LEC 1

SLIDE 6

sensory receptors are ascending; they move the information to the central nervous system.
integrating center AKA central nervous system (the brain, spinal cord and the nervous system).
effectors are descending, they take the information from the CNS to the organs.
response comes from the organs.
the response reverses the stimulus.
sensory receptors are ascending; they move the information to the central nervous system.
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SLIDE 13

if the stimulus increases the feedback works on increasing it.

SLIDE 16

forecast = prediction
an example of a disease caused by bad feed-forward control is the Parkinson's disease.

LEC 2

SLIDE 5

the excess intake is the output.

capillary membrane are blood vessels.

interstitial fluid is the fluid between the blood vessels and the cell membranes.
the substances that comes out of them should be equal to the fluid.

extracellular fluid is composed of the plasma and the interstitial fluid.

extracellular fluid should be around 14 L.
if the extracellular fluid goes above the normal range (14 L), it would be removed by the kidneys, lungs, feces, sweat and the skin (the output).

the intracellular fluid should be around 28 L.

the fluids would go to the extracellular fluid to then be removed by the output.

the numbers are to a normal healthy person who's 70 Kg.

why 70 Kg? in the 50's military medical exams put this as a rule.
there are ways to know the volumes of the fluids compared to their weight.
the inputs and outputs shouldn't affect the ranges.

homeostasis is a dynamic equilibrium.

SLIDE 11

100 is the starting value (set point)
50 is the error value
75 is the final value
gain = correction/ error
gain = (final value - error value) / (final value - starting value)
we ignore the sign of the gain.
SLIDE 12
starting value is 100
error value is 150
final value 110
the higher the gain the more powerful the control system.
if the error equals 0 then the gain would be infinite and would be a good control system such as the urinary system.

LEC 3

SLIDE 4

the phosphates are to the side of the water side.
the fatty acids are opposite to the water side.
glycoproteins look like flags and are different from one another to signal chemical substances and works like the "lock-key model".
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glycoproteins look like flags and are different from one another to signal chemical substances and works like the "lock-key model".

SLIDE 5

phospholipids look like balloons. the phosphate is the balloon; the fatty acids are the strings.
phosphates are to the outside of the extracellular fluid.
fatty acids are to the inside between the phosphates.
the cell membrane looks like a sphere.
minute 19
unsaturated fatty acids have double bonds, while saturated fatty acids have single bonds only.
the filaments of cytoskeleton gives stability and movement to the cell membrane.
cholesterol is between the phospholipid bilayer.
the phospholipid bilayer is always moving which causes space between them.
the cholesterol is embedded between the phosphate groups to bring them/ distance them from each other depending on the necessity.

SLIDE 6

the linkage of receptors to hormones is an example of transmitting signals.
junctions help in communication between tissues/ cells.
the linkage of receptors to hormones is an example of transmitting signals.
junctions help in communication between tissues/ cells.

SLIDE 7
cholesterol plays an important role to keep the fluidity of the cell membrane.
it prevents it from being 'crispy' when temperature decreases.
fluidity and the temperature has a
علاقة عكسية.
cholesterol is considered as a buffer in this model.
unsaturated fatty acids and fluidity has a
علاقة طردية.

SLIDE 8
the requirements for a substance to move easily across the membrane:
1-small
2- non polar
3- can dissolve in the lipid bilayer
small gasses are an example of this such as CO2 and O2
small polar molecules such as water and large non polar molecules such as benzene can pass slowly and not like non polar small molecules.
benzene was used in the past to wash their hands for their belief that it can't get into the membrane.

SLIDE 9
lipid-soluble substances depend on their size to get easily into the cell membrane. if large then slowly, if small then fast.

SLIDE 10
passive transport: the movement from the higher concentration to the lower concentration without the use of energy.

LEC 4

SLIDE 4
what makes the fluid move? the difference of pressure and concentration.
dynamic equilibrium DOES NOT mean that both sides would be equal BUT means an ALMOST equal balance which means "net movement" or "net equilibrium"
what makes the fluid move? the difference of pressure and concentration.
dynamic equilibrium DOES NOT mean that both sides would be equal BUT means an ALMOST equal balance which means "net movement" or "net equilibrium"

SLIDE 5
spreading goes with the concentration gradient by their kinetic energy.
osmosis only means diffusion of water ONLY.
solutes go by simple diffusion.
facilitative diffusion is mainly for large molecules and is considered passive because it doesn't use energy.
spreading goes with the concentration gradient by their kinetic energy.
osmosis only means diffusion of water ONLY.
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facilitative diffusion is mainly for large molecules and is considered passive because it doesn't use energy.

SLIDE 7
in osmosis the water goes from the higher water potential (the compartment with less concentration of solutes) to the lower water potential (the compartment with more concentration of solutes).
water potential = جهد الماء

SLIDE 8
T = thickness of membrane.
J = joules.

SLIDE 9
temperature increases the kinetic energy of the particles which makes the diffusion faster.

LEC 5

SLIDE 3
active transport goes against the concentration gradient (uphill).

SLIDE 4
facilitated diffusion and active transport both use carrier proteins BUT the difference is the pathway (active transport = against the concentration gradient, passive transport = with the concentration gradient) and the acting of the carrier proteins as pumps in active transport.

SLIDE 6
the sodium-potassium pump works in making/ keeping the cell more negative than the outside by increasing potassium inside the cell.
The pump works by getting three sodium's to the extracellular fluid and two potassium in.
since energy is needed for this process; ATP gets phosphorylated to release energy with the help of an enzyme and ATP turns into ADP.
Calcium pump is found in the membrane of the sarcoplasmic reticulum and works in places that involve contractions and relaxation.

SLIDE 7
uphill = against the concentration.
downhill = with the concentration.

SLIDE 11
uniport is another meaning of passive diffusion.

SLIDE 13
the sodium-hydrogen pump works with carbonic acid (H_2CO_3) and the CA (carbonic anhydrase) as the combination of H_2O and CO_2 would form H_2CO_3 then hydrolysis would create the H ion making it into HCO_3 ion making it get reabsorbed into the blood vessels with the Na ion.
the H ion gets in; the Na ion gets out to the blood vessels accompanied with HCO_3 ion.

SLIDE 14
from the lumen of the small intestines to the micro-villi (the brush border) on the apical surface of the epithelial cells:
glucose and galactose: secondary active transport with Na+.
fructose: facilitated diffusion.
fructose gets reabsorbed faster and easier than other mono-saccharides
of its simple structure compared to them.
amino acids: secondary active transport with the Na+.
dipeptides and tripeptides: secondary active transport with H+.
short-chain fatty acids: simple diffusion
micelle (long-chain fatty acids+monoglycendes): the micelle gets broken down to long-chain fatty acids and monoglycerides. because it is lipophilic it goes by simple diffusion.

from the epithelial cell to the blood vessels:
monosaccharides: ALL monosaccharides go by facilitated diffusion amino acids: ALL amino acids go by simple diffusion
short-chain fatty acids: by simple diffusion.
monoglycerides: monoglycerides combine with other monoglycerides to make triglyceride. because it is a very large molecule it is wrapped to become a chylomicron that gets absorbed by a kind of lymphatic vessels called lactale (which its primary function is to absorb fatty acids and triglycerides) AND NOT by normal blood vessels.

LEC 6

SLIDE 3
the materials can also be very small but need to be transported in large quantities.
endocytosis means from outside of the cell to the inside and vice versa for exocytosis.

SLIDE 4
vesicles are small cell membranes that have the same structure of the lipid bilayer which makes it easier to pass in and outside the cell.

SLIDE 5
pathogens are strange bodies like viruses, bacteria and etc...
endocytosis plays a big part in capturing the pathogen and break down the pathogen by "lysis".

SLIDE 6
phagocytosis is one of the functions that the immune system takes upon.
when the particle binds with the receptors it simulates the release of pseudopodia
(تذكر إنه بداية هاي الكلمة تلفظ كحرف الz)that surrounds the object to from a vesicle.
Lysosomes are responsible of "lysis"

SLIDE 7
the difference between phagocytosis and pinocytosis:
phagocytosis takes large molecules in very small quantities and the pseudopodium forms by pinching out.
pinocytosis takes small molecules and folds in.

pinocytosis vesicles are called "pinocyte vesicle".
the pinocyte goes to the endosome to be stored.
pinocytosis is also called cellular drinking; because the molecules get dissolved in the water.

SLIDE 9
extracellular molecules bind with their receptors that are on the cell membrane forming a coated pit (also called specific pit) by sinking inwards.
the coated pit separates from the cell membrane and gets inside the cell.
the pictures were taken by an electron microscope.
receptor mediated endocytosis is mainly noticeable for its function in up taking LDL (low density lipoprotein "bad cholesterol") from the bloodstream.
hypercholesterolemia is a disease caused by the accumulation of LDL in the bloodstream; because of the lack of receptors or the complete absence of receptors.

SLIDE 10
facilitation of cellular communication examples: the release of hormones and neurotransmitters.
exocytosis repairs the cell membrane from the damage that has been done by endocytosis.

SLIDE 12
when the vesicle reaches the Golgi apparatus it gets coated with another layer making the vesicle's name "the Golgi complex".
regulated exocytosis needs extracellular signals; this is why it is controlled.
constitutive exocytosis DOES NOT need extracellular signals.

SLIDE 13
if the movement of the molecules is towards the lumen then it is called secretion.
if the movement of the molecules is towards the blood vessels of the capillary then it is called absorption.
excretion means getting the molecules outside of the body.

SLIDE 14
the arterial end is the part that is AWAY from the heart. the ratio of water to solutes in this end is higher (water is more) which makes a hydrostatic pressure.
this causes net filtration by making the molecules move from the arterial end to the interstitial space; because of the high water potential in the arterial end compared to the interstitial space.
between the arterial end and the venous end, the hydrostatic pressure becomes equal to "oncotic" pressure.
oncotic pressure is form of pressure INDUCED by proteins.
in the venous end the oncotic pressure becomes higher than the hydrostatic pressure.
net filtration can be seen in the urinary system.

LEC 7

SLIDE 3
plasma is the water of the blood.

SLIDE 4
it is found in confined places.
peritoneal is found inside the abdomen.
pericardial fluid is found between to cardiac membranes.
synovial fluid is found between the joints.
intraocular fluid is found in the eye.

SLIDE 7
total body fluid (L) = ICF + ECF
ECF = plasma (20% of ECF) + interstitial fluid (80% of ECF)

SLIDE 8
homeostasis is linked with water balance; so the transport of molecules and ions can work.
if an excess of intake happened, it would get excreted out of the body.
when homeostasis happens, water balance gets achieved and all fluids get into their normal range.

SLIDE 10
no need to memorize.

LEC 8

SLIDE 3
centrifugation machines work on separating the plasma and the cells.
erythrocytes = red blood cells.
two ways of measuring total blood volume (TBV):
1- TBV = 8% * weight (kg)
2- TBH = plasma volume (L) / 1- PCV (%)

SLIDE 4
liver failure means the inability to produce certain proteins that are found in the blood plasma such as the albumin and globin; as the liver is considered the manufacturer of such proteins.

in severe infections and burns, there's a loss of proteins in the body; this causes the need of plasma transfusion.
platelets play a huge part in positive feedback.
leukemia is the cancer of the lymphatic system and bone marrow.

SLIDE 5
for example, when a person is 50 kg this means that he has 4 Liters of blood and he would donate 500 ml of blood which is MORE than 1/10 of his total blood volume.

SLIDE 6
because of the low exposure of oxygen, the body produces more blood cells to give oxygen to the rest of the cells.

SLIDE 9
both numbers of total milliosmoles and the corrected osmolar activity are correct.

SLIDE 10
hydrostatic pressure makes the water go from the higher water potential to the lower water potential whenever there's an increase of oncotic pressure the water potential will drop.
SLIDE 11
if a solution is more than 300 milliosmoles then it is a hyper-tonic solution which makes the water get out of the blood cells and make it shrink (تنكمش) these are called (unhappy cells).

the isotonic solutions have the same milliosmoles as the plasma (282- 301.8)
which makes the water get in and out of the cell WITH THE SAME PROPORTION these are called (happy cells).

if the solution is lower than 282 milliosmoles then the water would get into the blood cells any cause it to lysis (burst = تنفجر) these are called (unhappy cells).

LEC 9

SLIDE 3
plasma has slightly more proteins than the interstitial and intracellular; which makes it have a higher osmotic pressure of 20 mmHg than the other fluids.
there are three types of proteins in the plasma:
1- albumin
2- globulins
3- fibrinogen
electrophoresis is a device composed of two poles: one negative and one positive with a gel.
when the plasma fluid gets put on the device the proteins separate and move to the POSITIVE pole; because proteins are NEGATIVE.
they vary in distances because of their molecular weight.
albumin goes the furthest; because it has the lightest molecular weight then the globulin.
albumin is the reason of oncotic pressure because of its low molecular weight

SLIDE 4
the unit of osmolarity is mosm/L
if the compound makes an ionic bond then it would get disassociated in the solution.
in the first example, we have 4 mill mole of KCL. because of its ionic bond, the K+ would get separated from the Cl-.
so we would end up with 4 mill mole of K+ AND 4 mill mole of Cl- which means 8 mosm/L IN TOTAL.
in the second example, we have 2 mill mole of $CaCl_2$. because of its ionic bond, the Ca+2 would get separated from the Cl-.
so we would end up with 2 mill mole of Ca+2 and 4 mill mole of CL- (because we have TWO Cl- in the compound) which means 6 mosm/L IN TOTAL.
a general formula for IONIC COMPOUNDS:
the amount of molecules in the compound* the mill mole of the substance.
for example, if we add 5 mill moles of $AlCl_3$ to 1 L we will end up with 20 mosm/L
why? we have one Al+3 and three CL-
which means we have 4 molecules. so,

4 molecules * 5 mill moles = 20 mosm/L
non- ionic compounds (covalent compounds) do not disassociate completely in the solution, so it will stay the same.

SLIDE 5
if we want to convert from M to mM we multiply by 1000.
M --->mM *1000
mM ---> M / 1000

because the mosm/L of the NaCl in the question is 300 then it is considered ISOTONIC; because it is in the normal range (280- 300).

SLIDE 6
first, we convert the percentage into g/100 ml
0.9% = 0.9 grams of NaCl/ 100 ml.
then convert to g/L by * 10
0.9 g/100 ml = 9 g/ L
then we divide the amount of grams of the compound in the saline by its molecular weight to find the MOLARITY.
molecular weight of NaCl = 58 g/mol.
so,
MOLARITY = (the amount of compound in g/L)/ molecular weight of the compound.
MOLARITY = (9 g/L) / (58 g/mol)
MOLARITY = 0.154 M
0.154 M = 154 mM
to calculate the mosmolarity of the compound, we multiply the amount of molecules (2) with the millimolar (154mM) which equals 308 mosm/L which makes it an isotonic solution (because it is around 300 mosm/L and it is only a slight increase).
0.9% NaCl and 0.154 M NaCl and 154 mM NaCl solution mean the same thing.
remember that because it is an ISOTONIC solution this means that the red blood cells will be (happy cells).

SLIDE 7
first example:
first, we convert the percentage into g/100 ml
3% = 3 grams of NaCl/ 100 ml.
then convert to g/L by * 10
3 g/100 ml = 30 g/ L
then we divide the amount of grams of the compound in the saline by its molecular weight to find the MOLARITY.
molecular weight of NaCl = 58 g/mol.
so,
MOLARITY = (the amount of compound in g/L)/ molecular weight of the compound.
MOLARITY = (30 g/L) / (58 g/mol)
MOLARITY = 0.517 M
0.517 M = 517 mM

to calculate the mosmolarity of the compound, we multiply the amount of molecules (2) with the millimolar (517mM) which equals 1034 mosm/L which makes it a HYPERTONIC solution (because it is not in the normal range)
HYPERTONIC solutions make the red blood cells crenate/shrink (unhappy cells)
the solution infused would get inside the ECF causing it to increase and then homeostasis would occur inside the cell causing the water to get from the ICF (which it would decrease) to the ECF to balance it out.

second example NaCl is the same as the previous slide.
5% dextrose solution:
first, we convert the percentage into g/100 ml
5% = 5 grams of Dextrose/ 100 ml.
then convert to g/L by * 10
5 g/100 ml = 50 g/ L
then we divide the amount of grams of the compound in the saline by its molecular weight to find the MOLARITY.
molecular weight of Dextrose = 198 g/mol.
so,
MOLARITY = (the amount of compound in g/L)/ molecular weight of the compound.
MOLARITY = (50 g/L) / (198 g/mol)
MOLARITY = 0.2525 M
0.2525 M =252.5 mM
so, Dextrose 5% is 252.5 mosm/L which makes it an ISOTONIC solution (because it is only SLIGHTLY away from the normal range)
third example:
first, we convert the percentage into g/100 ml
0.45% = 0.45 grams of NaCl/ 100 ml.
then convert to g/L by * 10
0.45 g/100 ml = 4.5 g/ L
then we divide the amount of grams of the compound in the saline by its molecular weight to find the MOLARITY.
molecular weight of NaCl = 58 g/mol.
so,
MOLARITY = (the amount of compound in g/L)/ molecular weight of the compound.
MOLARITY = (4.5 g/L) / (58 g/mol)
MOLARITY = 0.077 M
0.077 M = 77 mM
to calculate the mosmolarity of the compound, we multiply the amount of molecules (2) with the the millimolar (77mM) which equals 154 mosm/L which makes it a HYPOTONIC solution (because it is not in the normal range)
the solution infused would get inside the ECF causing it to increase and then homeostasis would occur inside the cell causing the water to get from the ECF to the ICF to balance it out.
HYPERTONIC = decrease of ICF
ISOTONIC = no increase or decrease of ICF
HYPTONIC = increase of ICF

LEC 10

SLIDE 4

each number is called a generation.
for example, generation Z, generation 0, generation 1, etc...
the number indicates the amount of airways in the generation.
from generation Z till generation 16 is the CONDUCTING zone.
from generation 17 till generation 23 is the respiratory zone; because it contains the alveolar ducts, sacs and the gas exchange.

SLIDE 6

main keywords and definitions:
RV = right ventricle RA = right atrium
LV = left ventricle LA = left atrium
the left side (LA and LV) has the oxygenated blood and the right side (RA and RV) has the de-oxygenated blood.

artery: the part who is responsible of taking the blood AWAY FROM THE HEART (ALWAYS HAS OXYGENATED BLOOD).
veins: who is responsible of taking the blood TO THE HEART (ALWAYS HAS DE-OXYGENATED BLOOD).

the right ventricle pumps the de-oxygenated blood to the pulmonary artery (the only artery that carries DE-OXYGENATED blood) then to the capillaries to become oxygenated then to the pulmonary vein (the only vein that carries OXYGENATED blood) that carries the OXYGENATED blood to the left atrium.
the left ventricle pumps the blood to the aortic artery which goes through the systemic circulation that makes the internal respiration and the cellular respiration.

SLIDE 7

the macrophages "dust cells" work on destructing foreign bodies, it is considered a bulk transport example.
we have two type of cells:
1- type I cells
2- type II cells
type II cells work as a surfactant secreting cell which reduces the surface tension.
in the air-blood barrier, we will see the that the alveolus is filled with O2 (oxygen) and the capillaries are filled with CO2 (carbon dioxide). so, simple diffusion starts for both gases as they go from the HIGHER concentration to the LOWER concentration.
O2 = from the alveolus TO the capillaries
CO2 = from the capillaries TO the alveolus.

SLIDE 8

the air-blood barrier is very small and cannot be seen by a light microscope; because its diameter is two milli-micron so it can be ONLY seen by an electron microscope.
because of how thin it is, ONLY small particles can pass through by it and by diffusion.
dust and smoking particles can pass but in very little amounts; as it gets in with very large quantities but need active transport to get in which is not found in the air-blood barrier so it would be very hard for it to get in.
for example, if we have a heavy smoker then we would mostly see it in the conducting zone (ends at generation 16).

even though would see it after the conducting zone but in really small amounts.
Fick's law:
V gas = A/ T * D * (P1- P2)
A = surface area
T = thickness of membrane
D = diffusion co-efficient
P = partial pressure of a specific gas

the relation between diffusion and the following factors:
A ↑ ↑ diffusion
T ↓ ↑ diffusion
D ↑ ↑ diffusion
(P1-P2) ↑ ↑ diffusion

LEC 11

SLIDE 3
surface tension holds the water droplets together; because of the bonds that it makes.
in the first container the water droplets are close to each other.
in the second container we have water and a surfactant, so the distance between the droplets would increase and the bonds break; this makes substances penetrate the water molecules easily.

the length of the yellow arrows shows how much a surfactant can INCREASE the distance between the water molecules.
in other words, we can say that the surfactant INCREASED the diameter of the water droplets.
examples of water surfactants:
- detergents like soap (soaps are composed of lipids that play a role as a surfactant by increasing the distance between the water molecules and the breaking down the bonds; which makes the hand get clean).

SLIDE 4
type II cells are the surfactant secreting cells in the alveolus.
the surfactant is composed of lipids and proteins.
function of type II cells:
INCREASE the radius of the alveolus which decreases the surface tension that is caused by water and air on the surface of the alveoli.
when the radius of the alveolus increases, more oxygen would get in.
premature babies = babies born before due time (before 37 weeks of pregnancy).
premature babies get shots of lipids and proteins (that are like the natural surfactants) by a catheter; to increase the surfactants so that they can breath well.

SLIDE 5
law of laplace:
Pressure = (2* surface tension)/ radius of alveolus
radius of alveolus ↑ ↓ surface tension.
radius of alveolus ↑ ↓ pressure.
surface tension ↑ ↑ pressure

SLIDE 6
the right lung in the picture is inflated fully (with a surfactant), the left lung not inflated fully (without a surfactant).
right lung:
during inhalation, the radius of the alveoli in the right lung is normal and is increased because of the surfactant.
during exhalation, the lung stays the same (does not collapse).
left lung:
during inhalation, more effort is needed to inflate the lung; because there isn't a surfactant and the small radius of the alveoli.

during inhalation, the visceral pleura gets closer to the pleural cavity BUT do not stick to each other(لا يلتصقوا) ; because of the elasticity of the lung.
when a surfactant is not there, the visceral pleura would be FAR AWAY from the pleural cavity.
elasticity works opposite from the surfactant.
surfactant makes the lung increase in size to get more air.
elasticity makes the lung get back to a small size, but the surfactant stops it to make the lung in its normal size (semi-inflated).

SLIDE 7
the gain of the renal system can be negative infinity which means it is a very strong control system.
erythropoietin is a hormone secreted by the kidney in response at any hypoxia (Hypoxia is a condition in which the body or a region of the body is deprived of adequate oxygen supply at the tissue level). it works in the negative feedback system as it increases the production of red blood cells from the bone marrow to give more oxygen to the tissues.
patients with secondary polycythemia (Secondary polycythemia is the overproduction of red blood cells) have an increase of erythropoietin in their body.
1,25-dihydroxyvitamin D3 plays a huge role in producing the ACTIVE vitamin D.
when there's a problem in the renal system, you will see a problem linked with the amount of red blood cells and production of active vitamin D.
gluconeogenesis is the process of producing glucose from non-carbohydrates.

SLIDE 9
the first step of filtration is getting the blood from the afferent arteriole to the glomerulus.
the movement of the water is out of the blood vessels into the tubule; because of the high hydrostatic of the glomerulus.
then it goes from the glomerulus to the proximal tubule.

SLIDE 10
the nephron is separated to two parts:
1- the upper part (the cortex)
2- the lower part (the medulla)
the filtrate goes from the proximal tubule to loop of Henle.
loop of Henle is composed of a descending part and a descending part that is also composed of a THICK segment and a THIN segment.
the filtrate goes through this path:
1- thick descending
2- thin descending

3- thin ascending
4- thick ascending
then the filtrate goes to the macula densa then to the distal tubule which is BEHIND the macula densa.
the filtrate then goes to the cortical collecting tubule then to the medulla then the medullary collecting tubule then to the collecting duct then ureter then the urinary bladder to get it out of the body.

SLIDE 11
we have two types of nephrons:
1- cortical nephron
2- medullary nephron

the cortical nephron has two distinguished structural identities:
1- the bowman's capsule is AWAY from the middle line (farther from the medulla).
2- the loop of Henle is very short.
the medullary nephron is opposite from the cortical nephron, as the loop of Henle is taller and the bowman's capsule is CLOSER to the middle line (closer to the medulla).
the cortical nephron is more seen than the medullary nephron.

SLIDE 12
the filtration happens by the blood moving from the AFFERENT arteriole (the afferent arteriole is DIFFERENT than the efferent arteriole as it is the arteriole that gets the blood OUT of the glomerulus) to the glomerulus.
the filtrate then gets reabsorbed and secreted in the proximal tubule to the blood vessels.
in loop of Henle ONLY reabsorption happens.
in the distal tubule AND the collecting duct reabsorption and secretion happens.
when the filtrate reaches the bladder EXCRETION happens.

SLIDE 14
when there is an increase OR decrease of net filtration pressure (10 mmHg out) this means that there is a problem in the filtration process.

SLIDE 15
GFR = glomerular filtration rate.
hemorrhage = bleeding.

LEC 12

SLIDE 2
ABG =arterial-blood gas

SLIDE 3
VBG (Venus Blood Gas) is another test that takes blood from the veins that measure the same as the ABG but in a faster way BUT not as precise as the ABG.
the blood sample for the ABG is taken from the radial artery.
the pulse oximetry can give some information about the pH.

SLIDE 4
mEg/L in the HCO3- normal values is a unit that measures the negative or positive charges inside a solution.

SLIDE 6
HCO_3^- is responsible for the alkalinity.
H^+ is responsible for the acidity.
le chatelier's principles says that all reactions are in an equilibrium.
in the example, if there is a decrease in the left side ($CO_2 + H_2O$) the right side ($H^+ + HCO_3^-$) would work on compensating the decrease that is on the left side and vice versa so the equilibrium happens.

SLIDE 8
in a normal condition, a person would have a ratio of 1:1 of H^+ and HCO_3^- so the concentration of both substances is the same.
in metabolic acidosis:
for example, when a patient has diarrhea they lose a lot of HCO_3^- (which is responsible of alkalinity) which causes metabolic acidosis; as there would be MORE H^+ than the HCO_3^- which causes the acidosis of blood (pH UNDER 7.35).
in metabolic alkalosis:
for example, when a patient vomits they lose a lot of H^+ and hydrochloric acid that is found in the stomach (which are responsible of acidity) which causes metabolic alkalosis; as there would be MORE HCO_3^-than the H^+ which causes the alkalosis of blood (pH ABOVE 7.45).
acidosis = ↓ HCO_3^- ↑ H^+ ↓ pH
alkalosis =↑ HCO_3^- ↓ H^+ ↑ pH

SLIDE 9
chemoreceptors work on responding in any disruption of the pH of the blood, the CO_2 in the blood and the H^+.
there are two types of chemoreceptors that depend on its place:
1- peripheral (arterial chemoreceptors)
2- central chemoreceptors (inside the brain stem).
an example of an arterial chemoreceptor:
counted arteries which is found in the heart that work in sensing any disruption of CO_2 and H^+. when there is a disruption, the receptors get stimulated to notify a certain place in the brain which is the respiratory group that there is a problem.

SLIDE 10
respiratory rate refers to the inhalation and the exhalation process per A MINUTE.
depth refers to the volume of inhalation and exhalation.
the alteration of the respiratory rate can be an increase or a decrease depending on the change of pH.

SLIDE 11
in metabolic acidosis: the respiratory rate INCREASES and MORE CO_2 is getting out "blown off".
in metabolic alkalosis: the respiratory rate DECREASES and CO_2 is getting RETAINED.

SLIDE 12
respiratory mechanism works best in ACUTE cases.
in severe cases or chronic cases, the urinary mechanism is better.

SLIDE 15
respiratory acidosis:
for an example, heavy smokers have a lot of CO2 in the blood in long periods which causes them to have respiratory acidosis.
this causes the left side to be more and have an accumulation of H2CO3 and H+ which cause RESPIRATORY ACIDOSIS.
respiratory alkalosis:
for an example, a person with a lot of stress their respiratory rate increases
which causes the left side to be less; because of the DECREASE of CO2 that causes the right side to be less (H2CO3) and RESPIRATORY ALKALOSIS happens.

SLIDE 16
in case of a respiratory acidosis, there is a retention of bicarbonate and a secretion of H+ in the renal tubular cells; to increase the blood pH.

in case of a respiratory alkalosis, there is a secretion of bicarbonate and a retention of H+ in the renal tubular cells; to decrease the blood pH.
renal compensation takes more time.

LEC 13

SLIDE 2
this process happens in the early proximal convoluted duct.
the substances that go to the tubular lumen are "secreted" and the substances that go to the peritubular capillary are "reabsorbed."
the substances needed are reabsorbed and the substances secreted get EXCRETED afterwards.
we have three pumps in the picture:
1 -the yellow pump, a sodium-potassium pump that works in the primary active transport method.
2 -the red pump, a sodium-hydrogen pump that works in the secondary active transport method (it depends on the electrochemical gradient caused by a primary active pump)
3 -the blue pump, a sodium-bicarbonate pump.
the red pump works on secreting the H+ to the tubular lumen by the electrochemical gradient caused by the yellow pump.
then the H+ bonds in the tubular lumen with the bicarbonate with the help of the carbonic anhydrase that produces the carbonic acid which turns into CO2 and H2O that gets into the epithelium by diffusion; to make the cycle move again.
there is NO NET SECRETION OF H+ as it bonds with the bicarbonate in the tubular lumen. but, the bicarbonate that was reabsorbed in the peritubular capillary is recycled; this is why we call this the HCO3- reabsorption process.
the bicarbonate gets reabsorbed to the peritubular capillary by the blue pump.

SLIDE 3
this process happens in the alpha intercalated cell in the distal convoluted tubule.
the H+ gets secreted into the tubular lumen by an active primary pump with the K+.
the bicarbonate gets reabsorbed to the peritubular capillary while the Cl- gets into the epithelium (the bicarbonate and the Cl- always go in different directions while the bicarbonate and Na+ always go in the same direction).

this process is important to excrete H+ out of the body when there's an increase of the blood acidity. BUT when the blood becomes alkaline, the secretion of H+ becomes lower making the bicarbonate reabsorption less; to secrete it and then excrete it out of the body.
the normal range of the urine's pH is between 4.4-4.8, when there's an increase of H+ in the urine, the pH gets lower and the urine becomes MORE acidic.
to keep the pH of the urine in its normal range, the H+ binds with buffers such as the phosphate and the ammonia; which gets rid of (excretes) nonvolatile acids.

SLIDE 4
the H+ connects with the phosphate, when it does it is called a titratable acid that gets excreted out of the body.
in this process there is a net secretion of H+ and the HCO3- has not been recycled "new bicarbonate".

SLIDE 5
glutamine is an amino acid that is produced by the liver.
this process happens in the proximal convoluted duct.
glutaminase is an enzyme that is very sensitive to the pH.
the result of this process gives us two bicarbonate and ammonia

SLIDE 6
in the collecting duct, ammonia is secreted and H+ where they bind together in the tubular lumen to make ammonium (NH4), because they can't get diffused inside the cell, they connect with the Cl- to get excreted out of the body.
Slide 9
strong acids disassociate completely in water while weak acids do not.
strong acids react with monohydrogen phosphate and produce WEAK ACIDS
strong bases react with dihydrogen phosphate and produce WEAK BASES.
examples of physiological buffers:
1- the respiratory system
2- the urinary system
Slide 12
over 1/3 of the red blood cells weight is hemoglobin.
two ways of transporting CO2:
1- combining the CO2 with the carboxyl group.
2- the CO2 binds with H20 within the RBC to make H2CO3 which becomes to H+ and HCO3-. the H+ buffers with the hemoglobin to produce HHb. this means that we have a free HCO3- that diffuses to the plasma and exchanges with the Cl-
Slide 17
metabolical problems are always caused by the right side.
respirational problems are always caused by the left side.
the RESULT of metabolic acidosis is hyperventilation (التنفس بشكل سريع)
the RESULT of metabolic alkalosis is hypoventilation (التنفس بشكل بطيء)
there is a difference between RESULTS OF and LEADS TO
results of = ينتج من
leads to = يسبب
hypoventilation LEADS TO respiratory acidosis
hyperventilation LEADS TO respiratory alkalosis

LEC 14

SLIDE 3

it is a way of communication between a cell and another.
an example, Central Nervous System.

SLIDE 4

Hodgkin and buxley's method to measure voltage in a cell was by using a squid. (حبار) when tested, they measured the difference of voltage between the ECF and the ICF and was found to be between -70 to -90 millivolts which was called the RMP (Resting Membrane Potential).
the negative refers that the ICF is more negative compared to ECF which is positive.
this depends on the type of cell as some cells might have -80 or -85 as their RMP.
we have around 60 TRILLION cells in our body and if we round up the RMP from 70 mV to 100 mV and multiply it to the amount of cells (60 trillion) we would have a great amount of voltage in our body.
a lot of tests have used this information to record activity of certain cells and so on. for examples,
1 - EMG (electromyography) which measures and records the signals across the membrane in MUSCLE cells. this is done by putting two electrodes (one cathode and one anode) and measures their potential voltage.
2-EEG (electroencephalogram) which measures and records the signals across the membrane of BRAIN cells. this is done by putting a cap on the brain that are composed of electrodes. they are used in different ways. for an example, his voltage when he is asleep, awake or when thinking.
3-ECG or EKG (electrocardiograph) which measures and records the signals across the membrane of CARDIAC MUSCLE cells.
voltage is always constant in all cells EXCEPT:
1 - muscle cells.
2 - nerve cells.
Slide 5
K+ (potassium) is HIGHER in ICF than in ECF.
Na+ (sodium) is LOWER in ICF than in ECF.
K+ should move FROM ICF TO ECF
Na+ should move FROM ECF TO ICF
both have their own channels (sodium channel, potassium channel) and have another name for them which is leak channels and they only work when the cell is in rest (no activity).
there are MORE potassium channels than sodium channels in the cell membrane; which means a lot of potassium would get out to the ECF. this causes the cells to be MORE negative compared to the outside which would be MORE positive.
because of potassium getting out of the cell in large amounts; there are MORE negative ions than positive ions INSIDE THE CELL this causes an electrochemical force.
this electrochemical force would try to get potassium AGAINST THE CONCENTRATION GRADIENT (from outside to inside).
the word electrochemical force is composed of two parts:
1- electro: the electrical gradient
2- chemical: the concentration of chemical ions
electrochemical force is an OPPOSING FORCE to concentration gradient that is only apparent with IONS.
the cell achieves RMP when both the concentration gradient of the K+ and the electrochemical force are equal; this causes no net diffusion (no K+ inside or outside of the cell).

SLIDE 7
a resting cell could either INCREASE its rest (re-polarization) by INCREASING the NEGATIVITY inside the cell compared to the outside.
and can DECREASE its rest (also called depolarization) to make it an excitable cell by DECREASING the NEGATIVITY inside the cell compared to the outside.
nerves are a bundle of neurons.
neurons are the body of the cell.
examples of action potential:
signal transduction between neurons.
contraction of skeletal and smooth muscles.
as previously mentioned ONLY nerves, neurons and muscle cells with all of its types can go from RMP to become an excitable cell.

SLIDE 8
sodium-potassium pump is a PRIMARY ACTIVE TRANSPORT

SLIDE 9
if there is a disruption in the cellular respiration there would be a disruption in making the ATP and the function of the sodium potassium pump.

SLIDE 11
in the Gibbs-donnan model, the electrochemical force is established because of the LARGE molecules that are on one side of the cell that can't get past the semi-permeable membrane of the cell.

SLIDE 12
Pr = protein
KCL is a strong acid so it disassociates completely in water so it goes from one side to the other.
container I:
[K+] = X, we don't know the concentration but we know that it is in the container.
[Cl-] = 0, it is in the II container.
[Pr-] = X, we don't know the concentration but we know that it is in the container.
container II:
[K+] = X, we don't know the concentration but we know that it is in the container.
[Cl-] = X, we don't know the concentration but we know that it is in the container.
[Pr-] = 0, it is in the I container.
how equilibrium happens:
NOTE that the Pr is negative and is a large molecule that will not be diffused so it only stays in the I container.
since Cl- is not in the I container so it diffuses from the II to the I (with the concentration gradient).
so, the [Cl-] in the II container would be:
[Cl-] = X (the concentration in the beginning) - Y (the concentration that has diffused to the I container).
and the [Cl-] in the I container would be:
[Cl-] = Y (the concentration that has diffused from the II container) making the I container MORE negative than the II container.
but the electrical gradient (electrochemical force) would oppose the concentration gradient so it would diffuse the [Cl-] BACK to the II container so that the electrical gradient would become EQUAL to the concentration gradient.

since K+ is in BOTH containers but the I container is MORE negative the K+ would move to the I container.
because of the electrical gradient, the [K+] in the II container would be:
[K+] = X (the concentration in the beginning) - Y (the concentration that has diffused to the I container).
and the [K+] in the I container would be:
[K+] = X (the concentration in the beginning) + Y (the concentration that has diffused from the II container).
but the concentration gradient would oppose the electrical gradient so it would diffuse the [K+] BACK to the II container so that the electrical gradient would become EQUAL to the concentration gradient.
K+ leakage channels wouldn't affect the concentration at all; since it diffuses one ion per channel which wouldn't cause a big change.
REMEMBER:
- chemical gradient and electrical gradient are forces that are OPPOSITE IN DIRECTION TO EACH OTHER.
- equilibrium ONLY occurs when both of them are equal to each other.

SLIDE 13
note that:
[k+] = [Cl-] + [Pr-] inside (I container)
160 mM = 40 mM+ 120 mM
and,
[k+] = [Cl-] outside (II container)
80 mM = 80 mM
the total of POSITIVE IONS equals NEGATIVE IONS in both of them; this causes a state of equilibrium.

LEC 15

SLIDE 3
in the I container we have concentrated KCl.
in the II container we have diluted KCl.
the I container resembles how concentrated KCl is inside the cell (ICF), the II container resembles how diluted KCl is outside the cell (ECF).
concentrated = مركز
diluted = مخفف

SLIDE 4
at the beginning, the K+ would move from inside the cell to outside by the leakage channels (potassium channel); because of the concentration gradient.
because of the movement of K+ (which is positive), THE POSITIVITY OF THE OUTSIDE OF THE CELL INCREASES and THE NEGATIVITY OF THE INSIDE OF THE CELL INCREASES.
الخلية داخل بالسالبية وزيادة الخلية بخارج بالموجبية زيادة.
do not forget that there are ALREADY large negative molecules and ions.
but because an electrical gradient is formed WHICH IS AN OPPOSING FORCE TO THE CONCENTRATION GRADIENT; the K+ ions get INSIDE THE CELL until both the CONCENTRATION GRADIENT AND THE ELECTRIAL GRADRIENT ARE EQUAL. this causes an equilibrium potential of K.+
NOTE that this does not mean the FULL STOP of movement of K+ ions BUT the movement still does not affect the equilibrium.
for example, when an equilibrium is reached, there is STILL movement of K+ ions to the outside but Cl- gets in. so, no effect on the equilibrium.

SLIDE 5

Ek = ((R*T)/ (Z*F)) * (ln([K+]out/ [K+]in))
Ek = equilibrium potential of K+
R = universal gas constant
T = temperature in Kelvin °K
Z = valence of the ionic species
for example, Z= +1 for K +1, Z= -1 for Cl- and so on depending on how many electrons the ion can gain/ loss.
F = Faraday's constant.
since all of them are constants we can basically say that:
(R*T)/ (Z*F) = 25 mV at 20 Celsius.
ln= 2.3*log10
so,
25 mV * 2.3 = 58 mV at 20 Celsius.
so, we can basically change the equation to the following:
Ek= 58 * log10 ([K+] out/ [K+] in)

SLIDE 6

NO NEED TO MEMORIZE THE EQUATION, THIS IS TO UNDERSTAND THE ELECTRICAL POTENTIAL.
Ek= 58 * log10 ([K+] out/ [K+] in)
from the previous lecture in the example that we had, we know that the concentration of K+ out was 80 and the concentration of K+ in was 160.
so,
Ek= 58 * log10 (80/ 160)
and 80/160 = 0.5
so another way to say is this:
Ek= 58 * log10 (0.5)
now, calculate log10 (0.5) in the calculator.
log10 (0.5) = -0.3
so, rephrase the log10 (0.5) to -0.3 and the equation becomes:
Ek = 58 * -0.3 = -17 mV
the negative refers that the inside of the cell is negative COMPARED to the outside of the cell.
the Ek = -17 mV which means when the difference of voltage between inside the cell and the outside BECOMES -17 mV, the K+ becomes in a state of equilibrium.
so, the K+ electrical potential EQUALS -17 mV.

SLIDE 7

differences between Nernst equation and GHK equation:
- Nernst considered that the cell is a closed system, which mean that there is only one ion moving in and out of the cell.
- Nernst only considered one method which is facilitated diffusion.
- Nernst didn't consider permeability.
- Nernst didn't consider that the cell ALWAYS has net movement (movement of ion, molecules, etc... EVEN IF there is an equilibrium). Nernst basically referred to the cell as if it goes by thermodynamics (that energy in a closed system goes from the higher energy point to the lower energy point till they reach an equilibrium and no net movement happens).
- GHK considered permeability in his equation.

- GHK considered the permeability of each ion in his equation.
- GHK considered the cell as an OPEN SYSTEM.

SLIDE 9
the first graph shows the resting membrane potential for the cell, K+ and Na+.
by Nernst equation, in the graph we see that:
1- the cell's resting potential is -70
2- the K+ Nernst potential is -90 (inside the cell compared to the outside)
3- the Na+ Nernst potential is +72 (outside the cell compared to the inside)
so, we can say that the cell tries to reach the K+ RESTING potential to make it reach an equilibrium UNTIL it reaches -17 mV which makes the K+ in an equilibrium.
and we can also say that the cell would also tries to reach the Na+ to its resting potential so it gets into an equilibrium.
in the second graph, we see the opening of channels of K+ and Na+ in the cell.
for K+, we see that the K+ channels open to get an OUTFLOW (because the concentration gradient is to the outside of the cell) for a certain time UNTIL it reaches an equilibrium.
for Na+, we see that the Na+ channels open to get an INFLOW (because the concentration gradient is to the inside of the cell) for a certain time UNTIL it reaches an equilibrium.

SLIDE 10
dramatically = a sudden and huge increase.

LEC 16

SLIDE 3
action potential is the opposite of resting potential.
in action potential the cell reverses the polarity inside of the cell by making it POSITIVE on the INSIDE compared to the OUTSIDE which becomes NEGATIVE.
dramatically = huge and sudden change.
SLIDE 5
in this graph we have the following:
the Y- axis shows the membrane potential in volts.
the X- axis shows the time in milliseconds.

in the beginning, we see that this cell's RMP (resting membrane potential) is -90 mV and it goes as a flat line UNTIL an action potential happens which makes the membrane potential RISE.
the membrane potential rises until it reaches the threshold level of the cell that makes a change of the membrane potential from NEGATIVE to POSITIVE.
threshold level = العتبة
depolarization:
when the potential of the cell membrane reaches the threshold level(- 65in this cell), voltage gated Na+ channels open (THEY ARE DIFFERENT THAN SODIUM LEAKAGE CHANNELS) so that sodium gets inside the cell in large quantities; because of the concentration gradient.
this makes the membrane potential positive on the inside COMPARED to the outside so that the voltage becomes MORE THAN 0mV (+ 35mV in this cell). we call this "depolarization".
when the cell reaches the PEAK voltage in depolarization ALL OF THE VOLTAGE GATED Na+ CHANNELS CLOSE.
repolarization & hyperpolarization:

after the cell reaches its peak and all of the voltage gated Na+ channels close, voltage gated K+ channels open and try to get the K+ to get out of the cell; TO GET THE CELL TO BE MORE NEGATIVE THAN THE RMP (BEYOND THE RMP), more than - 90mV. which reaches the K+ equilibrium potential of potassium.
the voltage gated K+ channels then close to get the cell into its RMP gradually.

action potential happens in10 milliseconds.

SLIDE 7
during repolarization, the cell becomes very positive inside.
this causes the K+ ion to go by two forces:
1- concentration gradient; because the K+ ion inside the cell are MORE than K+ ions outside of the cell.
2- electrical gradient; because of the huge positivity inside the cell to try to get the cell to be negative COMPARED to the outside.
NOTE:
THIS IS NOT LIKE THE EQUILIBRIUM THAT WE TALKED ABOUT IN THE PREVIOUS LECTURES.
in RMP:
concentration gradient and electrical gradient are OPPOSING FORCES.
in action potential (repolarization):
concentration gradient and electrical gradient are NOT OPPOSING FORCES.

SLIDE 8
Na/K = sodium-potassium pump
hyper-repolarization is like a warning for the cell to get back (regain) into its RMP.

SLIDE 9
if the cell does not reach the threshold then action potential will not happen.

in this graph we see that the threshold of this cell is -50 mV, the RMP is -70 mV.
when an electrical stimulation happens, and the stimulation DOES NOT reach the threshold then it is called a sub-threshold stimuli.
sub-threshold potential = UNDER the threshold value of the cell (-50 mV in this cell)
if the electrical stimulation reaches the threshold, then it is called a threshold stimulus.
if the electrical stimulation reaches the threshold AND MORE THAN ONE action potential happens, then it is called a supra-threshold stimulus.
this is needed for cellular communication.

LEC 17

SLIDE 3
in this slide we see the following shapes of a Na+ voltage gated cation channel that has two parts.
1- the hands that have the +++ signs in grey which are called "activation gated channels", they are responsible of getting Na+ from the ECF.
2- the tear-like (اللي بتشبه القطرة) in grey is called "inactivation gated channel", they are responsible of getting the Na+ from the channel to inside to the ICF.

the first picture (in the left) is a RESTING CLOSED voltage gated cation channel, meaning no inflow of Na+ from outside to inside.

the second picture (in the left) is an ACTIVATED OPEN voltage gated cation channel.

the third picture (in the middle) is an INACTIVATED CLOSED voltage gated cation channel.

- the first conformational change that we can see is the voltage gated cation channel going FROM a RESTING CLOSED channel TO an ACTIVATED OPEN channel and vice versa (deactivation - activation).

- the second conformational change that we can see is the voltage gated cation channel going FROM an ACTIVATED OPEN channel TO an INACTIVATED CLOSED channel and vice versa (reopening - inactivation).

- the third conformational change that we can see is the voltage gated cation channel going FROM an INACTIVATED CLOSED channel to a RESTING CLOSED channel and vice versa (recovery - inactivation).

from deactivation to activation:
here we see that the hands of the channel (activation gated channels) have opened; to get an INFLOW of Na+ to the ICF and the tear-like stays the same "inactivation gated channel".
this would cause an INCREASE of positivity inside the cell until it reaches the peak of the cell's potential (+ 35for example, from the last lecture) which ultimately means '"till it reaches the equilibrium potential of Na+".

from activation to inactivation:
here we see that the hands of the channel (activation gated channels) have STAYED open; to get an INFLOW of Na+ to the channel BUT the tear-like CLOSES "inactivation gated channel", this results in NO INFLOW OF Na+ TO THE ICF.
because of the tear-like "inactivation gated channel" being closed in INACTIVATION and no inflow of Na+ to the ICF; the ICF gets back to being MORE NEGATIVE which prepares the membrane to getting into HYPER-REPOLARIZATION. this is called " relative refractory period"
relative = نسبي
re-factory period = الفترة التهيئية
DO NOT FORGET THAT:
when the Na+ voltage gated cation channel becomes INACTIVATED there is no inflow of Na+ inside the cell and the K+ voltage gated cation channel OPENS.

from inactivation to recovery:
here we see that the hands of the channel (activation gated channels) have closed; to get an INFLOW of Na+ to the channel BUT the tear-like opens "inactivation gated channel", this results in getting the cell to RMP.

SLIDE 4
in the top left picture and the middle picture NO IONS CAN PASS "ion impermeable".
top left picture = closed/ deactivated
middle picture = inactivated
when the channel is INACTIVATED, the tear-like "inactivation gated channel" is closed so no Na+ ions can get inside the ICF. EVEN THOUGH, the hands "activation gated channel" are open which means that there is an inflow of Na+ to the channel BUT the tear-like acts as a barrier to not get it into the ICF.

when the channel is DEACTIVATED, the hands "activation gated channels" are closed.so, NO INFLOW OF Na+ TO THE CHANNEL OR THE ICF. EVEN THOUGH, the tear-like "inactivation gated channel" is open.
بالعربي، الفرق ما بينهم إنه بالصورة الي بالنص بيكون عندنا تدفق للقناة لكن شبيهة القطرة بتشتغل زي البوابة الي بتمنع دخولهم لداخل الخلية .
وبالصورة الي على الشمال مافي حتى تدفق للقناة لأنه شبيهة الأيادي بتكون مغلقة. بالرغم من إنه شبيهة القطرة بتكون مفتوحة.

SLIDE 9
tonically = that the membrane is still positive (still in depolarization) and can't get into repolarization.
over-excited = over depolarization

SLIDE 10
we have two types of nerves in the body:
1- myelinated nerves (the upper nerve in the picture) that has myelin sheath.
myelin sheath are lipids. they surround the nerve fibers and works on giving stability, protection and INCREASES the speed of action potential.
ACTION POTENTIAL DOES NOT GO THROUGH THE MYELIN SHEATH AS IT IS BASICALLY INSULATED BY IT.
action potential ONLY happens in nodes of Ranvier (the places between two myelin sheaths) that have voltage gated channels.
2- unmyelinated nerves (the lower nerve in the picture) which DOES NOT HAVE MYELIN SHEATH.
un- = not found

the action potential gets transmitted from the cell body until it reaches the hillock (a place in the nerve where the action potential starts) and goes AWAY from it with the nerve fibers.

SLIDE 11
propagation = how the action potential goes through the nerve.

NOTE THAT:
action potential DOES NOT HAPPEN along the whole nerve BUT happens in specific area THEN moves to the area next to it (adjacent area).
check the pictures on the right to notice this.

action potential in unmyelinated cells:
the first picture shows where the action potential starts (axon hillock) and the action potential STIMULATES ONLY ONE AREA. this area gets depolarized and then works on STIMULATING THE ADJACENT CELL; which makes it get depolarized and this cycle happens on repeat BUT DO NOT FORGET that when the adjacent area reaches depolarization THE AREA BEFORE IT BECOMES REPOLARIZED.
this is called "continuous conduction".

SLIDE 13
another name for the salutatory conduction is JUMPING CONDUCTION.
macroglia (a special type of cell that produces the myelin sheath) has two types that depends on their places:
in the CNS = oligodendrocytes
around sensory and motor cells in the peripheral CNS = Shawn cells.

SLIDE 16
we see in the picture a long myelinated nerve that is coming from the ventral root of the spinal cord that makes synapses.

if we zoom in the synapse we will see the following:
1- the motor neuron (the nerve which is in yellow) which is called PRESYNAPSES.
2- the synaptic cleft (the space between the neuron and the muscle)
3- the skeletal muscle fiber (the fiber which is pink-ish colored) which is called POSTSYNAPSES.

the motor neuron turns the electrical signal TO a chemical signal (acetylcholine)
the skeletal muscle fiber turns the chemical signal TO an electrical signal.

LEC 18

SLIDE 4
motor units are in bundles (حزم)
the big bundle is called a fascicle then it branches to muscle fibers.

SLIDE 5
recruit = increasing the amount of motor units for a stronger contraction.

SLIDE 8
NOTE:
Schwann cells are found in the peripheral CNS.

SLIDE 10
acetylcholine is a neuro-transmitter that is responsible of muscle contraction.
CAT = choline-acetyltransferase
COMT = Catechol-O-methyl transferase
^^ NO NEED TO MEMORIZE ^^
acetyl choline gets out to the synaptic cleft by exocytosis.
when there is excess of acetyl choline inside the nerve terminal or the acetyl choline finishes its job in transmitting signals, an enzyme called acetylcholinesterase DEGRADES IT by getting it back to acetyl + choline.
the process of synthesizing acetyl choline is based on RECYCLING acetyl choline by degrading it back to acetyl + choline and getting it back inside the cell BY FACILITATED DIFFUSION.

SLIDE 11
quantum = large amounts of acetyl choline
there is more than one way to secrete acetyl choline:
- the immediately releasable stores (vesicle pool 2, "VP2"): only 1% of the vesicles, works under low nerve activity (no action potential).
- the reserve pool (vesicle pool 1, "VP1"):
80% of vesicles.
- the stationary store: the remainder of the vesicles الحويصلات من الباقي

SLIDE 12

the calcium channels that are opened are voltage gated calcium channels.
synchronous release = calcium entering the nerve terminal and exocytosis for the vesicles (50-100 vesicles).
calcium concentration ↑ ↑ vesicles released.

SLIDE 13

docked = fusion
the dock happens for the vesicles on the active zones (the terminal-end).
تذكروا إنه الحويصلة عبارة عن كيس. أول ما يرتبط هاذا الكيس بنهاية التشابك العصبي حيفرغ الأسيتيل كولين للخارج وحيتم إعادة تدوير الكيس مرة ثانية بحيث إنه يتم تعبئته بأسيتيل كولين جديد.

SLIDE 14

axoplasm = the cytoplasm of the neuron

SLIDE 15

in the bottom left picture we see the release of acetyl choline from the terminal end in the following steps:
1- an action potential motivates the cell
2- the voltage gated Ca 2+ channels open to get calcium inside the cell.
the calcium activates the phosphorylation of synapsins.
3- the vesicles docks (fuses) with the terminal end of the terminal bouton, which later on release acetyl choline to the synaptic cleft.
4- the acetyl choline binds on nicotinic receptors (ligand channels) found in the post-synaptic membrane. when the binding happens, sodium gets inside the post-synaptic (making it more positive) and potassium would get out; this would get the post-synaptic to the threshold (another name for it, end plate potential) to make an action potential for the muscle fiber. this makes the potassium and sodium voltage gated channels open (depending on the process of course) and the action potential happens (depolarization, repolarization, hyper-repolarization).
in the bottom right picture, you will see the arrows going through a path which is called the T tubule. the arrows are the action potential which moves to stimulate the reticulum to release Ca 2+.