stryer

4/1/18 Diversity in biological system

Biological system is complex network of biological entities such as populations of organisms, or organ and tissure su scale such as circulatory, respiratory and nervous system in animale.

Bio diversity

Bio → life

Diversity → variety

°interdependence → complex interactions among all living things including microorganisms.

Three components of biodiversity

(1) Diversity of genes

same spieces → ~~life~~ different genes

Eg Chihuahua, Beagle, Rotwerlers

(2) Diversity of ~~spieces~~ species

Eg monkey, aragonflies and meadow beauties.

(3) Variety of ecosystems

Lakes ponds and rivers freshwater systems

Rocky coasts, sand dunes, estuary, salt march, Coral reef, are all Marine system.

A group of morphologically similar

Creatures who are related through

phylogeny

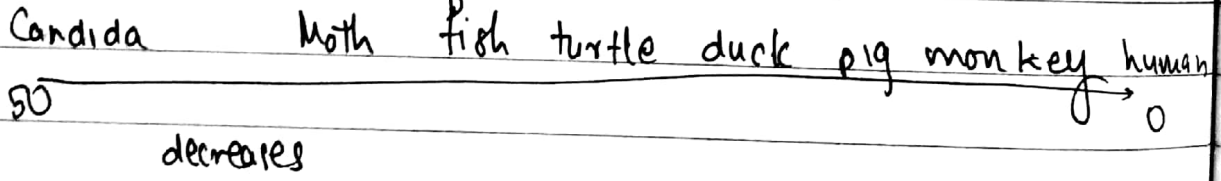
- similar DNA
- Similar protein eg 'n blood (bodily processes)
- similar biochemistry
- similar embrology

DNA profile of primates

Man
Chimp
Gonlla
Orongutan
Gibbon

Humans share 98-99 '/. of their DNA with chimps.

No. of Amino acid differences compared to humane cytochrome C

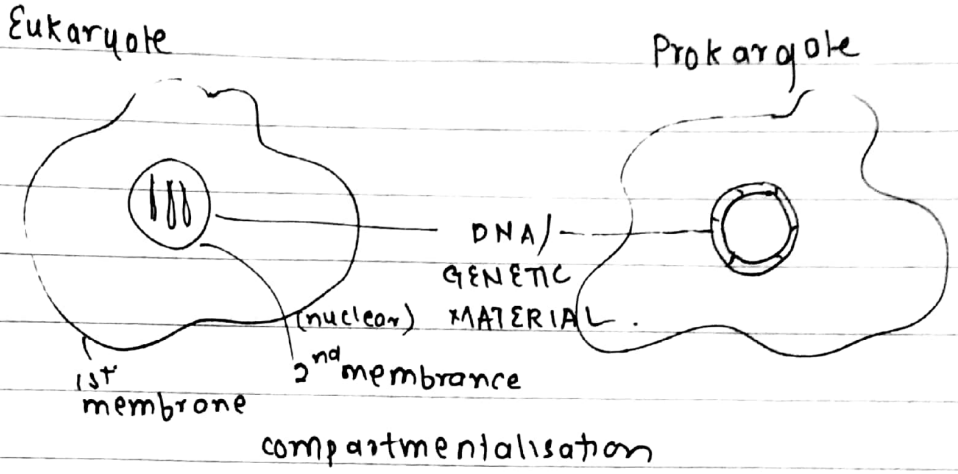


Biodiversity has intrinsic value.

What do we get from biodeversity?

Oxygen, Food, Clean water, Medicine, aesthetics

Earth is losing biodiversity at an ara alarming rate!



compartmentalisation

What is the need / purpose of biodiversity?

→ Survival

Diversity

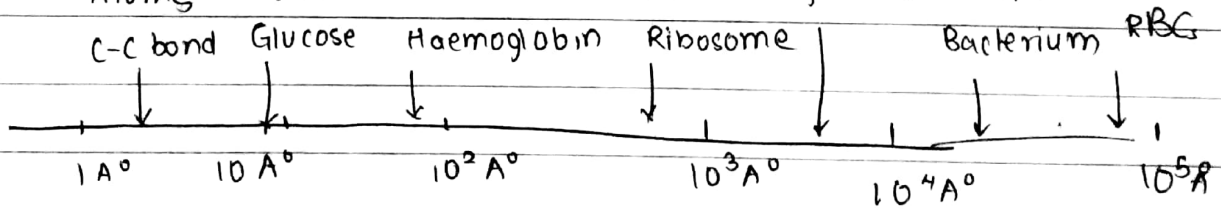
Diversity Species

- Reproductive isolation (can't cross rice with wheat)

Cell → fundamental unit of life

assembles

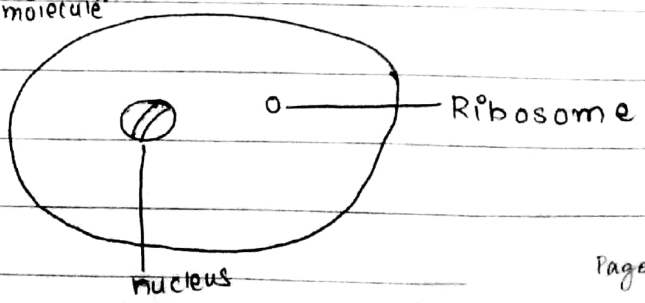
Atoms molecules Macromolecules Resolution of cells light microscope



(1) Electron microscope (nm or μm) (To see ribosome and nucleus)

(2) X ray crystallography (A°) [protein structure]

(gives e⁻ density, you have to "freeze" the molecule)



DNA

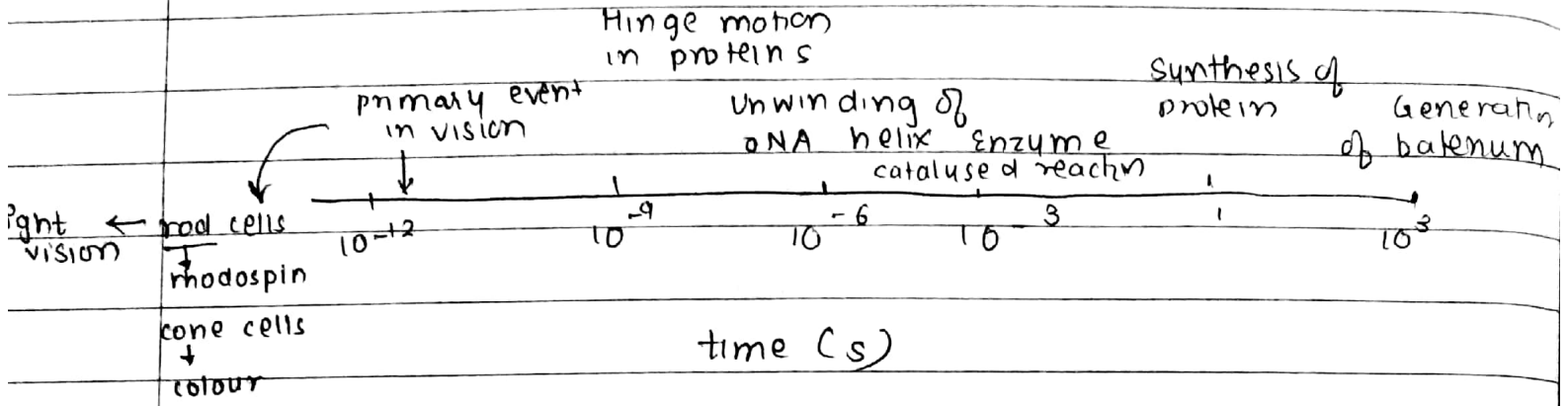
↓

messenger RNA (m RNA) can perform

↓

→ synthesis of protein → function

(Ribosome can "read" this message)



The molecules of life are constantly in flux

The ultimate source of life energy of life is the sun.

Energy of a 'green' photon = 57 kcal/mole

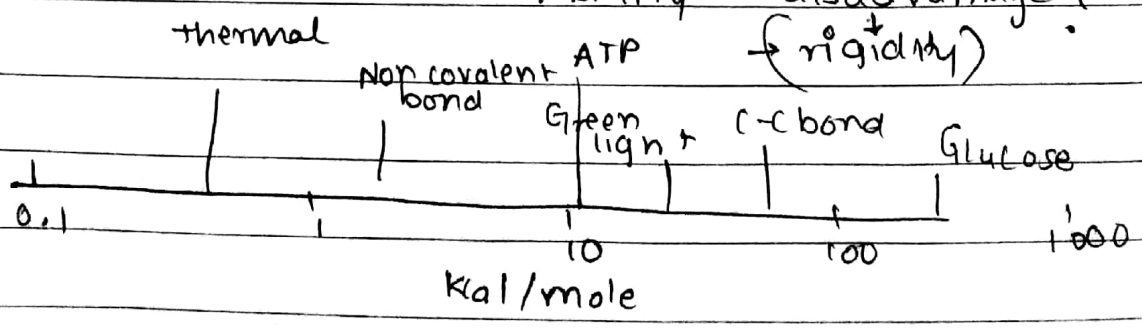
Energy of an ATP = 12 kcal/mole

Average energy of each vibrational degree of freedom in a molecule is about 0.6 kcal/mole at 25°C (TEMPERATURE

Covalent bond C–C = 83 kcal/mole

(fundamental source of stability in all living systems) (whi | with ~~wiggle room~~

stability → disadvantage? (+ rigidity)



Page No

Non - covalent bond

PTO

Electrostatic bond

$F = \frac{kq_1q_2}{r^2}$ $\quad F = \frac{q_1q_2}{r^2D}$

- ionic bond - salt bridge
- salt linkage - ion pair

q_1, q_2 charge of the groups

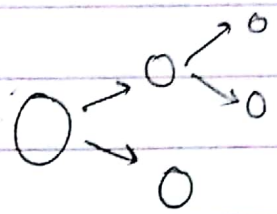
r = distance

D = dielectric constant

↓ dielectric constant of water is high so, weak forces

$-CH_2-C$ (=O, O^-) charged group

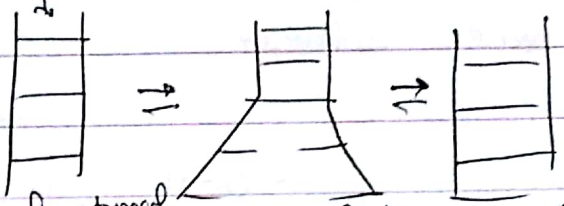
(1) DNA replicatpon



Generation time

H bonds

Unwinding of DNA helix (for reading message or during replication)



becoming functional

a reversible process

(2) Prolein folding

aquiring 3D structure

because the bonds are non covalent they have the inherent property of unwinding & winding

(3) Recognition of substrate

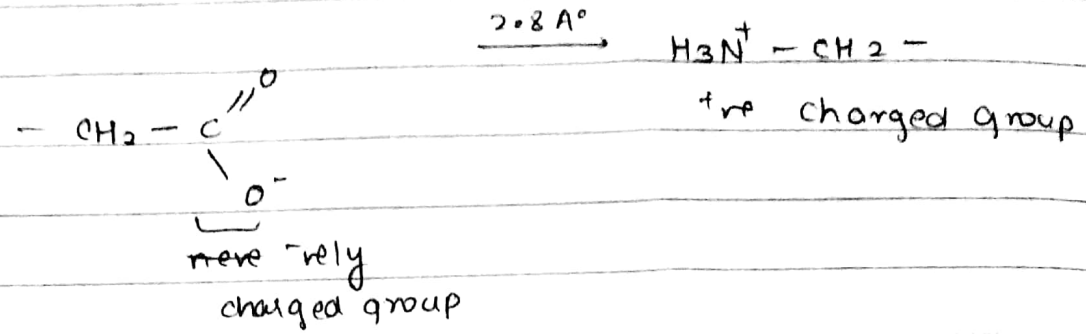
↳ recognition imperative for replication

(4) signaling 'time at which replication needs to be performed'

'biological molecular clock

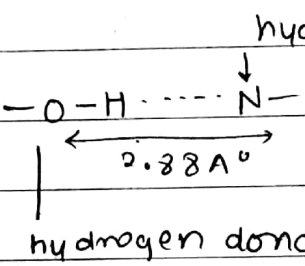
Eg sense by eye

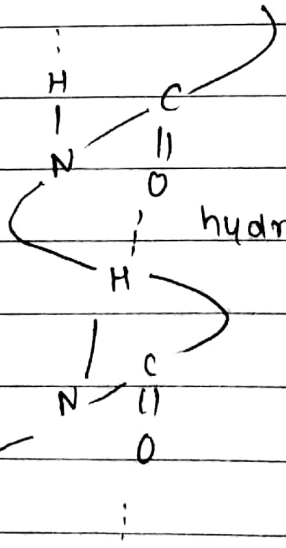
Reversible molecular interactions are at the heart of dance of life



(2) Hydrogen bond

- directional
  - → strongest when colinear
- O, N





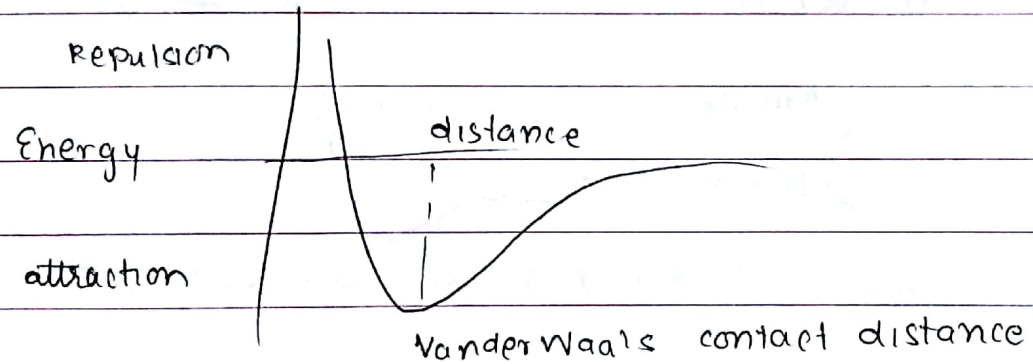
	Vander Waals contact radii (in A°)
H	1.2
C	2.0
N	1.5
O	1.4
S	1.85
P	1.9

(3) Vander Waal's bond.

3 - 4°A - optimum distance

steric complementarity

- weak but multiplicity matter in this case

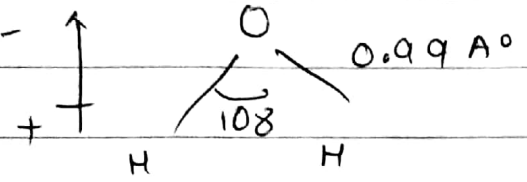


Covalent bond	Energy (KJ/mole)
C - C	350
Electrostatic	15
Van der Waals'	16
Hydrogen	21

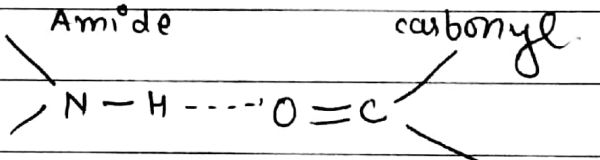
1 kcal = 4.18 kJ

4 Hydrophobic interaction

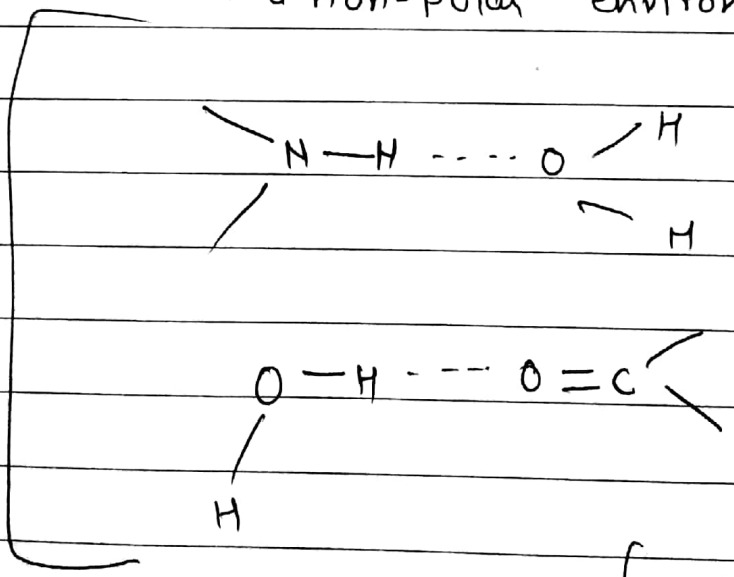
The biologically important properties of water are its polarity and cohesiveness
→ triangle not linear
→ asymmetrical distribution of charge.



⇒ hydrogen bond. Solid → cage like structure
Liquid (avg H bond 3.4) → more H bonds (avg → 4 H bond)
→ some H bonds



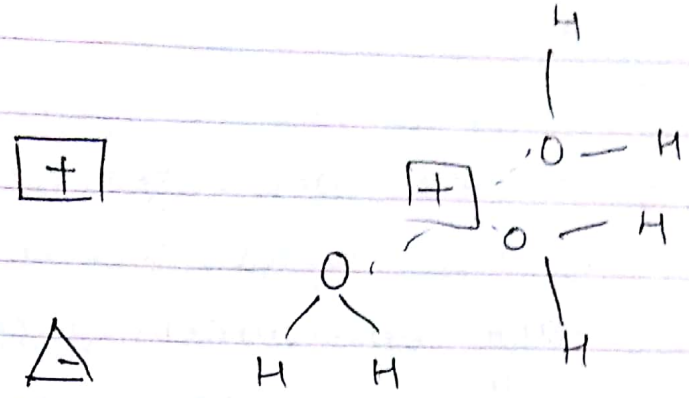
In a non-polar environment



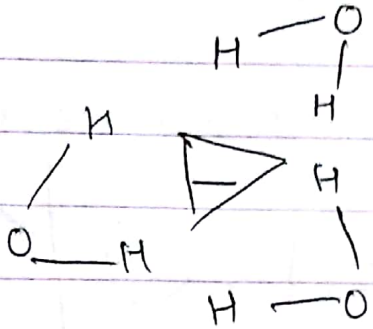
In water (competitive)
water gives strong interaction
weakening C=O & N-H bond

H-bond requirements
• close proximity •

Page No



Non-polar environment



~~attenuates~~

water surrounds the charged groups and attenuates their interaction.

Electro static interaction:

The existence of life on earth depends critically on the capacity of water to dissolve a remarkable array of polar molecules.

→ fuels (eg glucose in water glucose ~~ATP~~)

→ building blocks (eg proteins)

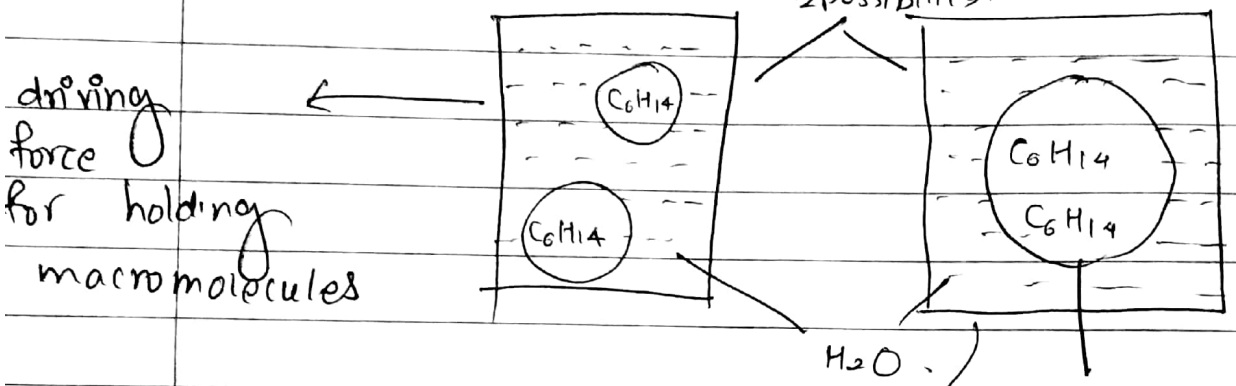
→ catalysts (eg some proteins)

→ information carriers (info communicated b/t cells)

Protein → 23 different amino acids

→ water free micro environment
(because water weakens H-bonds
some environments need water-free
"zones" for stable existence)
Such environments are termed as

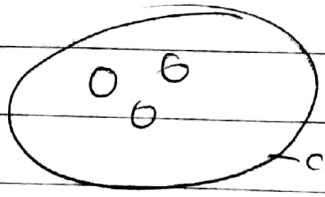
Non polar molecule in polar environment



C_6H_{14} needs 'space'
(∵ matter occupies space)
H bonds are broken
for it
These H atoms ~~are called~~ results in ↓
High ordered water molecule

Two hexane molecules in a cavity
Hydrophobic interaction they colasce to form 1 molecule

(4) Hydrophobic interaction
→ folding of macromolecules
→ binding of substrate to enzymes
~~→~~
→ ~~active~~ formation of membrane boundaries and their internal compartments



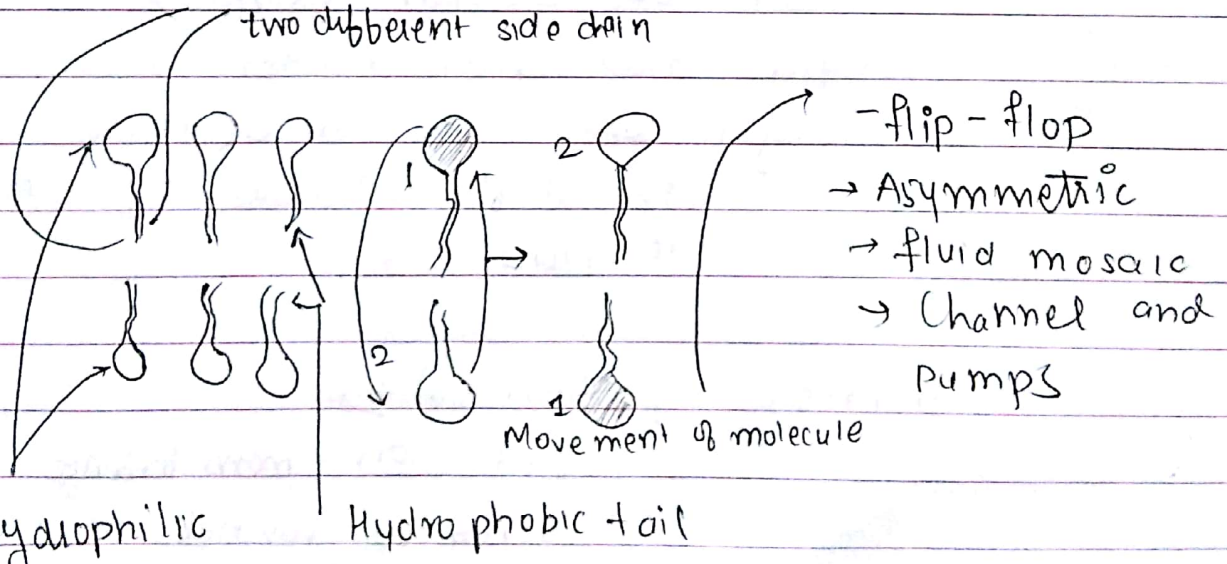
cell wall / membrane

→ p amino acids single linear chain
→ folding occurs such that hydrophobic amino ~~asi~~ acids fold "in" (occupy interior)
→ hydrophilic amino acids fold 'out' (occupy exterior)

→ only to its target audience
eg antibiotics

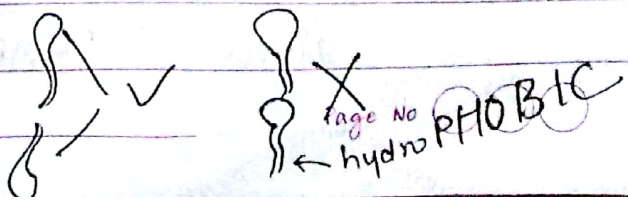
Dielectric constant of HCN (116) is > water (81)

Hence CH disrupts internal systems by breaking bonds. Destabilizing vital system hence poisonous even in tiny proportions.



- flip - flop
→ Asymmetric
→ fluid mosaic
→ Channel and Pumps

Lipids → tail to tail interactions



Asymmetric
→ external and internal surface do not look the same.

fluid mosiac → provide flexibility
Many single celled organisms hence cell has to move

channel and pumps
nutrients as well as faecal matter of the cell i.e. substance needs to flow in and out of cell, hence channel & pumps exp
Eg

In cell diagram (slide)
Sugar side chain → for recognition of target on outside
for different cell different receptors

Intrinsic protein (
→ present on membrane
→ serve as channel
(for ions and molecules)

Lipid → BARRIER.

Hydrophobic interactions "cement" the lipids together forming strong "walls"

Importance / uses of membranes

Photosynthesis → membrane on chloroplast
↓ energy

Oxidative phosphorylation → ATP - Mitochondria membrane

Membrance → characteristics.

Membrane are sheets like structures.

(a) 60 A° to 100 A°

(b) —"— consists of lipids and proteins in ratio 1:4 to ~4:1

(c) Membrane also contains carbohydrates.

(d) —"— lipids have both hydrophilic and hydrophobic moety → present on membrane amphipathic

(e) Specific proteins

lipids of membrane

(f) Non-covalent assembles. (the way they arrange themselves)

(g) asymmetric

(h) fluid structures

Most membranes are electrically polarized (−60 milliV)

→ mainly nerve cells.
→ surge difference

Lipids: (present on membrane) (cholesterol) helps them form membrane

water insoluble but soluble in organic solvents like chloroform

→ fuels → signalling → membrane → phospholipid → mitochondria

→ fuels (though carbohydrate are principle source of energy, desperate types call for fats - while fasting etc)

→ signalling (cell to cell communication) facilitates

→ membrane

→ phospholipid. → primarily found on membrane

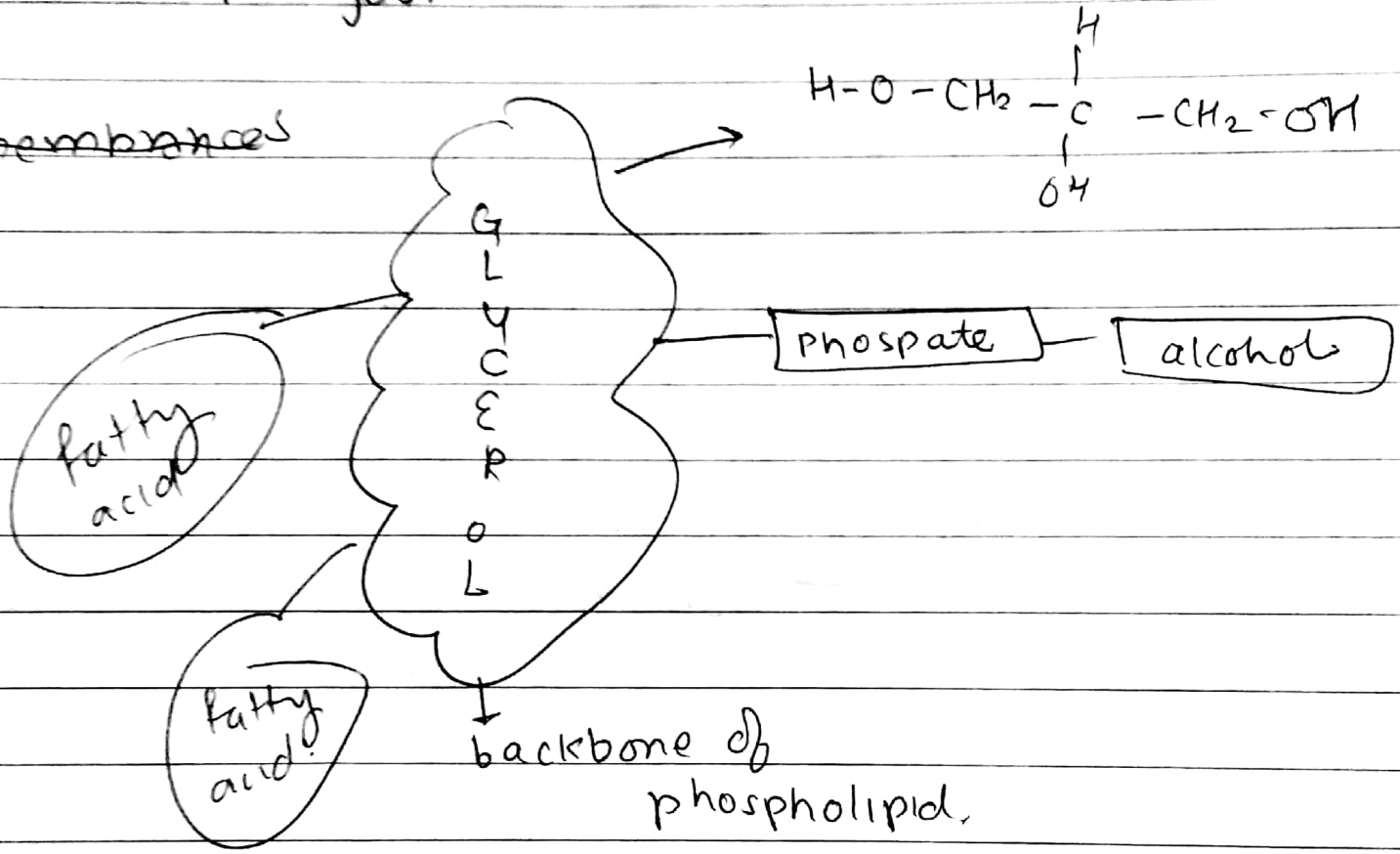
Page No

mitochondria

(carbohydrate + lipid)

Phospholipid glycolipid cholesterol.

- glycerol
- or sphingosine



In fats, fatty acids eg palmitate oleate (look up structure)

Even no. of C

14 to 24 → mostly 16 to 18

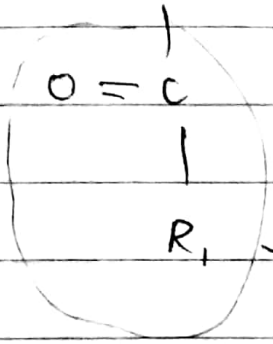
C-chain could be Saturated or unsaturated → cis

palmitate → saturated

oleate → → unsaturated

unsaturate oleate helps / provides bend in ~~carb~~ hydrocarbon chain.

Sphingomyelin → not derived from glycerol
→ derived from sphingosine
→ an amino alcohol



→ fatty acid unit

~~Chol~~ Cholesterol
↳ aromatic ring? resonance

1773

Benzamin franklin.
Lord Rayleigh - effect of oil on water
Agnes Pockets
Irving langmuir
Charles Tanford.

oil spreads over a surface area

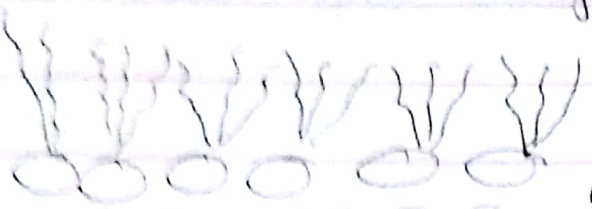
~2 cm^3 → ~ $2 \times 10^7 cm^2$ of

→ 10^{-7} cm (16A° or 1nm)

amount of oil poure

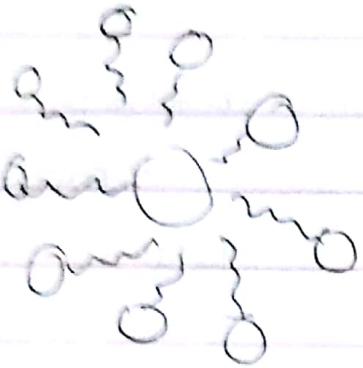
thickness of layer

Monolayer - how oil spreads over a larger surface area



mono layer as the name suggests, spreads across no "stacking"

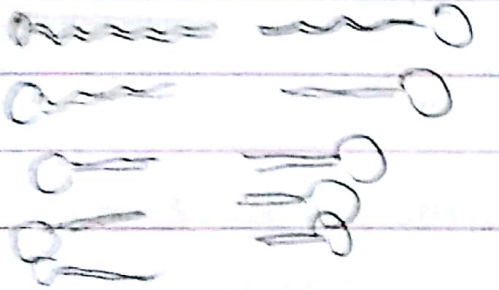
Two pos possible conformations to shield from water



micelle → application → drug inside can ~~by~~ be transferred to ~~desired~~ desired location

200 A° (20nm)

Eg No palmilate (soap)



provides opportunity to grow 'big' to increases surface cell inside

bilayer (10^6 mm or 10^7 A°)

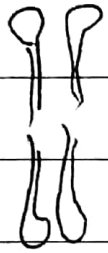
In bilayer, there are two fatty acids

micelle single fatty acid chain.

So monolayer and micellen not possible (smaller sizes)

Hence cells have lipid ~~by~~ bilayers

Hydrophobic interaction
→ major driving force keeping lipid intact



The lipids are kept close to each other leading to development of Vander Waals forces they help in folding & packing

The hydrophilic ends can perform electrostatic or hydrogenbond with water around

Lipid bilayers are non-covalent co-operative structure

inherent tendency (their tendency to form bilayer is INHERENT ~~(must posses~~

self sealing

- molecule is tightly packed
- hydrophobic interactions give it self sealing capabilities

Wonder Waals

any molecule aspiring to form cell membrane must have hydrophilic hydrophobic structure

References

A course in multivariable calculus & analysis by SR Ghorpade & BV Limaye.

Elementary Clemical Analysis by JE Marsden & MJ Hoffman.

$B(x_0, \varepsilon)$

Lipid vesicles (Liposomes)

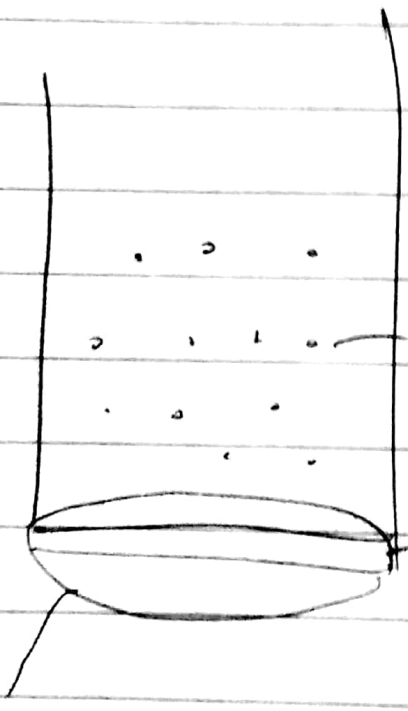
0.1 M

a kind of force (vibrations)

(1)

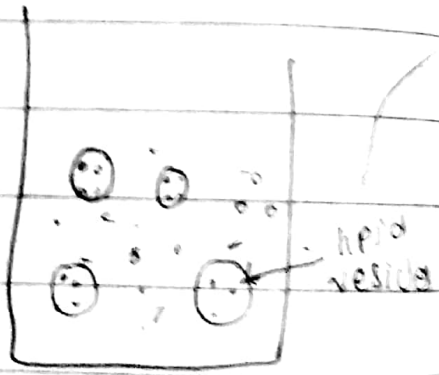
(Sonication)

(2)



Glycine
(water containing)

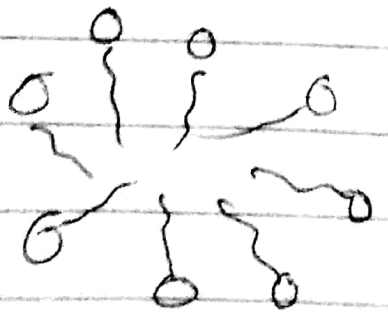
phospholipid
(lipides are
water insoluble)



some phospholipid form lipid vesicles)

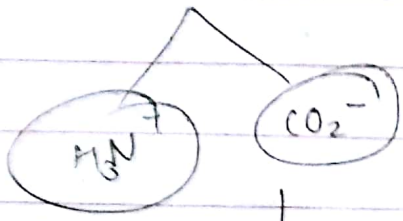
Vesicles → 50 nm diameter

→ 2000 Gly



(Glycine)

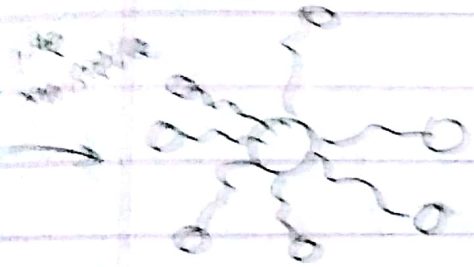
$NH_2 - CH_2 - COOH$



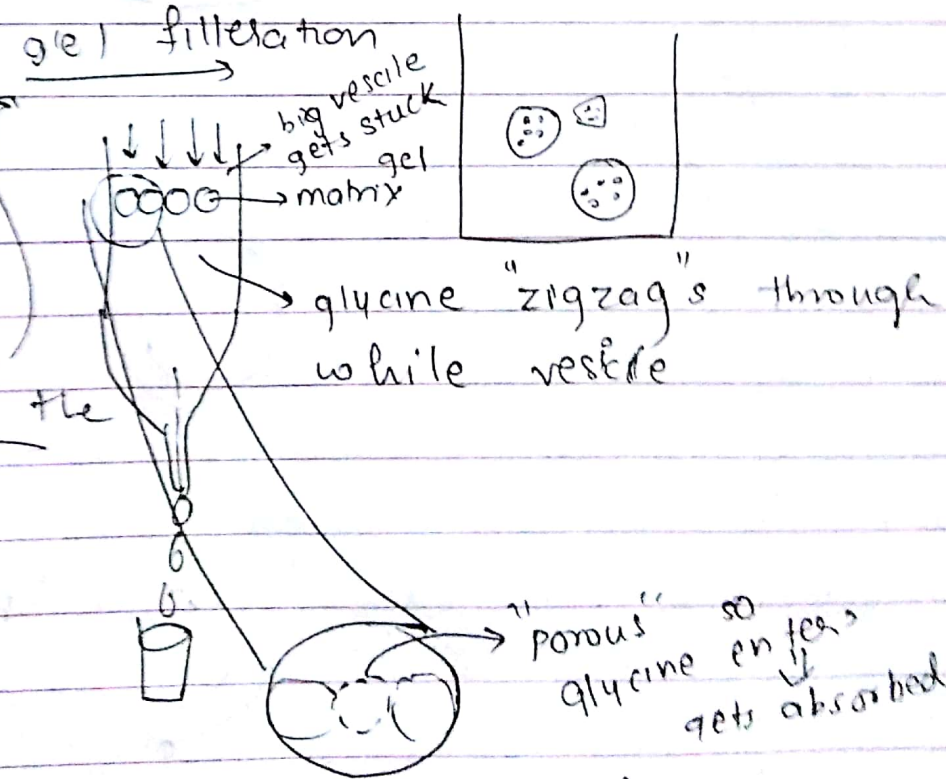
glycine zwitterion at pH 7

amino terminal

carboxyl terminal



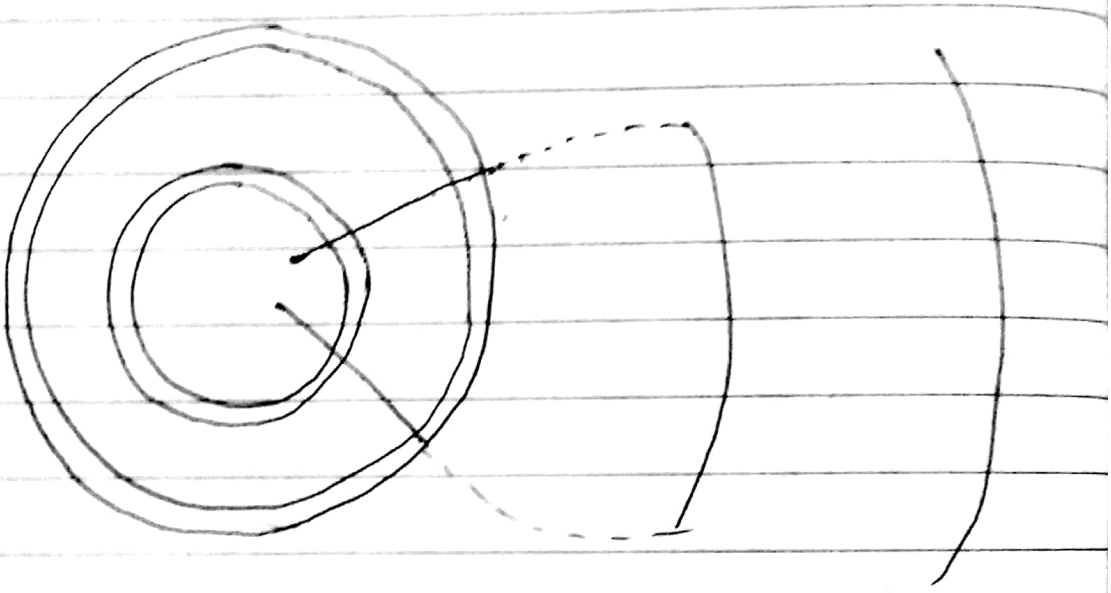
solution of lipid in ethanol (the solution obtained after sonication, ~~we~~. we just want the lipid vesicle)

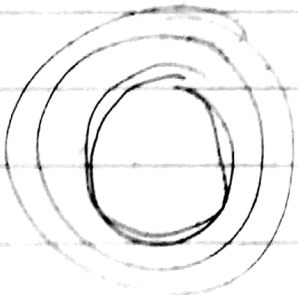


matrix → PEG (poly ethylene glycol)

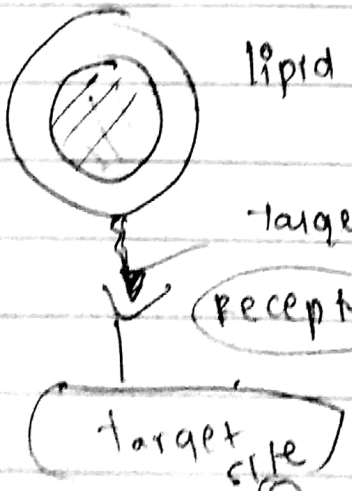
Vesicles have a diameter of 50nm → 2000 Gly

Liposomes: because of this structure, they carry drugs.

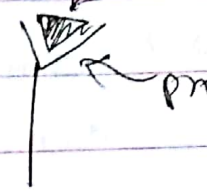




With

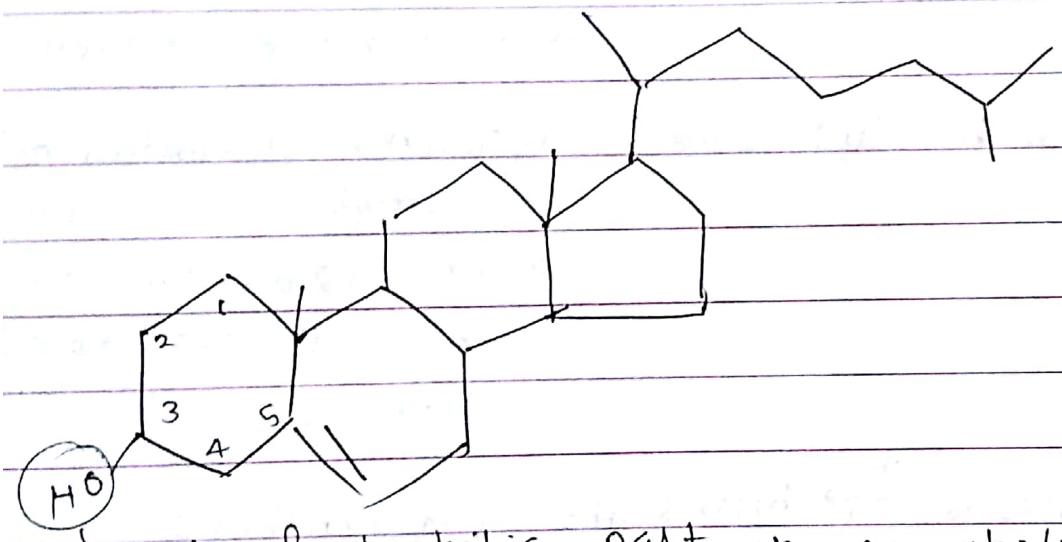


Now every protein has some shape aquired by folding



~~rec~~ ~~prog~~ targeting signal, has to have a particular structure fitting the protein it is targetting

→ so specific.



↳ only hydrophilic part in ~~co~~ choleshol.

~~Cole~~ cholesterol and triacylglycerol transported in the form of lipoprotein particles
↳ soluble in blood. (makes it)
↳ cell - targeting signal. (see previous page)

↳ it is hydrophobic not soluble in blood so for transportation it needs help provided by lipoprotein

Page No

Very low density lipoprotein, VLDL $d < 1.006\ g/cm^3$

Intermediate density lipoprotein (IDL) $1.006 < d < 1.019\ g/cm^3$

Low (LDL) density lipoprotein $1.019 < d < 1.063$ g/

High (HDL) density lipoprotein $1.063 < d < 1.21$ g/

LDL most important

lock key analogy particular LDL particular receptor

(1) an LDL particle binds to its receptor

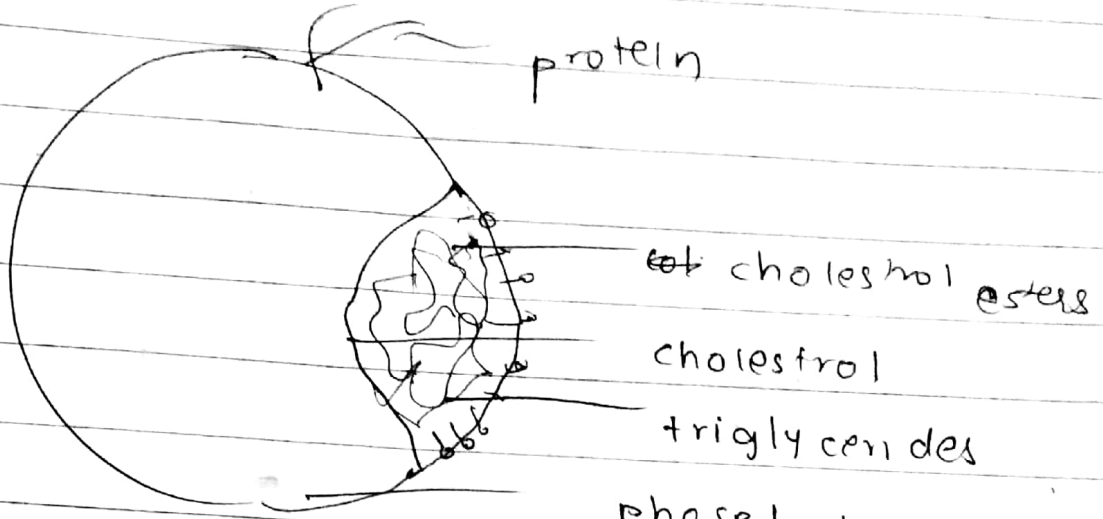
(2) Endocytosis → something inside the cell cholesterol has to be recieved inside the cell

(3) fuse with lysosome lysosome → contains enzymes that break down cholesterol to make it available inside the cell

uses

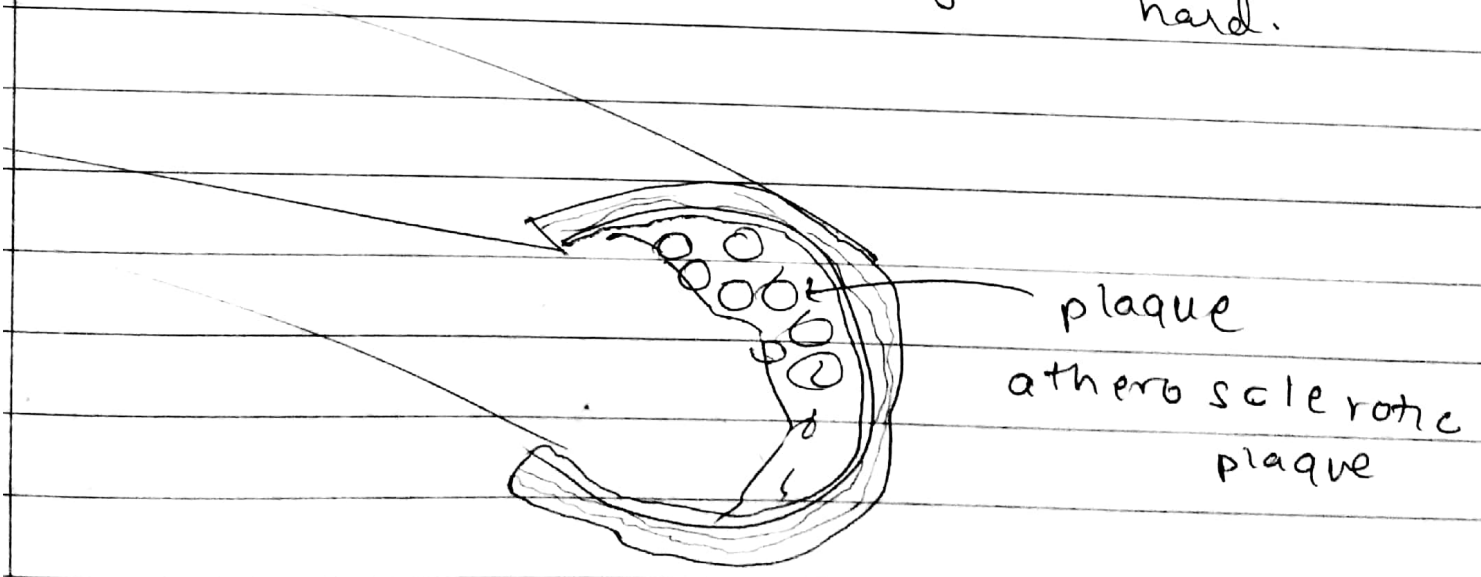
cholesterol → membrane bio synthesis

→ re-esterified for storage



HDL (Good cholesterol)
LDL (Bad cholesterol)
both dietary and endogenious

Cholestrol gets deposited on walles of the arteries making blood flow hard.



BP

atherosclerosis.

(mg/100 ml)

680 mg/dl → homozygous familial hyper cholesteromia (FH) (disease)

300 mg/dl → heterozygous FH

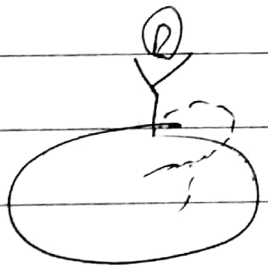
175 mg/dl → normal

cholesterol reproduced in body

~~& receptor recog~~

cholesterol inside cell but does not want too much cholesterol

so - -

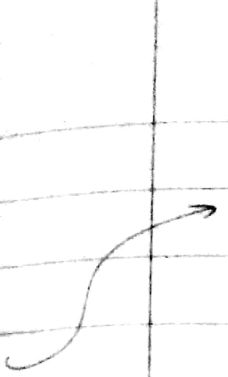


receptor delivers cholesterol inside cell and comes back to its original position

process takes 10 min

after (24 hours approx) new receptor replaces older worn & torn receptor

Class one two, three



in This receptors are absent
no cholestrol absorbed in cell
so too ~~mu~~ much cholestrol in
blood

Either of the two diseases
→ both diseases interested.

homozygous
→ both parents ~~or~~ have the same
NO RECEPTORS

heterozygous
→ one parent has one doesn't.
- partial but still too low.