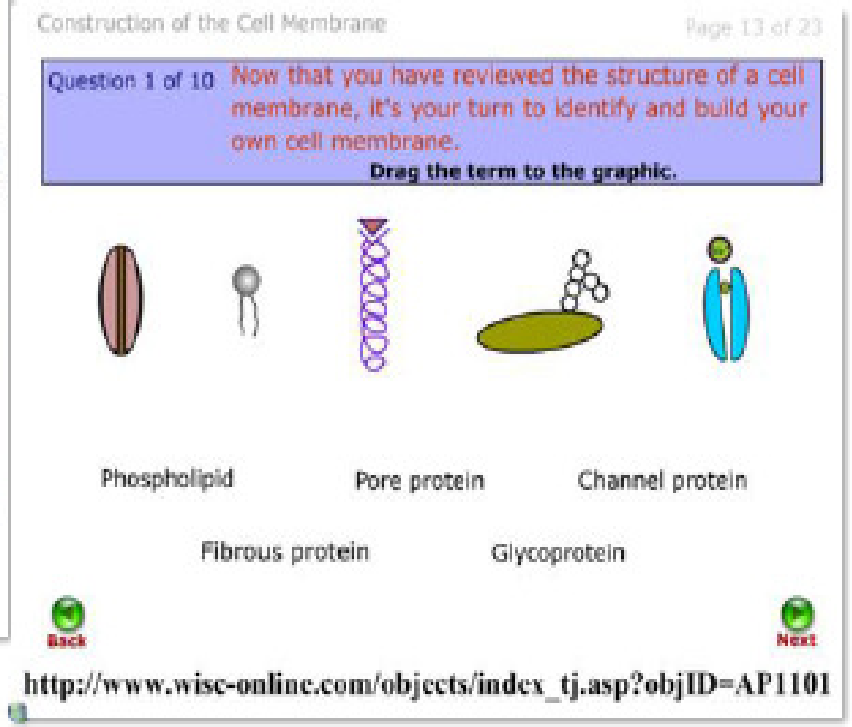
Membrane proteins in cell signaling:



http://bio1151.nicerweb.com/med/Vid/Campbell7e/ch11/11_05CellSignaling_A.swf

Membrane Structure Tutorials





http://www.wisc-online.com/objects/ViewObject.aspx?ID=AP1101

http://www.johnkyrk.com/cellmembrane.html

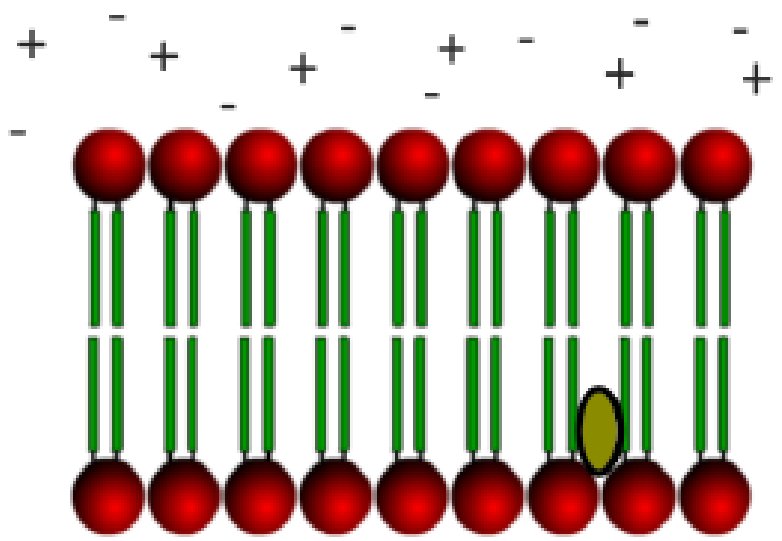
The phospholipid bilayer is selectively permeable

controlled entry/ exit of molecules

Some molecules pass through easily (diffusion), or go through a 'tunnel' (facilitated diffusion)
Others need energy to get them through (active transport)
Large molecules use their own membrane to get them through (endo-/exo-cytosis)

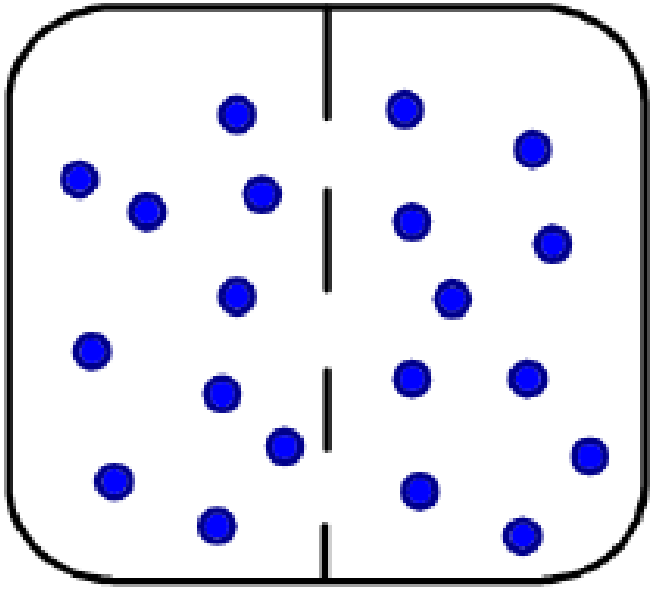
polar heads:
attracted to other polar (charged) molecules

non-polar tails:
will repel any charged molecule, therefore preventing passage of ions through the membrane.

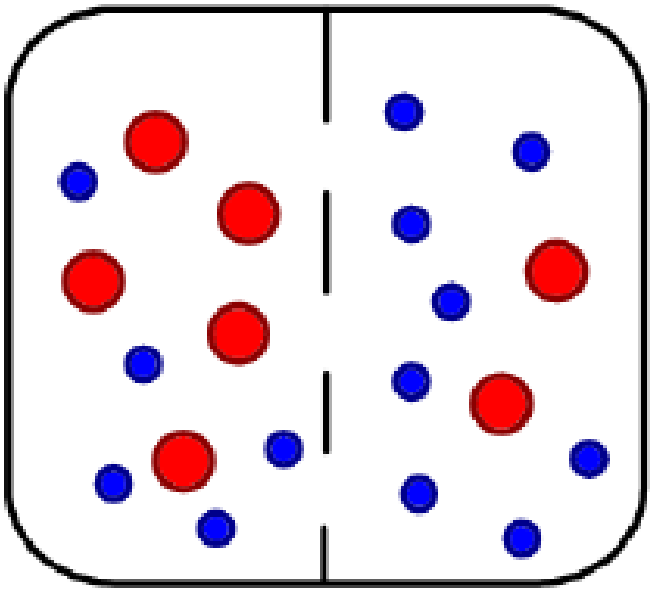


Solutions consist of solutes dissolved in a solvent.

Concentration is a measure of the amount of solute in the solution.



Pure water (no solute)



50% salt solution 20% salt solution

water (solvent)

salt (solute)

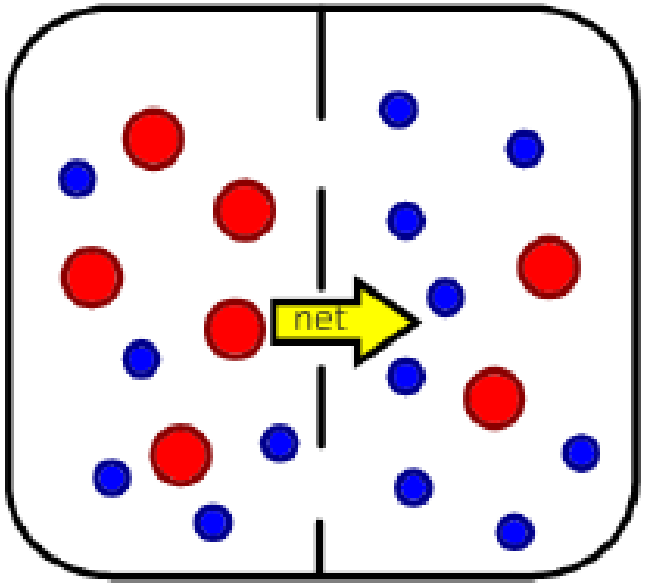
Diffusion is the passive net movement of molecules from regions of high concentration to low concentration.

passive = requires no energy

net = overall movement (remember that all molecules are moving all the time in all directions)

high to low = **down** a *concentration gradient*

Diffusion can occur through a partially or selectively permeable membrane or from regions of high to low concentration in a solution or environment.



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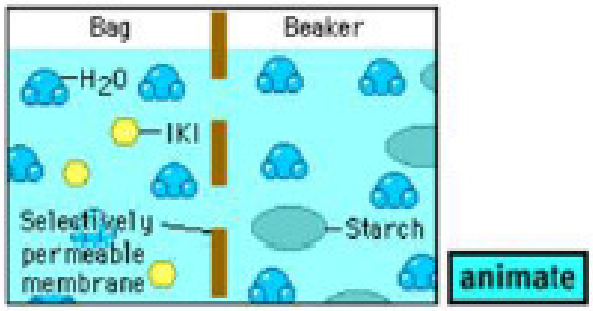
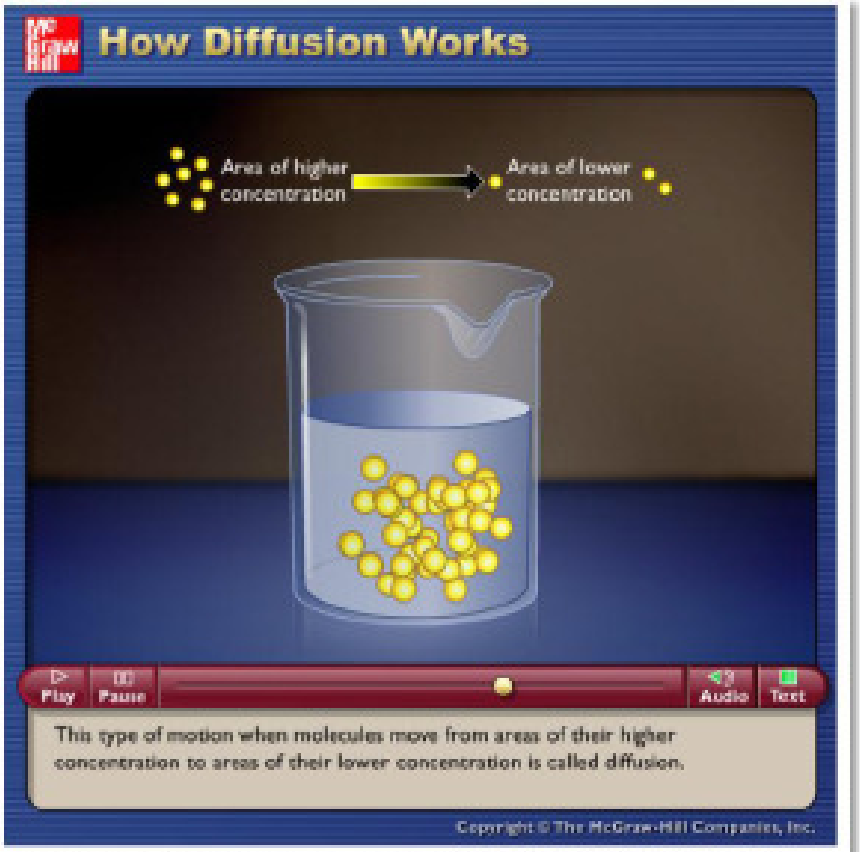
Try the tutorials here:



http://www.phschool.com/science/biology_place/labbench/lab1/concepts.html

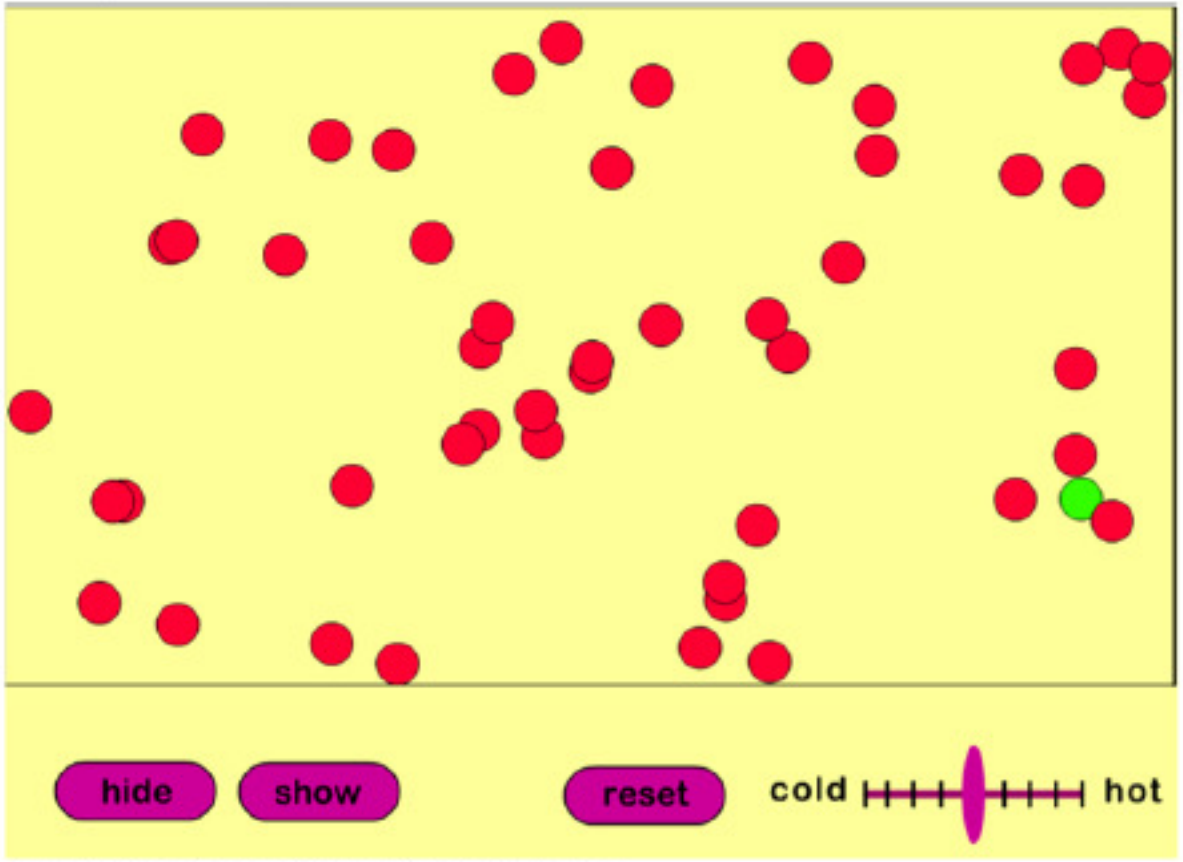


http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_diffusion_works.html

- http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_diffusion_works.html
- http://prod2.phschool.com/science/biology_place/labbench/lab1/intro.html

Brownian Motion:

The random movement of particles in a liquid or gas.
With more energy, particles move more quickly and collide more often.
Due to brownian motion, particles will diffuse evenly (on average) throughout the system, over time.



http://www.kscience.co.uk/animations/brownian.swf

Him again?

http://en.wikipedia.org/wiki/Robert_Brown_(botanist)

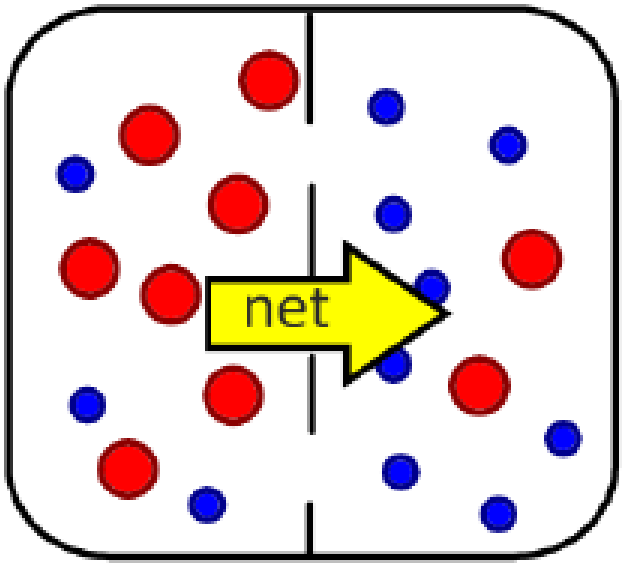
Robert Brown discovered this action when studying the random motion of pollen particles in water.

He also discovered and named the eukaryote nucleus.

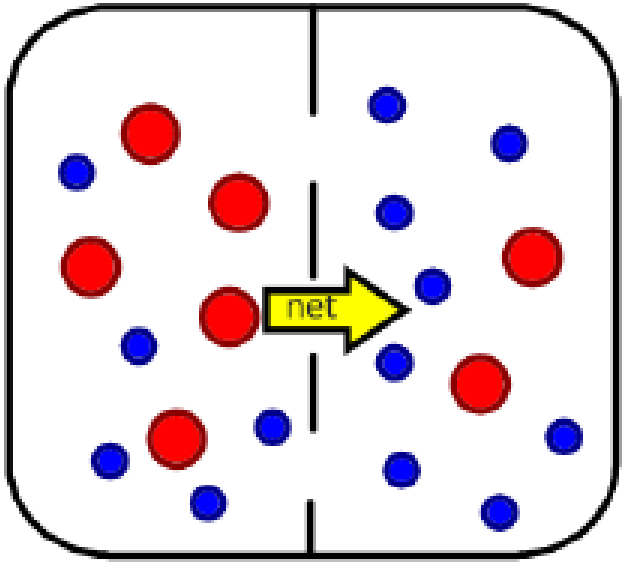
He didn't make this animation.

- http://www.kscience.co.uk/animations/brownian.swf

Diffusion is the passive net movement of molecules from regions of high concentration to low concentration.



70% salt solution 20% salt solution



50% salt solution 20% salt solution

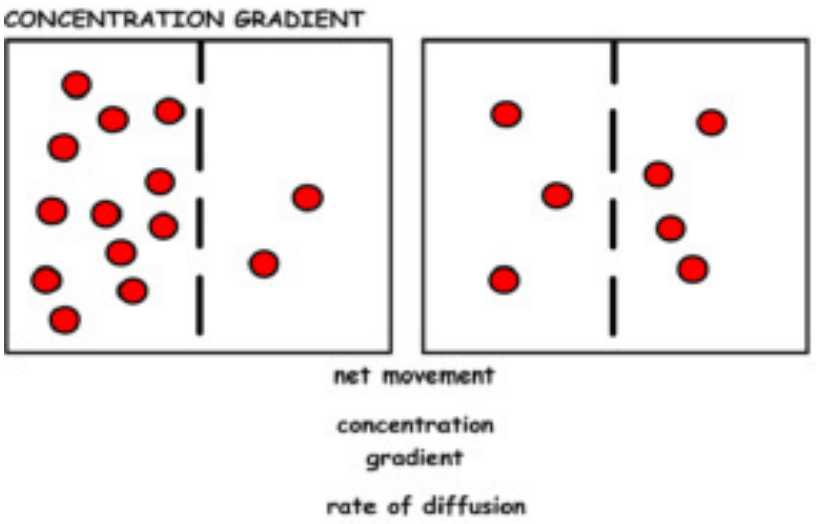
A higher concentration gradient leads to an increased rate of diffusion as molecules have more energy and move more quickly.

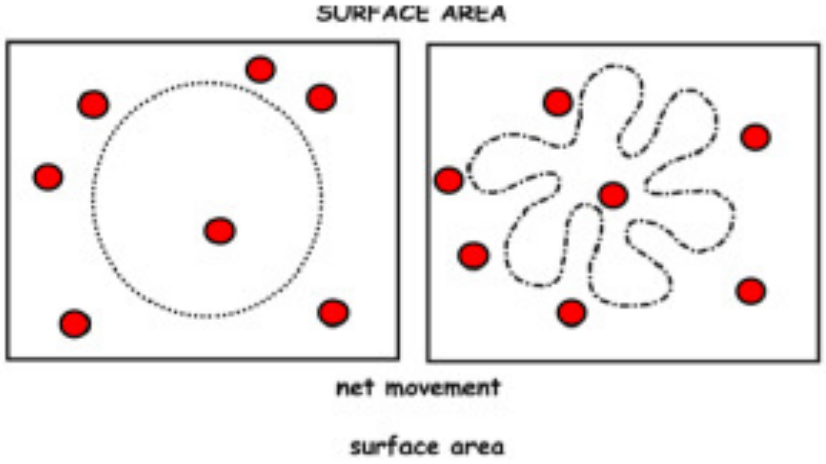
water (solvent)

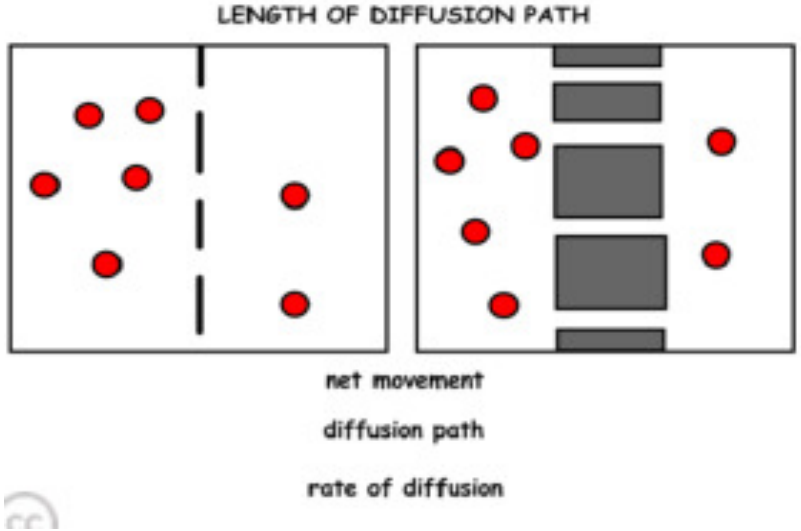
salt (solute)

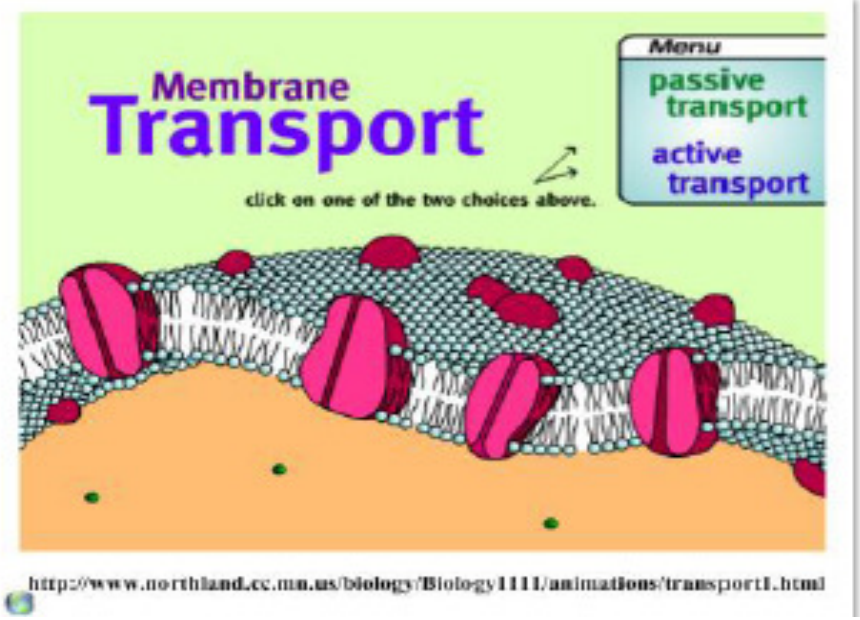
Explain three factors, other than temperature, that affect the rate of diffusion of a solute across a membrane.

Explain three factors, other than temperature, that affect the rate of diffusion of a solute across a membrane.



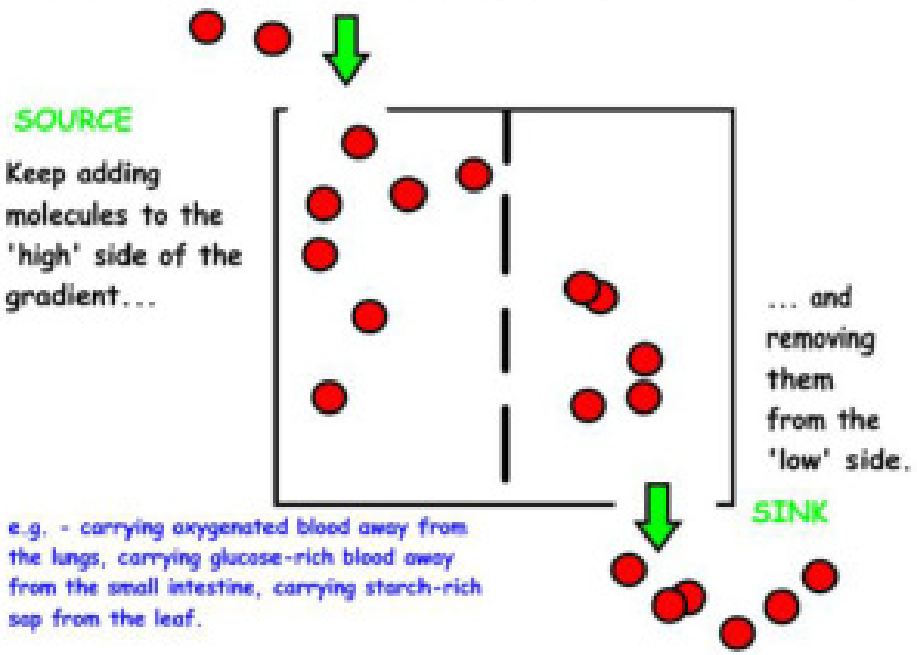






- http://www.northland.cc.mn.us/biology/Biology1111/animations/transport1.html

ADAPTATIONS IN BIOLOGY: maintaining a large gradient.



Reducing the length of diffusion path:

1. Membranes are incredibly thin (7-10nm)
2. Folded membranes increase the SA:VOL ratio
3. More membrane in a smaller volume means shorter distances across which molecules must diffuse.

Maximising surface area for absorption:

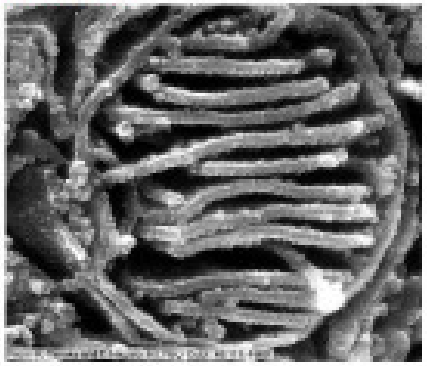
1. Alveoli in lungs

2. Membrane folds in mitochondria and in cristae in the chloroplasts

3. Root hais for water and mineral ion uptake

4. Villi for absorption of digested food molecules.

cristae:



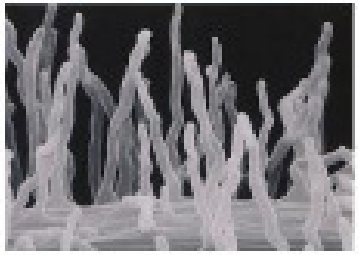
http://porpax.bio.miami.edu/~cmallery/150/cells/mitoSEM2.jpg

alveoli:

http://www.3dscience.com/img/Products/3D_Models/Human_Anatomy/Alveoli/supporting_images/3D_Model_Anat_Alveoli2_web.jpg

root hairs:

(villi look very similar)



http://quorumsensing.ifas.ufl.edu/HCS200/images/leghiz/rootha2.jpg

Facilitated diffusion is the passive net movement of particles fro regions of high concentration to low concentration, through a selectively permeable membrane, facilitated by carrier proteins.

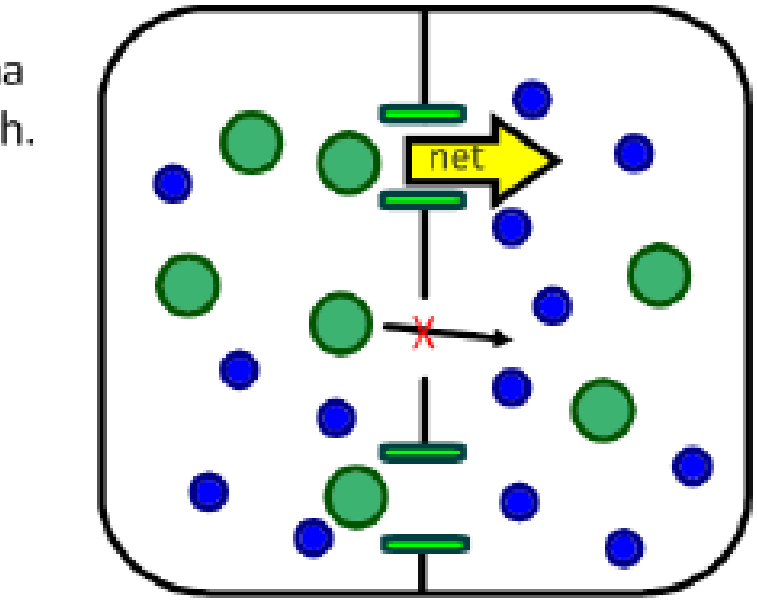
Selectively permeable membranes, such as the plasma membrane, do not allow all molecules to pass through.

This depends on the properties of the molecules.

Carrier proteins (channel proteins) are integral globular proteins in the plasma membrane that allow some molecules to pass through.

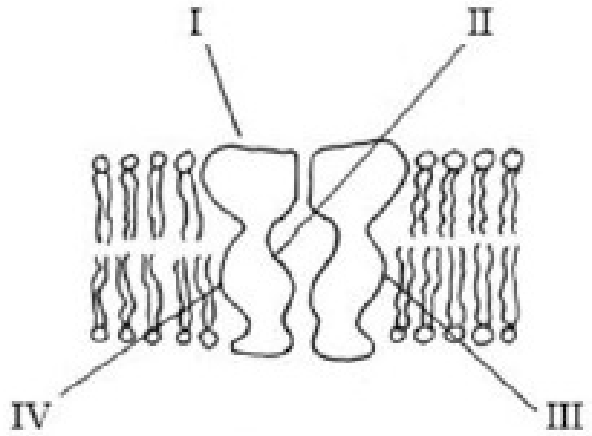
Channel proteins are specific to their molecules. This is determined by the polar regions on the proteins (more on this later).

Facilitated diffusion is down a concentration gradient, therefore is passive (does not require energy).



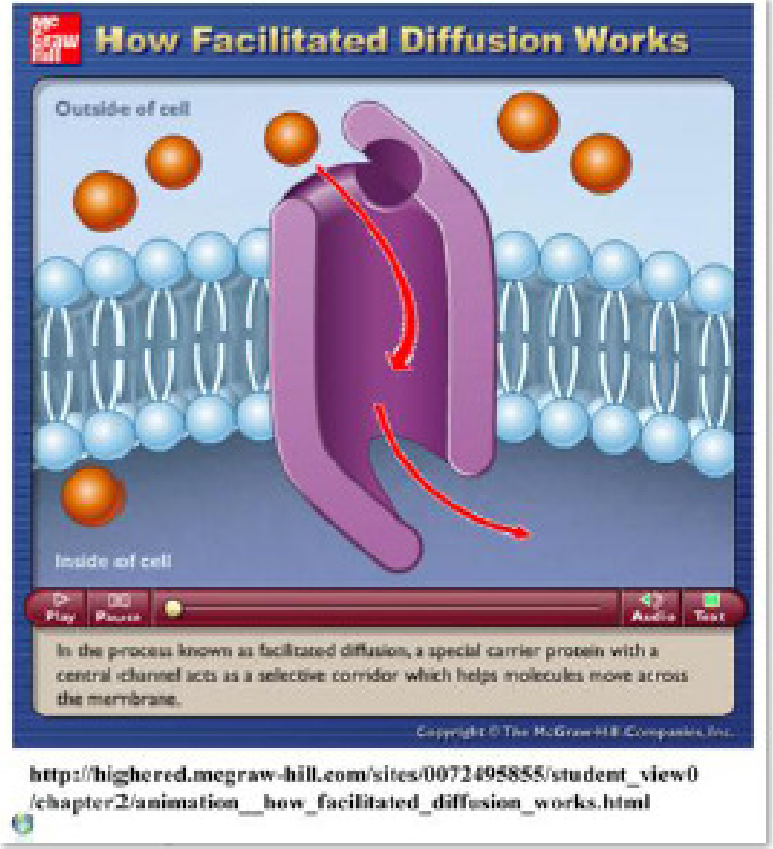
Facilitated diffusion is the passive net movement of particles from regions of high concentration to low concentration, through a selectively permeable membrane, facilitated by carrier proteins.

Voltage-gated sodium channels are used in facilitated diffusion. These are found in neurons.



The properties of parts I and II in the diagram allow specific molecules to pass through.

Diagram: QuestionBank CDRom

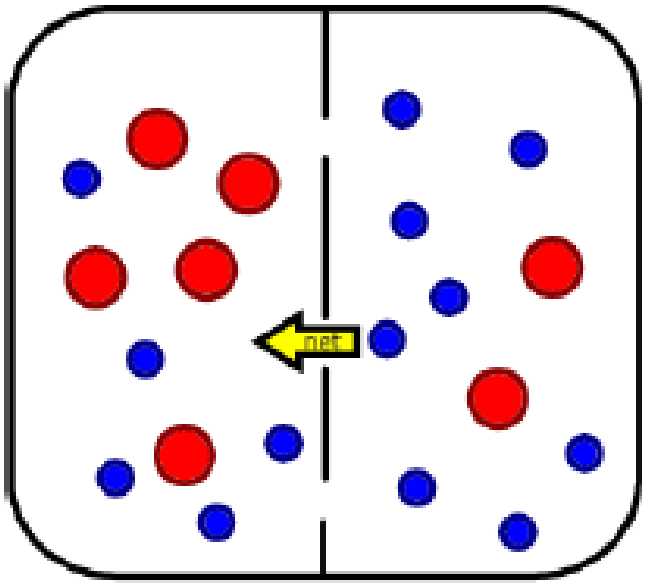


- http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_facilitated_diffusion_works.html

Osmosis is the passive net movement of water molecules from regions of low **solute** concentration to high **solute** concentration, through a partially/selectively permeable membrane.

passive = requires no energy

net = overall movement (remember that all molecules are moving all the time in all directions)



50% solute solution 20% solute solution

∴low water ∴high water

water (solvent)

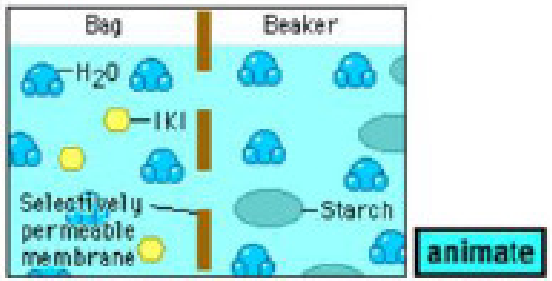
solute

The solute molecules cannot pass through the membrane, due to their properties.

Osmosis is also movement **down a concentration gradient** - but we are considering the movement of water molecules, not the solute molecules.

Osmosis is the passive net movement of water molecules from regions of low **solute** concentration to high **solute** concentration, through a partially/selectively permeable membrane.

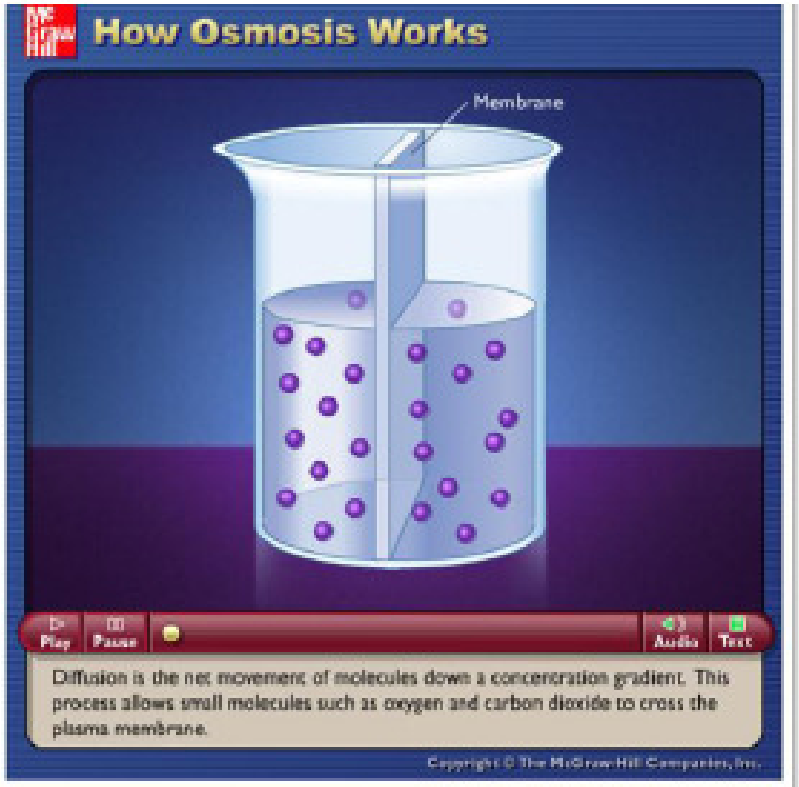
Try the tutorials here:



http://www.phschool.com/science/biology_place/labbench/lab1/concepts.html

The solute molecules cannot pass through the membrane, due to their properties.

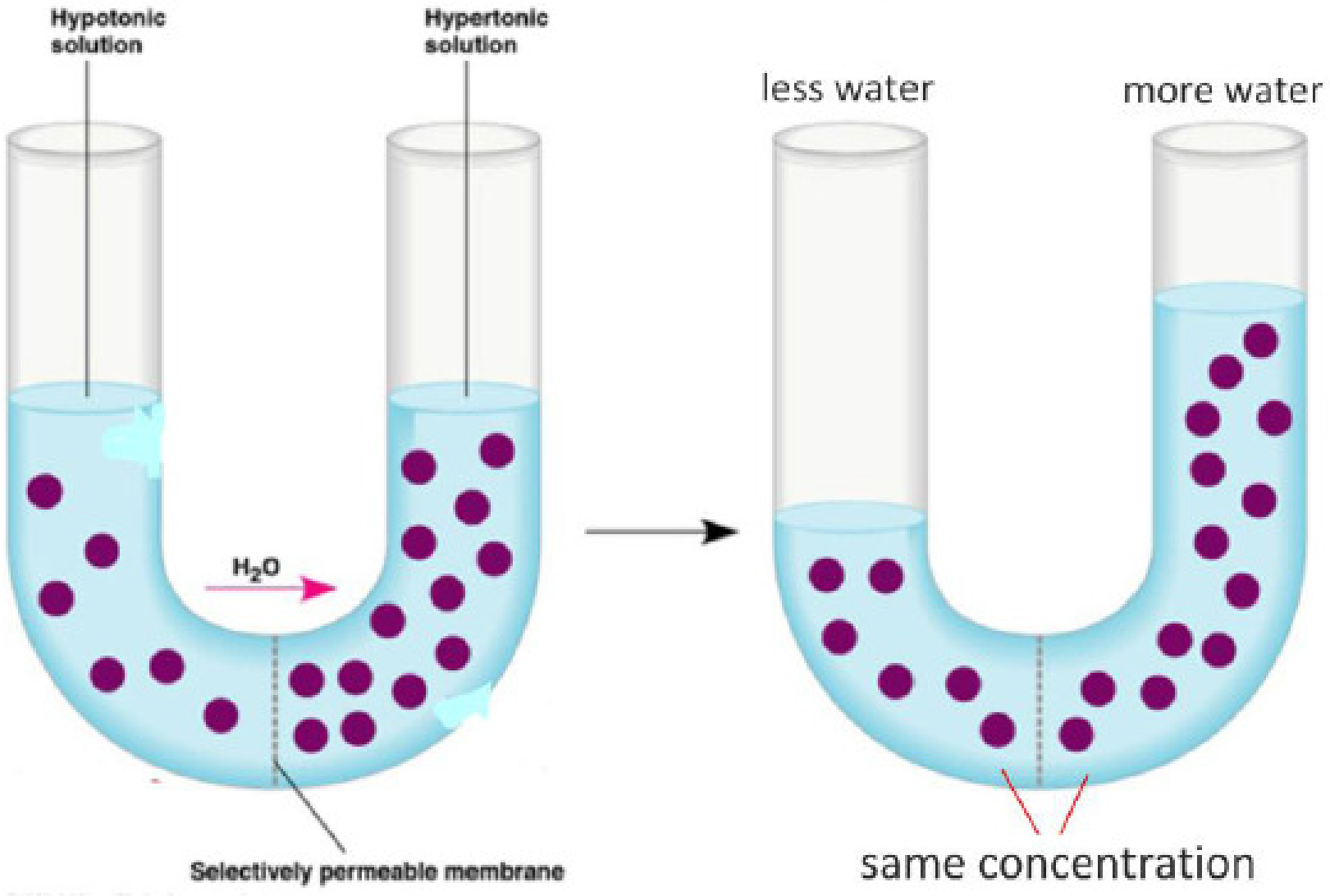
Osmosis is also movement **down a concentration gradient** - but we are considering the movement of water molecules, not the solute molecules.



http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_osmosis_works.html

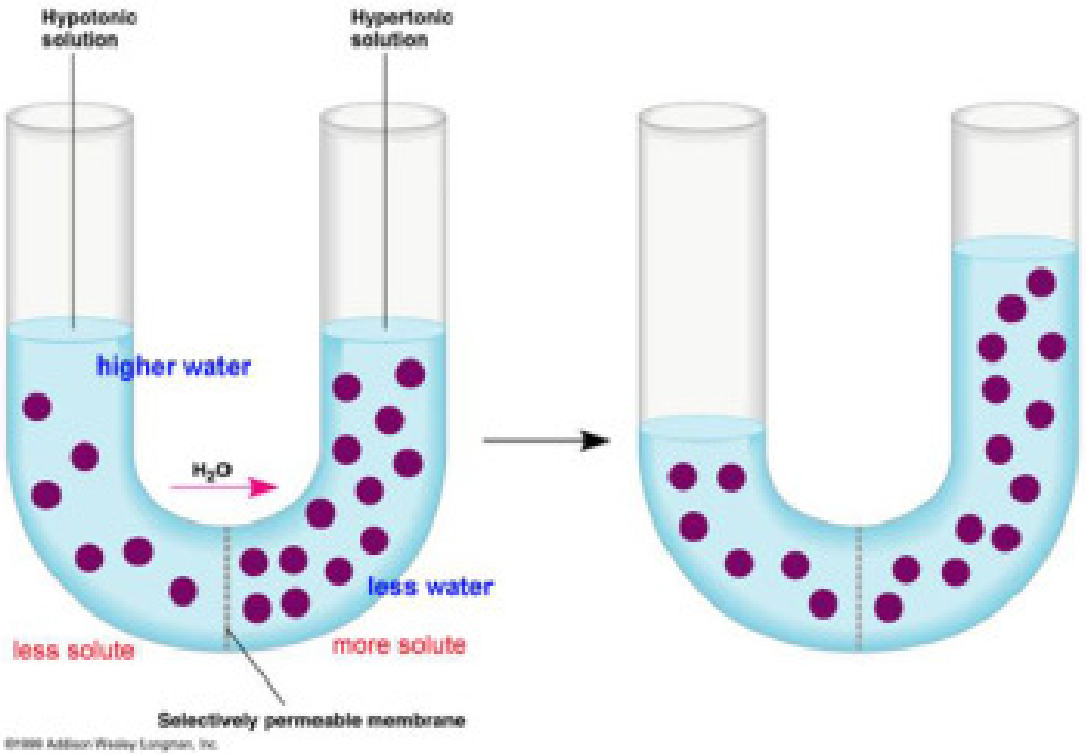
- http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation__how_osmosis_works.html

Can you explain why water levels change?



http://www.hansenkg.de/english/osmosis.jpg

Can you explain why water levels change?



http://www.hansenkg.de/english/osmosis.jpg

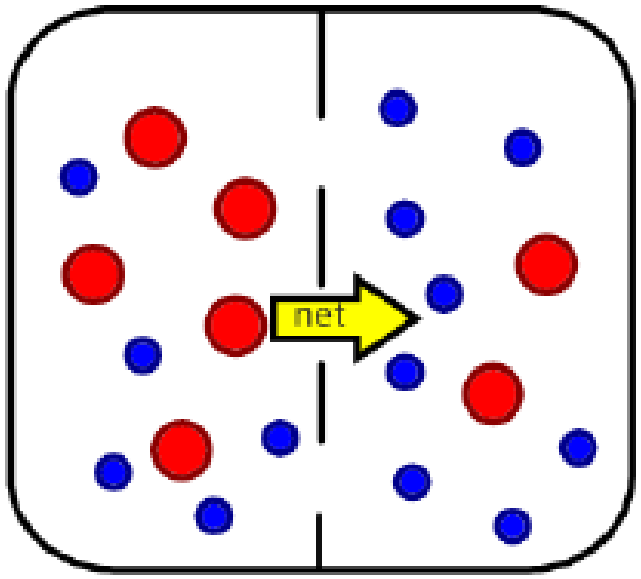
Water moves by osmosis from an area of low solute concentration (more water) to high solute concentration (less water). The solute particles cannot move to balance the concentrations as they are *too large to fit through the pores of the selectively permeable membrane.*

What is the meaning of *hyper-*?
What about *hypo-*?

Think about hypothermia, hyperactivity, hypoxia, hypertension.

Compare diffusion and osmosis.

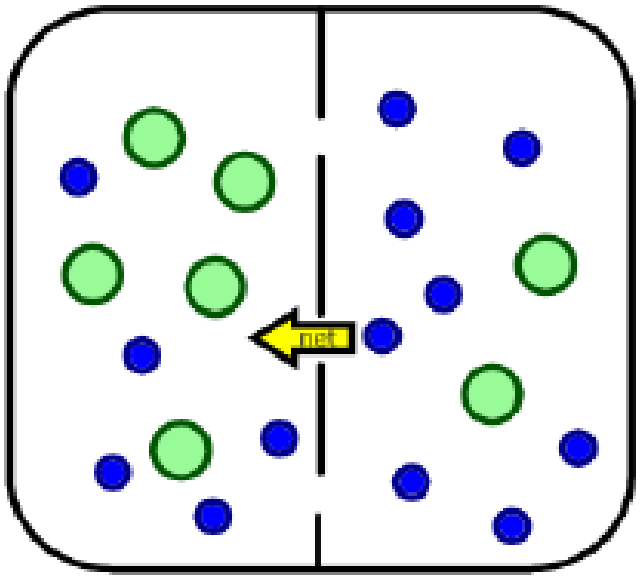
Compare diffusion and osmosis.



water (solvent)

solutes

50% solute solution 20% solute solution

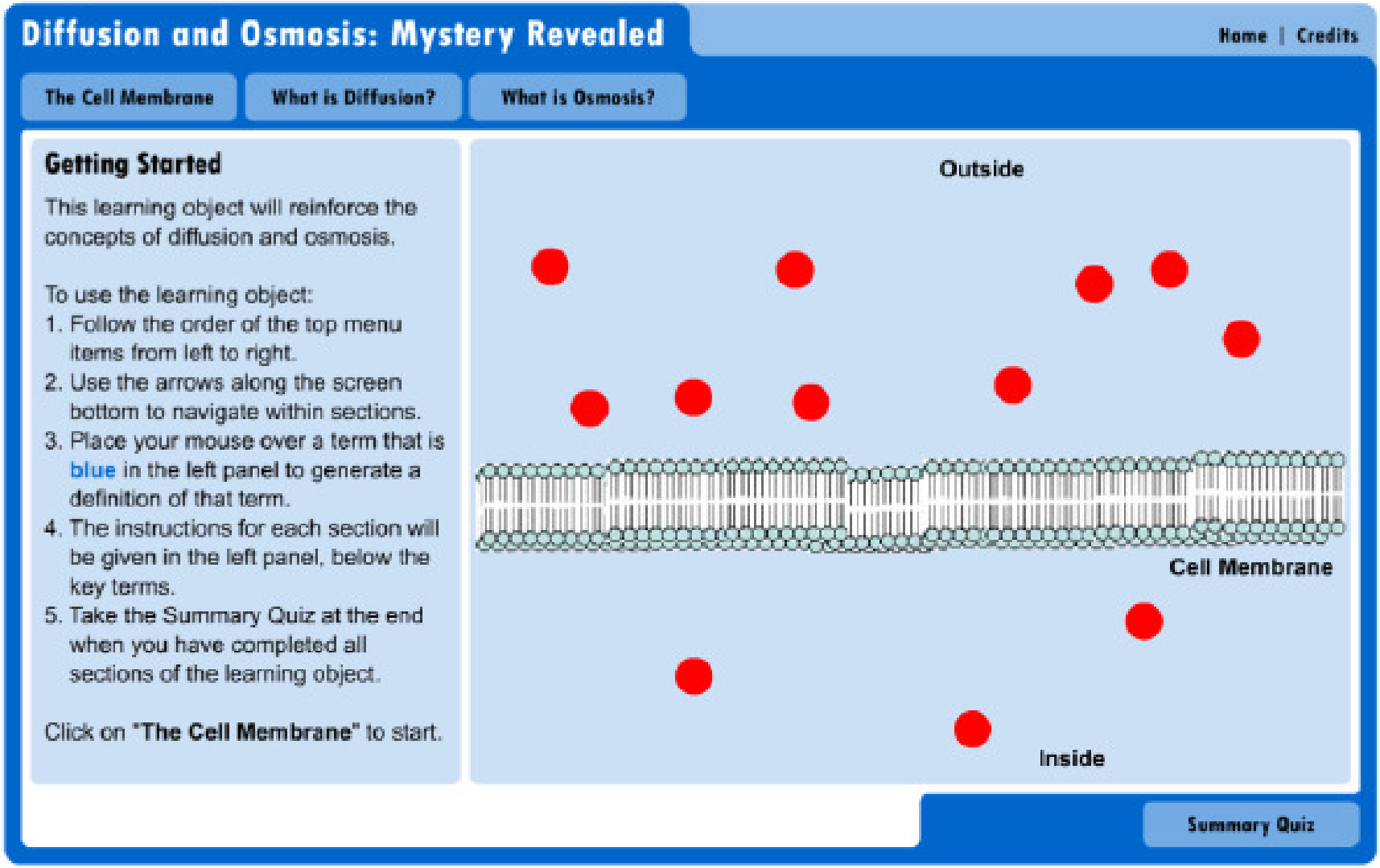


50% solute solution 20% solute solution

∴ low water ∴ high water

Similar:	both are passive	both are down a concentration gradient
Different:	diffusion is of solutes	osmosis considers water molecules only
	membrane not needed	partially-permeable membrane essential

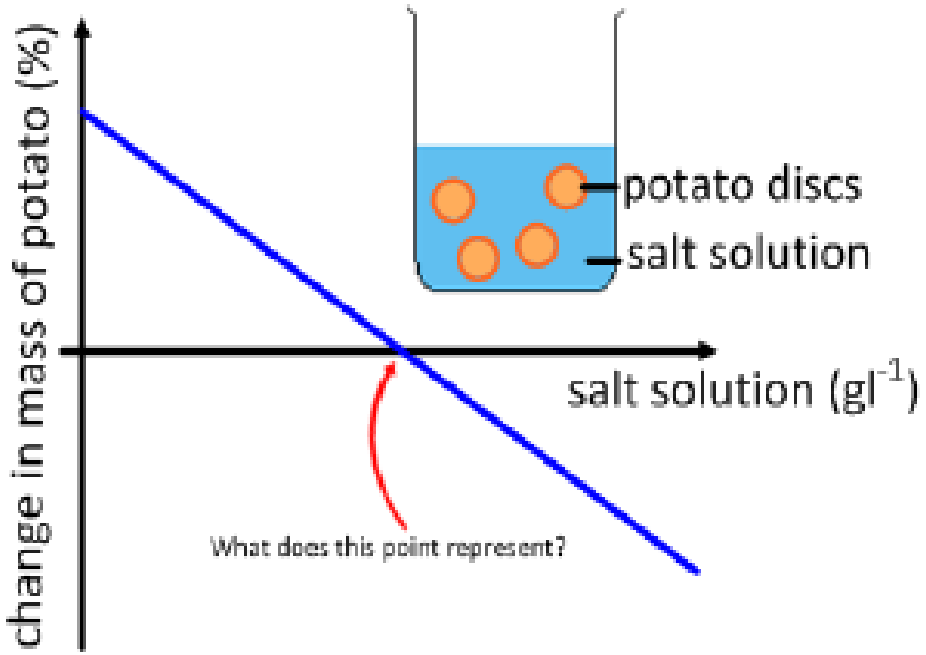
Useful tutorial on diffusion and osmosis:



http://education.uoit.ca/lordec/ID_LORDEC/diffusion_osmosis/garib_diffusion_osmosis.swf

- http://education.uoit.ca/lordec/ID_LORDEC/diffusion_osmosis/garib_diffusion_osmosis.swf

Analyse the information in this sketch graph.



1. Explain the significance of the point labeled in red.

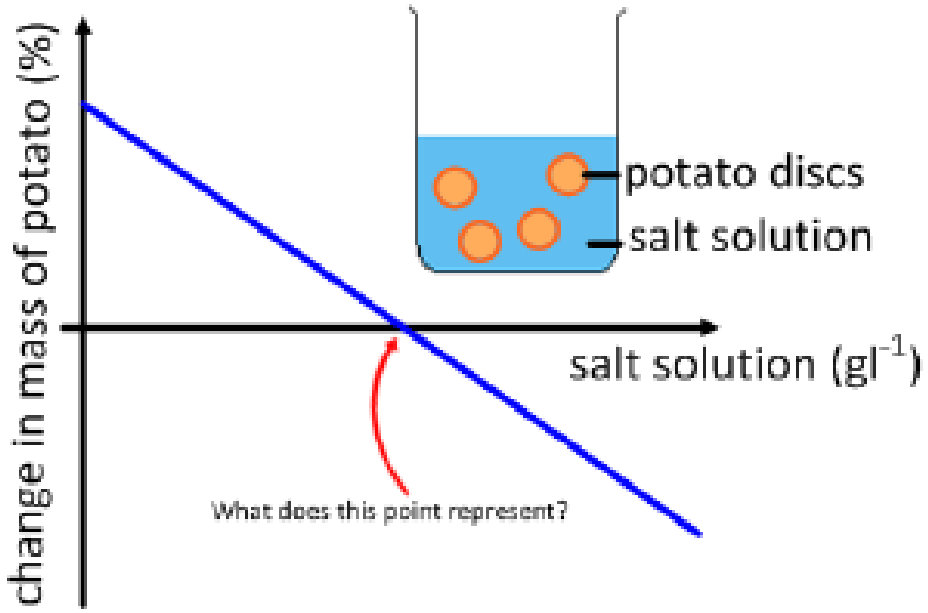
2. Explain the blue line.

3. Deduce the experimental method used to generate this graph.

4. Discuss how the dependent variable was recorded and calculated.How would the researcher ensure that data were sufficient, relevant and reliable?

5. Discuss the variables that needed to be controlled in the investigation. What could be the impact of each of them? How could they be controlled?

Analyse the information in this sketch graph.



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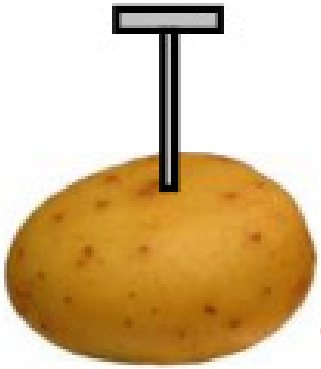
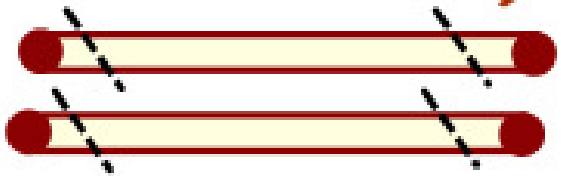
5. Discuss the variables that needed to be controlled in the investigation. What could be the impact of each of them? How could they be controlled?

Now use your answers to carry out the same investigation. Refer to the criteria for Design, DCP and CE throughout.

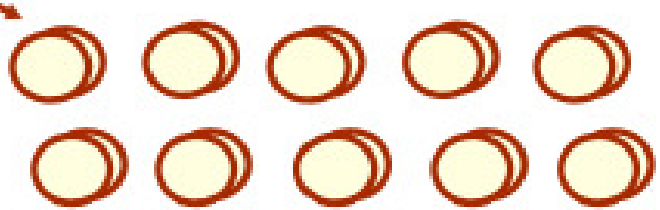
Osmosis: finding the concentration of salt in potato cells



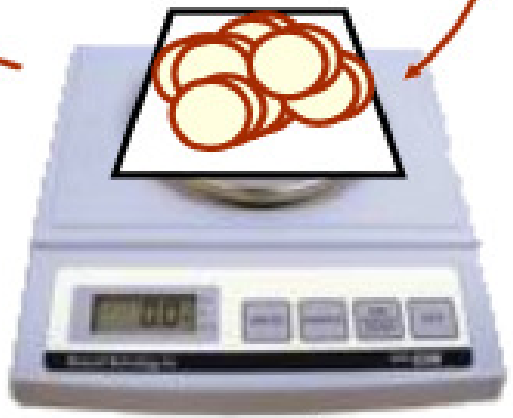
take a core



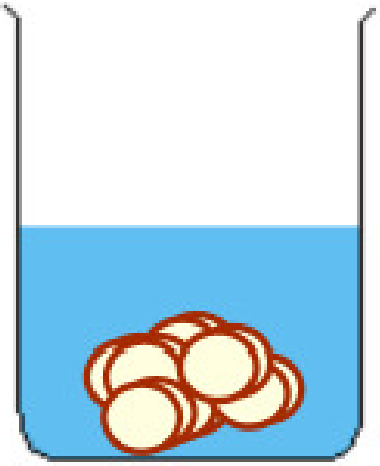
cut sections of equal length
(don't use the ends)



chop section into 10 discs



weigh



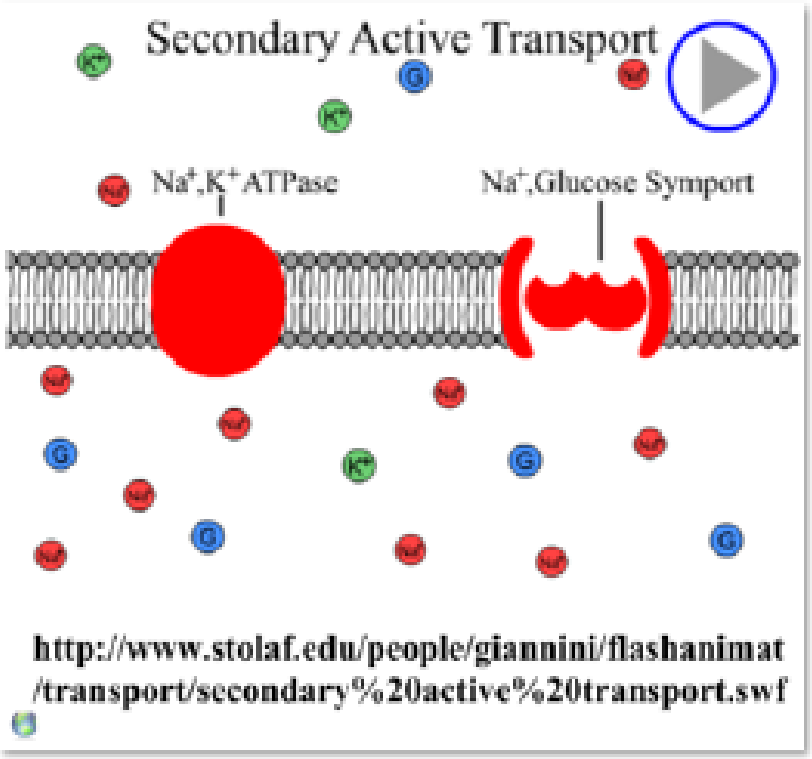
submerge discs in solution of known
salt concentration for 45 mins

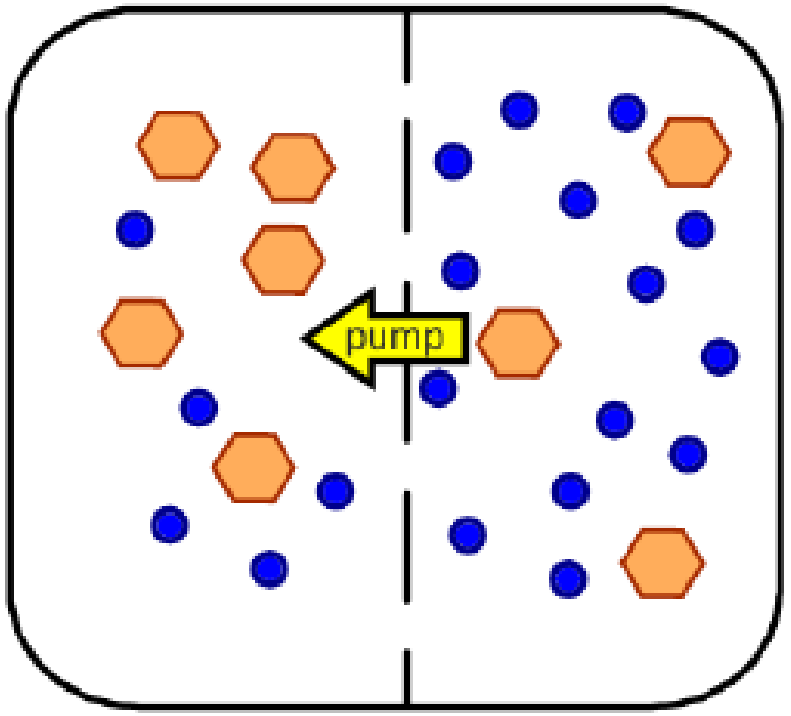
remove, shake off
excess water and re-weigh

Active transport uses energy, in the form of ATP, to move molecules against a concentration gradient, using membrane protein pumps.

The molecules cannot pass through the membrane, due to their properties.

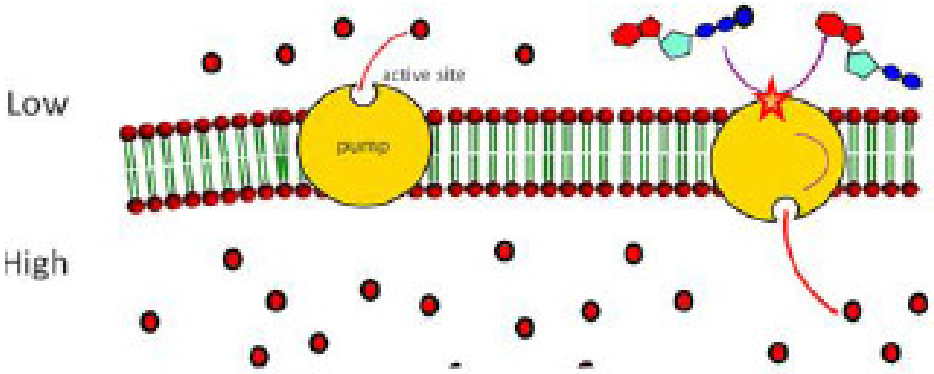
Active transport is key in homeostasis in organisms, such as re-setting nerves after impulses have passed through, or absorbing glucose in the gut.



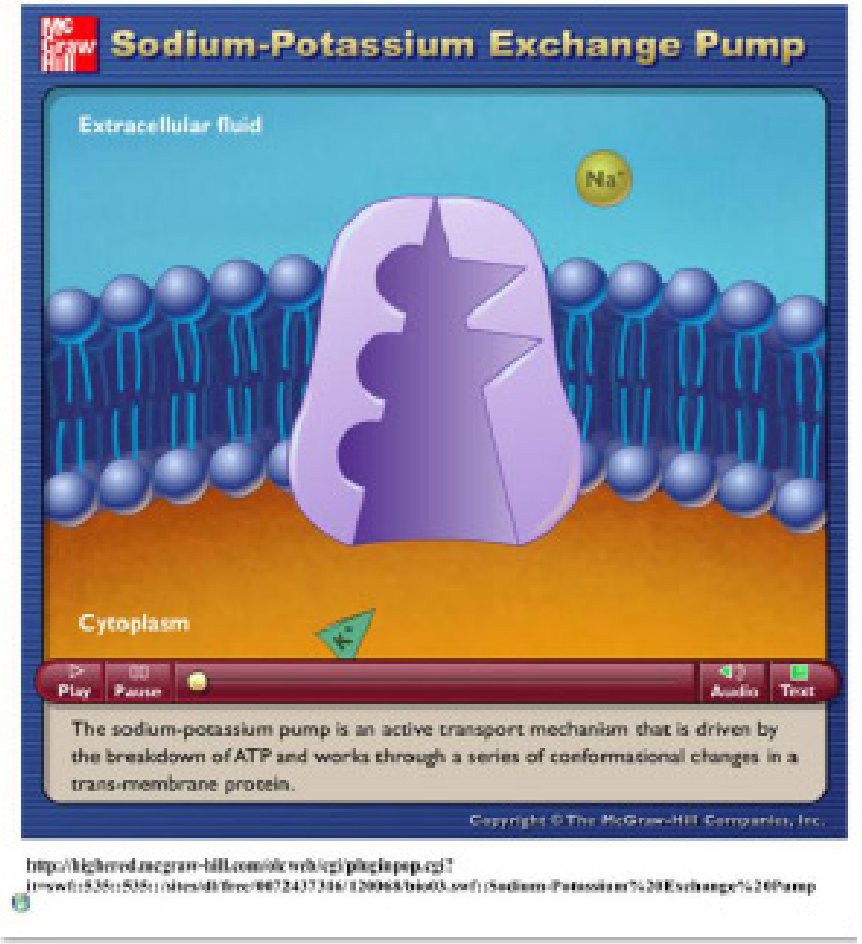


Active transport uses energy, in the form of ATP, to move molecules against a concentration gradient, using membrane protein pumps.

Protein pumps are specific to their molecules.
The molecule binds to the active site of the pump.

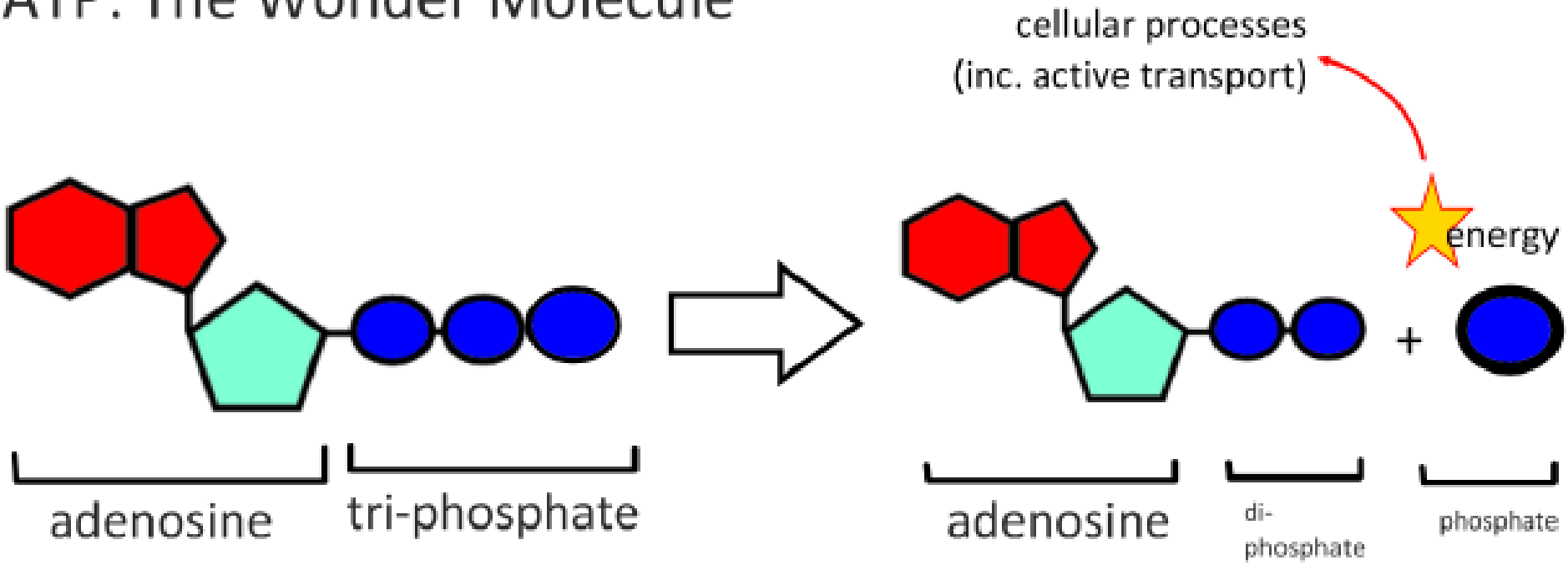


The release of energy from ATP results in a conformational change in the shape of the protein pump. The molecule is pushed to the other side of the membrane.



- http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120068/bio03.swf::Sodium-Potassium%20Exchange%20Pump

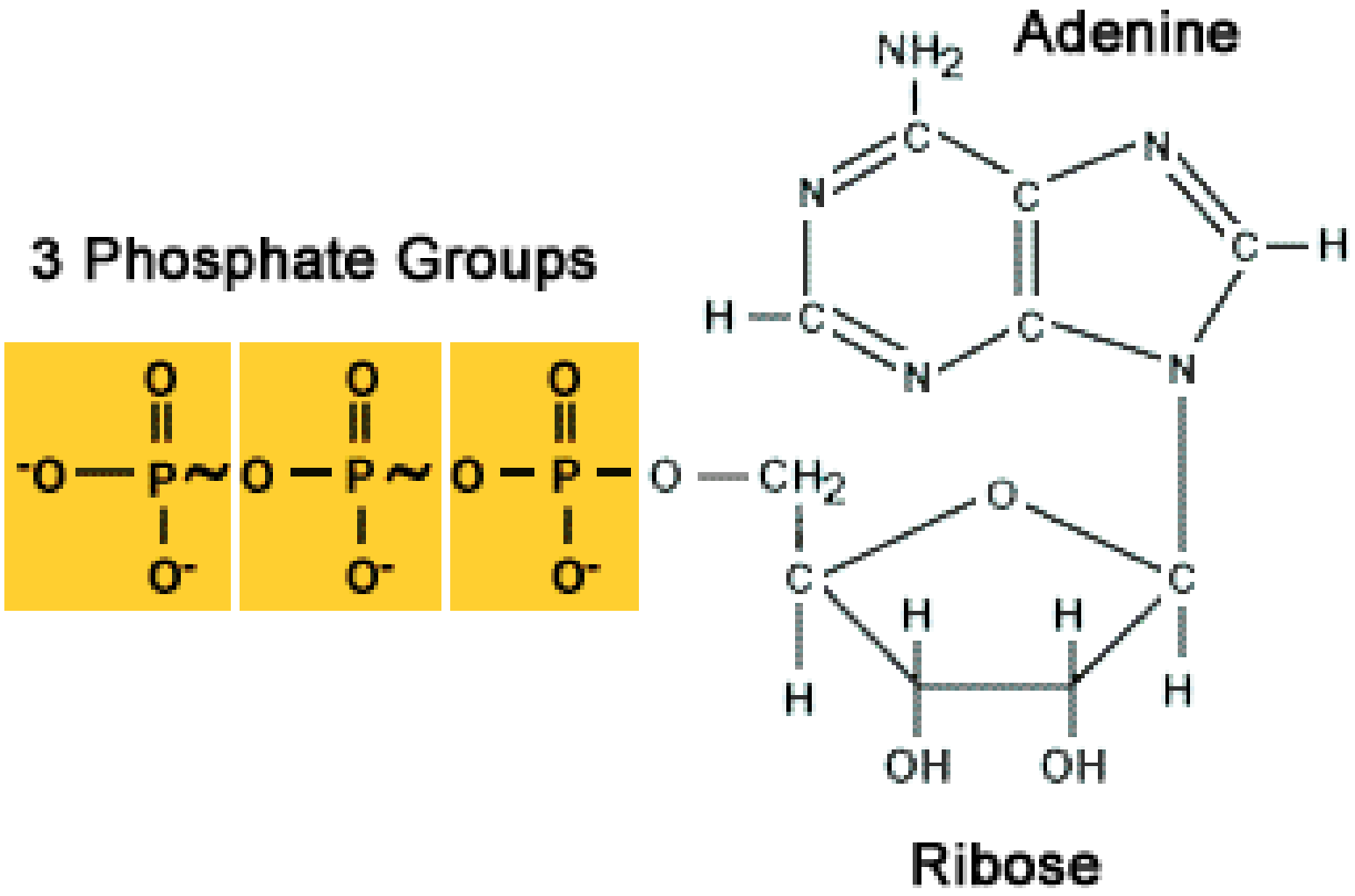
ATP: The Wonder Molecule



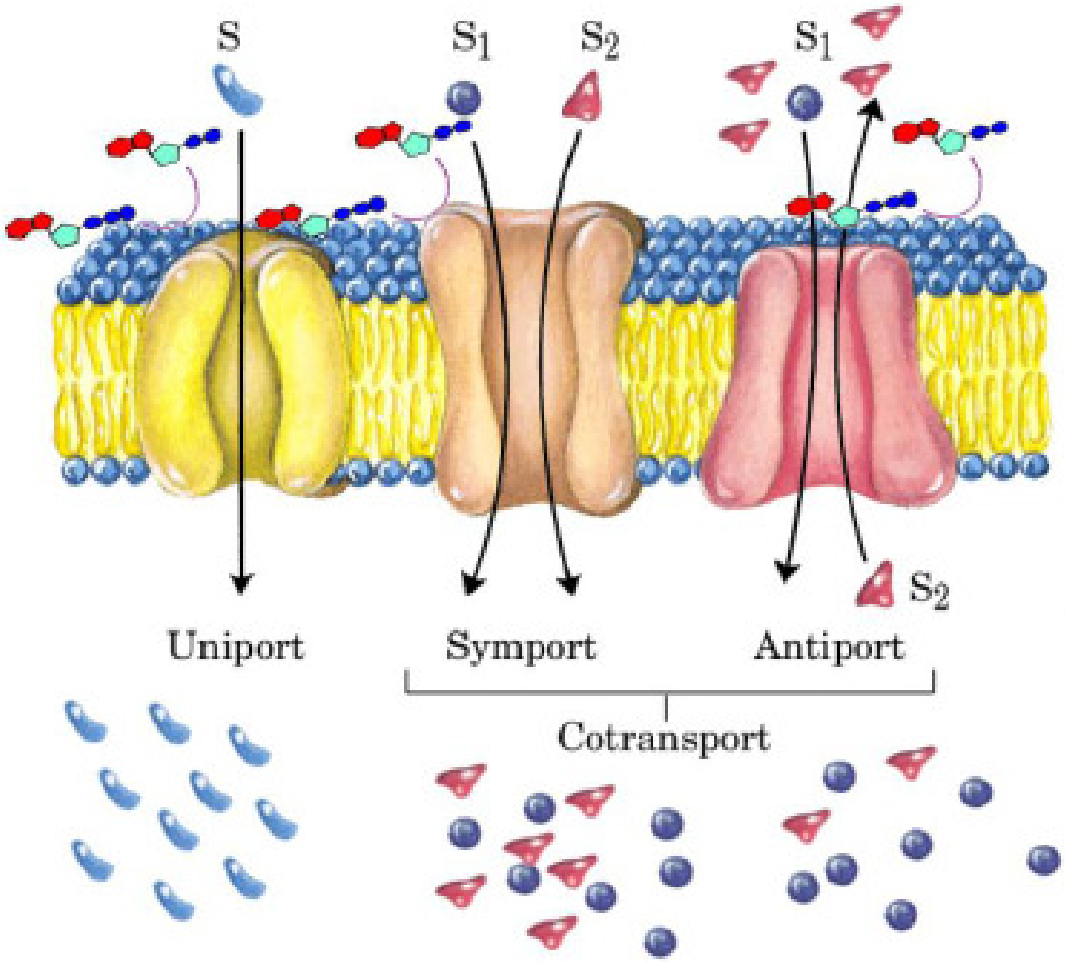
Hydrolysis of the bond releases one phosphate and a lot of energy.

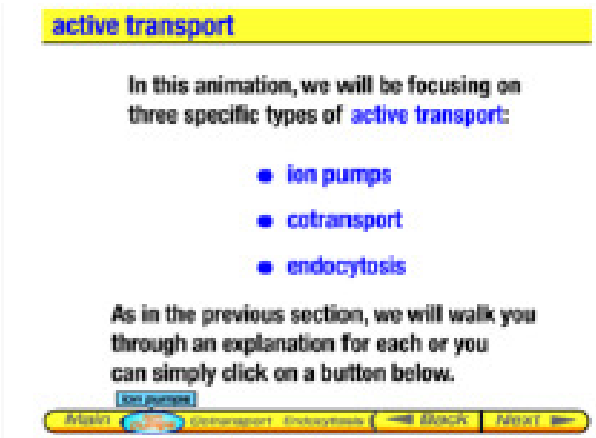
use water split

Respiration in the cells recombines ADP with a phosphate ion, to be used for further cellular processes.


Adenine
3 Phosphate Groups
Ribose

There is diversity in active transport methods.





http://www.esnips.com/doc/45c10ddf-96a4-4731-a4d5-7455ff682054/Phospholipid-Bilayer

Can you deduce the meanings of these terms?

http://www.biochem.arizona.edu/classes/bioc462/462a/NOTES/LIPIDS/Fig12_29UniCotransport.GIF

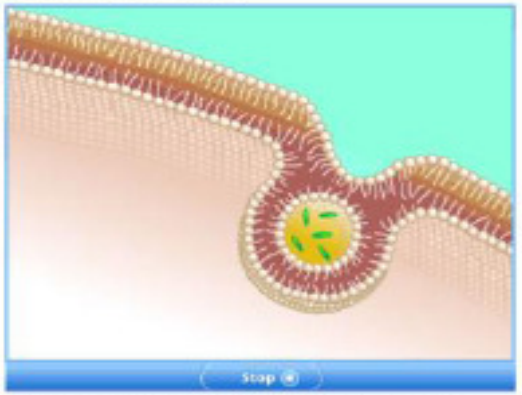
Exocytosis vs Endocytosis

exit cell process enter cell process

Exocytosis is the export of macromolecules from the cell.
Endocytosis is the import of macromolecules.

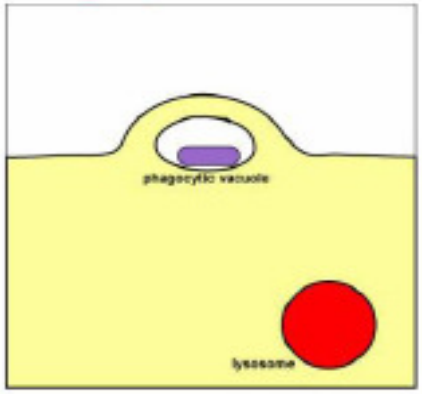
Phagocytosis is the ingestion of solid molecules.
Pinocytosis is the ingestion of liquids and solutes.

Exocytosis:



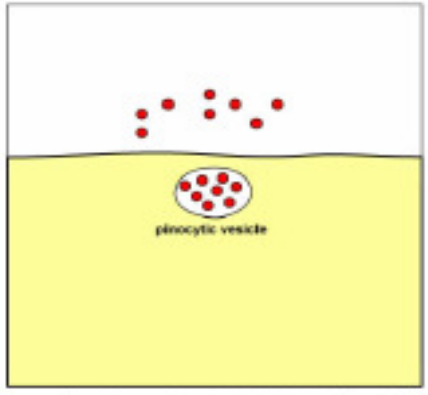
http://www.northland.cc.mn.us/biology/Biology1111/animations/transport1.html

Phagocytosis:



http://student.ecbcmd.edu/~gkaiser/biotutorials/eustruct/phagocyt.html

Pinocytosis:



http://student.ecbcmd.edu/~gkaiser/biotutorials/eustruct/pinocyt.html

Endocytosis

http://www.youtube.com/watch?v=W6rnhiMxtKU

- http://www.northland.cc.mn.us/biology/Biology1111/animations/transport1.html
- http://www.youtube.com/watch?v=W6rnhiMxtKU

Vesicle transport: Exocytosis of protein molecules via the Golgi apparatus

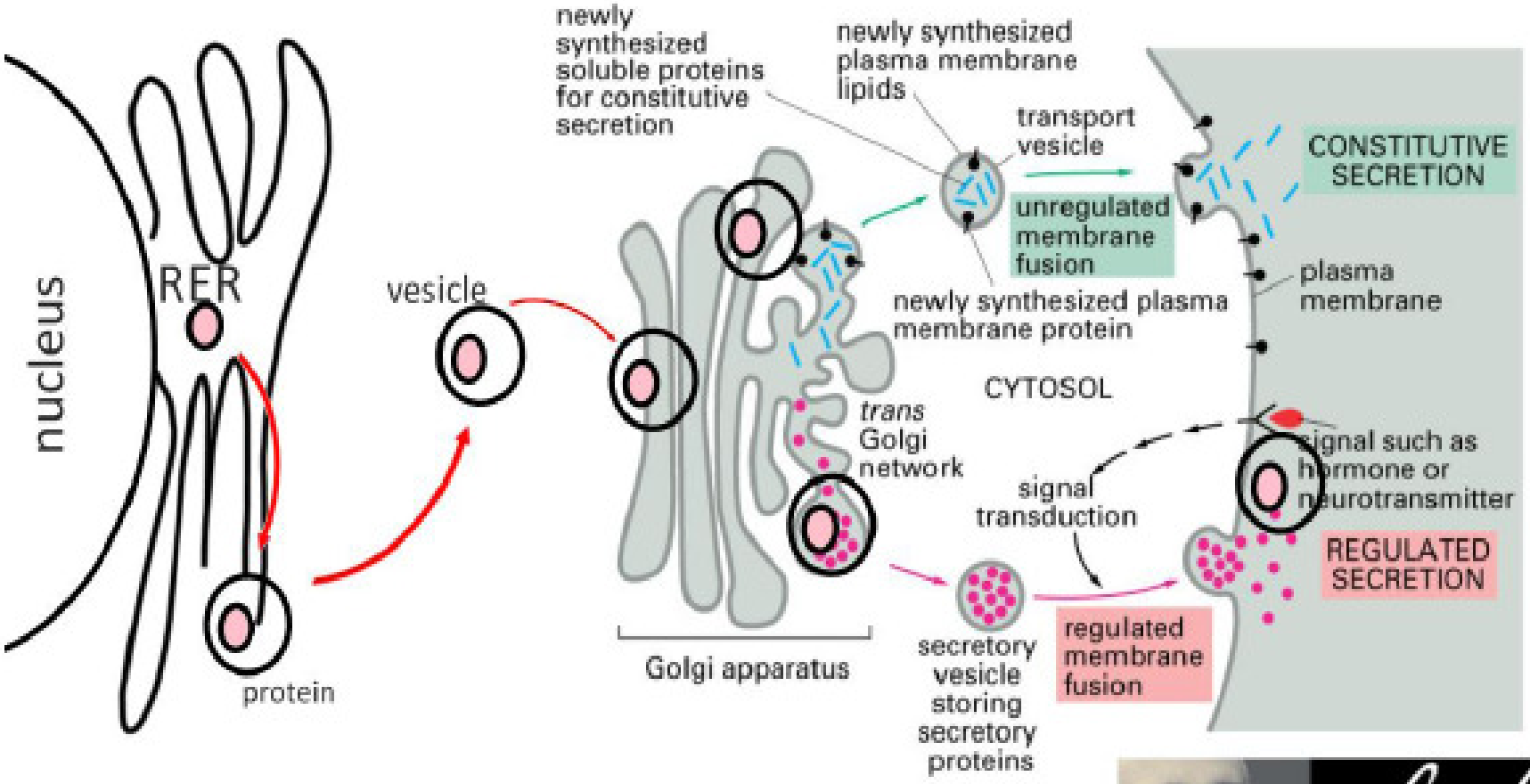
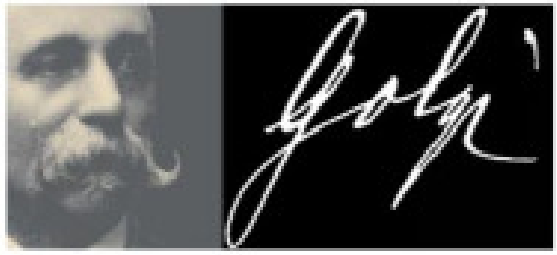


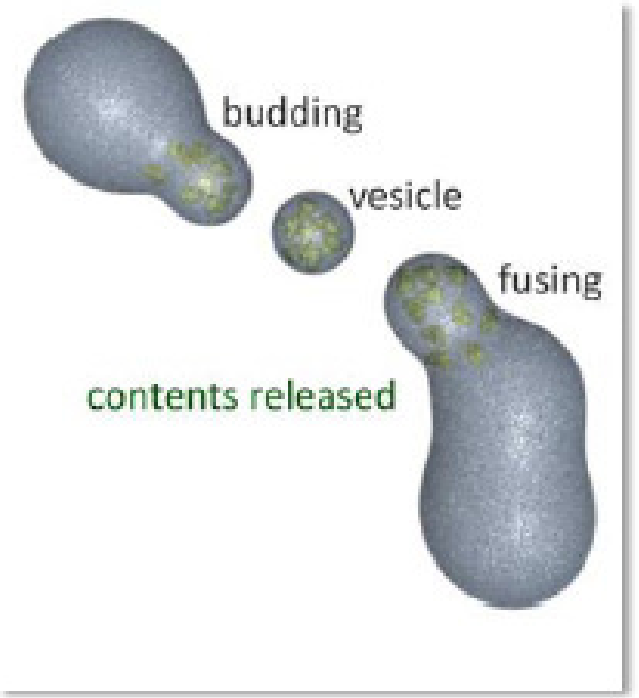
Figure 15-28 Essential Cell Biology, 2/e. (© 2004 Garland Science)



http://vcell.ndsu.nodak.edu/animations/proteintrafficking/movie.htm

Vesicle transport resources:

http://learn.genetics.utah.edu/content/begin/cells/vesicles/



Vesicles transport macromolecules (those which are too large for diffusion or protein channels) and newly-formed molecules such as proteins. The vesicle is formed from the phospholipid bilayer, and protects the contents as they travel through the reactive cytoplasm.

When the vesicle reaches its destination, it fuses with the membrane and releases its contents. Try the link above to see some movies on how the vesicles move around the cell.

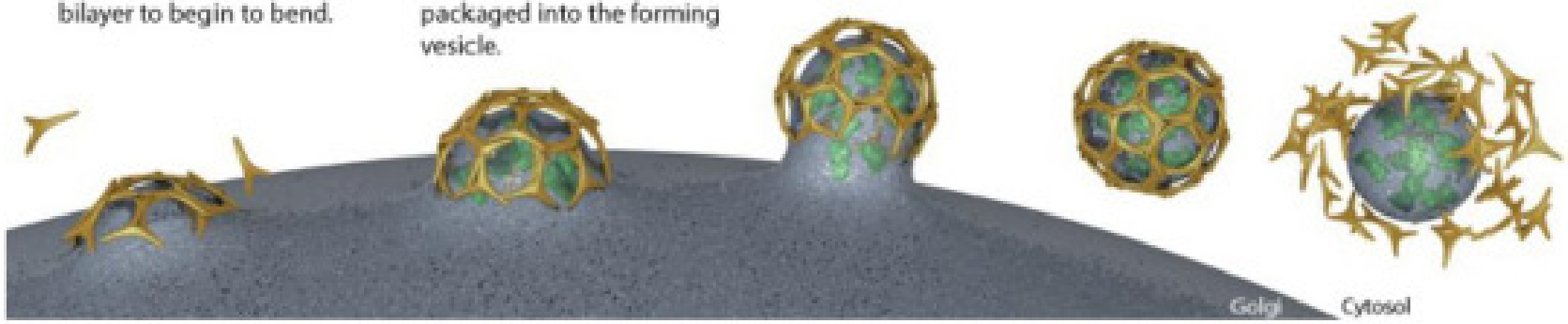
Budding Vesicles Wear Coats

1 When coat proteins assemble at the membrane, they force the lipid bilayer to begin to bend.

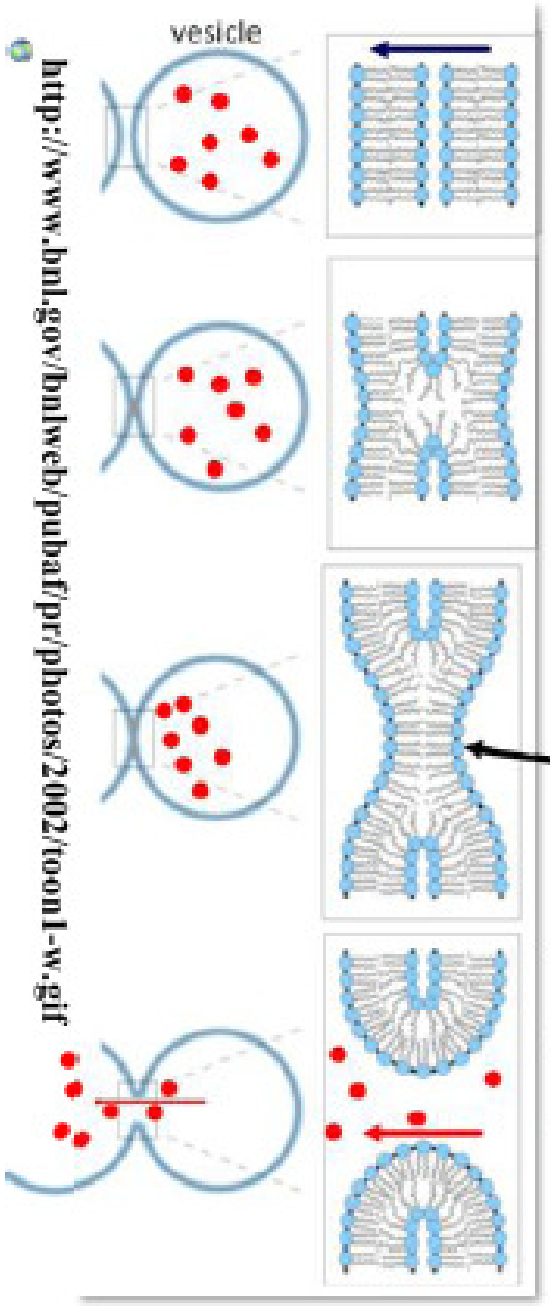
2 As they gather at the membrane, coat proteins may also select the cargo that is packaged into the forming vesicle.

3 As more coat proteins are added, they shape the surrounding membrane into a sphere.

4 Once a coated vesicle pinches off, the coat falls off, and the cargo-filled vesicle is ready to travel to its destination.



How do membranes fuse?



The vesicle approaches the plasma membrane. All membranes are made of the phospholipid bilayer, so share the same properties.

The membranes begin to fuse. Remember the fluidity of the plasma membrane - the phospholipids can flow around each other.

For a moment, there is a single phospholipid bilayer at the point of contact.

small single bilayer:
"temporary intermediate structure"

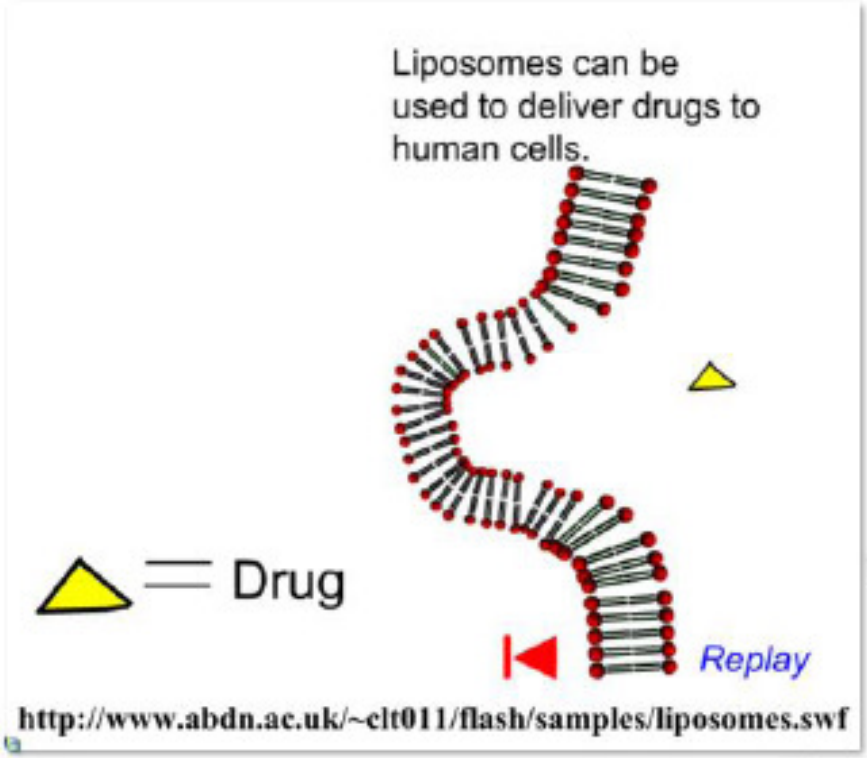
The membrane pore opens, allowing the contents to pass through. Notice that through the whole process, there is never an unbroken section of the bilayer.

Lin Yang

It wasn't until 2002 that the method for membrane fusion was discovered - by Yang and Hwang - using X-ray diffraction images.

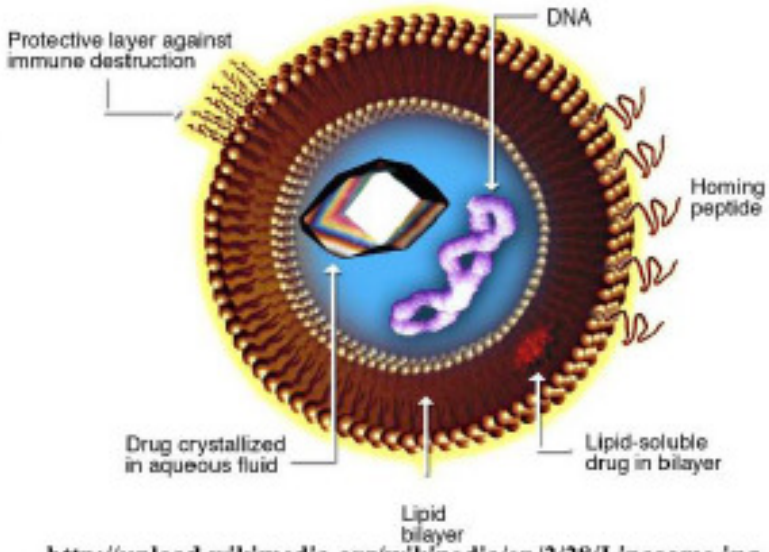
How can the properties of the phospholipid bilayer be used in medicine?

Liposomes are artificially-produced **vesicles** which can be used to transport drugs around the body and deliver them to cells*.



http://www.abdn.ac.uk/~clt011/flash/samples/liposomes.swf

Liposome for Drug Delivery



http://upload.wikimedia.org/wikipedia/en/2/28/Liposome.jpg

Liposomes are a good potential method for targetting cancers, as the cells in a tumour are not bound as tightly as regular cells (so it is easier to fuse with their membranes and deliver a drug).

*How do they know which cells to bind to?

Ultra-sound guided liposomes boost drug delivery:
http://news.bio-medicine.org/medicine-news-2/Ultrasound-guided-liposomes-boost-imaging--target-drug-gene-therapy-4355-1/

- http://www.abdn.ac.uk/~clt011/flash/samples/liposomes.swf
- http://news.bio-medicine.org/medicine-news-2/Ultrasound-guided-liposomes-boost-imaging--target-drug-gene-therapy-4355-1/

The Inner Life of the Cell

Which organelles can you recognise in these Harvard animations?

Full commentary:

Quick Version:

Really clever plasma membrane rap:

- http://multimedia.mcb.harvard.edu/
- http://www.youtube.com/watch?v=D1KXibLIOGY

Entrance exams are like a selectively permeable membrane.

Cartoon: **http://www.jhu.edu/virtlab/course-info/ei/notes/KAL_cartoon.jpg**