

CELL THEORY

* Cell Theory was proposed by german botanist M-J. Schleiden (1838) and a British zoologist T. Schwann (1839). They gave the concept that →

"All living organisms are made up of cells and products of cell"

→ They together formulated the cell theory but this theory did not explain how new cells were formed.

* Rudolf Virchow (1855) first explained that cells divide & new cells ~~arise~~^{are formed} from pre-existing cells. He modified the hypothesis of ~~Schleiden & Schwann~~ & gave the cell theory. Schleiden & Schwann

Cell Theory states: →

- 1) All living organisms are composed of cells and products of cells.
 - 2) All cells arise from pre-existing cells.
 - 3) All cells have similar fundamental structure & metabolic rxns.
- Exception to cell theory : Viruses, Viroids & prions.

- ★ Cells differ in size, shape & activities for e.g.
- Mycoplasma is the smallest cell and 0.3 μm in length. and bacteria could be 3-5 μm.
- Among multicellular organisms, human red blood cells are about 7 μm in diameter and nerve cells are some of the longest cell.
- Longest cell: Ostrich egg.



★ Cell → Cell is the fundamental structural & functional unit of all living organisms.

→ Cell could constitute an entire organism i.e. unicellular organism or it could be a part of a multicellular system, where there is division of labour.

➤ Discovery of cell

Hooke

- Robert ~~Brown~~ (1665) → Discovered hollow cavities like compartments in a very thin slice of cork (cell wall) with microscope and ~~named~~ named them as cellulae or cell wall.
- Anton Van Leeuwenhoek (1674) → first saw and ~~described~~ described a new cell (living cell).
- Robert Brown → ^{later} discovered & named nucleus in a cell.

► TERMS

- PROTOPLASM → ~~fluid in cell~~ fluid in cell (cytoplasm + nucleus)
- PROTOPLAST → cytoplasm + plasma membrane.
- CYTOPLASM → Fluid in cell except ^{the} nucleus.

★ Evidence for the cell theory → Scientists thought that cells must arise from non-living material but it was eventually proven that this was NOT the case and instead, cells arise from pre-existing cells.

1838
1839
1855
1665
1674

► Simple experiment to prove this →

- 1) Take 2 containers → put food in both of them
- 2) Sterilise both → so that living organisms are killed.
- 3) Leave one of them open and seal the other closed.

→ We observe the growth of mould in the open container ~~in the~~, whereas there is no such growth in the sealed container as cells are able to enter from the external environment in the open container & start to divide & grow.

FIVE KINGDOM CLASSIFICATION

(given by R.H. Whittaker in 1969).

★ Five kingdoms are :-

- 1) Monera } → Prokaryotic
 - 2) Protista }
 - 3) Fungi }
 - 4) Plantae }
 - 5) Animalia }
- , eukaryotic

1) Kingdom "Monera".

- prokaryotic
- unicellular
- rigid cell wall
- reproduce by fission.
- Genetic recombination can take place by conjugation, transformation and transduction.
- include archaeabacteria, eubacteria and cyanobacteria.

2) Kingdom "Protista"

- Eukaryotic
- can be unicellular / multicellular
- can be photoautotrophic / heterotrophic.
- include dinoflagellates, diatoms, protozoa & slime moulds.

3) Kingdom "Fungi".

- Eukaryotic
- Achlorophyllous and are mostly decomposers that invade their food from the source by secreting digestive enzymes & absorb small organic molecules.

- Includes all fungi (sac fungi, club fungi, imperfect fungi; etc).

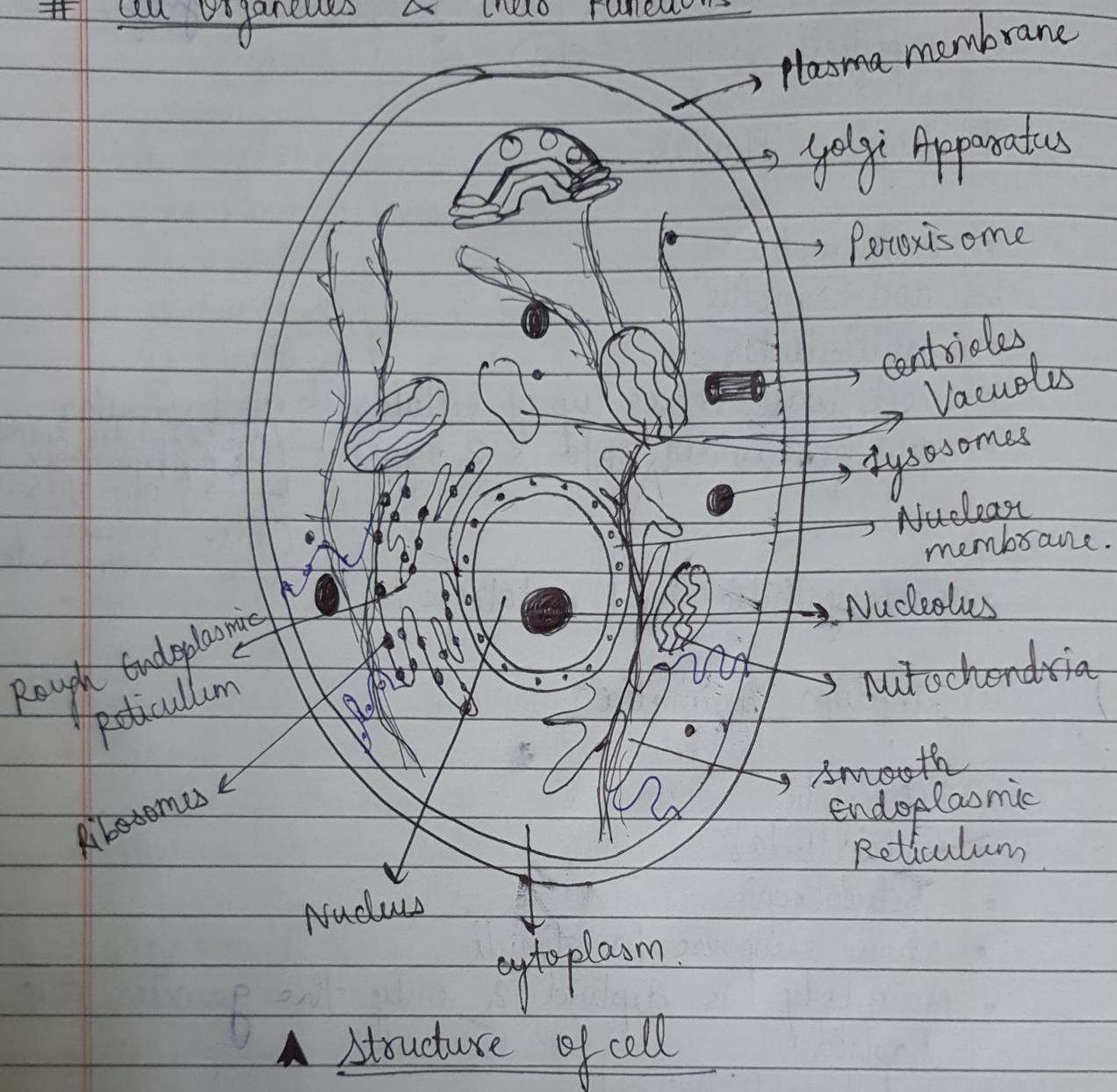
4) Kingdom "Plantae"

- Eukaryotic
- non-motile
- multicellular
- cell wall made up of cellulose.
- can be divided into 2 types →
 - Vascular (Pteridophytes, Gymnosperms & Angiosperms)
 - Non-vascular (Algae, mosses, hornworts, etc.)
- photosynthetic and autotrophs.

5) Kingdom "Animalia"

- Eukaryotic
- multicellular
- heterotrophic
- show response to stimuli.
- Main body is diploid & only the gametes are haploid
- Includes all animals.

Cell Organelles & their functions



i) Cell / Plasma Membrane :-

- outermost layer of the living cell that gives structure & shape.
- chief function is to regulate the passage of materials in and out of the cell.
- Singer & Nicolson → MOSAIC MODEL → explains the dynamic nature of proteins in the cell membrane.

2) Nucleus and Nucleolus →

- Nucleus is a round or oval body lying in the center of the cell enclosed by a double membrane known as nuclear membrane.
- Within the nucleus, one or more nucleoli may be seen. These are dense bodies containing the subunits for the ribosomes.
- Nucleolus is involved in assembly & synthesis of ribosomes.
- Nucleus is the store-house of genetic material known as chromosomes.
↳ fine individual rod or string throughout the life of the cell, but in the resting (non-dividing cell), they look like a single network of thin threads.
- Nucleus is called the brain of the cell as it controls & co-ordinates all the cellular activities.

3) Cytoskeleton → It is contained within the cytoplasm and is made out of protein.
→ present in both prokaryotic & eukaryotic cells.
→ plays imp. role in transport of material & cellular division.

4) Cytoplasm → fluid part of the cell which contains the cell organelles.

5) Centrioles →

- pair of cylindrical rods
- play a role in the formation of spindle apparatus
- essential feature for both mitosis & meiosis.

6) Mitochondria →

(powerhouse of the cell).

- Rounded or long rod-shaped organelles prominent in cells with high metabolic activity.

→ Double wall ; outer smooth membrane

- inner extensively-folded

- The folds, or cristae, project into the interior of the organelle & have a variety of enzymes embedded in them.

- These enzymes are responsible for breakdown of sugar molecules to release ATP (used to transport energy within the cell for metabolism)
- Mitochondria contain their own DNA and ribosomes.

7) Endoplasmic Reticulum: series of membranous channels, continuous network extending from cell membrane to nuclear membrane.→ General functions; facilitation of protein-folding and transport of synthesized proteins in sacs called cisternae.► RER and SER

↓
contains
ribosomes.

★ RER (Rough endoplasmic reticulum); contains ribosomes & helps in the production, secretion & transportation of proteins & few hormones.

★ SER (Smooth endoplasmic reticulum); involved in transportation of lipids & detoxification of variety of poisons.

8) Ribosomes → Components of cell that make proteins from amino acids (Workhorses of protein biosynthesis)

→ Work

9) Golgi Apparatus →

- stacks of flattened sacs
- Major function is the storage, modification & packing of materials for release outside the cell membrane.

10) Lysosomes →

- similar in shape to mitochondria, but are smaller and consist of a single membrane covering the structure.
- contain powerful enzymes that would digest the cellular contents if they were not contained within the impermeable lysosomal membrane.
- Plays a role in intracellular digestion & may also be important in the destruction of certain structures during the process of development.

ii) Vacuoles →

- discrete, clear regions within the cell that contain water & dissolved materials.
- may act as a reservoir for fluids and salts.
- Their fm is to handle waste products.

★ Organelles found only in Plant cell.

★ Organelles in Plant cell (not in animal cell)

★ Organelles in Plant cell.

➤ Chloroplast → contain stroma → site of photosynthesis.

➤ Cell Wall →

- provide structural support & protection to the cell.
- controls the turgidity of the cell.

Homeostasis

• coined by American physiologist 'Walter Cannon'

(Greek) homiois (same) and stasis (to stand)

→ The processes by which body regulates its internal environment are referred to as homeostasis.

e.g. → after a cut in the body:

• Primary homeostasis: Formation of platelet plug.

• Secondary homeostasis: formation of fibrin through coagulation cascade.

• Tertiary homeostasis: formation of plasma for breakdown of the clot.

* Homeostatic regulation:

→ Adjusting of physiological systems ~~within~~ within the body in order to maintain a stable internal environment and which requires constant monitoring and adjustments as conditions change is called homeostatic regulation.

3 mechanisms:

- 1) Receptor: receives information that something changes in the environment.
- 2) control center: receives & processes information from the receptor.
- 3) Effectors: responds to the commands of control center by either opposing or enhancing the stimulus.

q) For regulating body temp:

- 1) Receptors: temp. receptors in skin
- 2) control center: Brain
- 3) Effectors: blood vessels & sweat glands in our skin

► factors which are homeostatically regulated:

- 1) concⁿ of ~~nutrients~~ nutrients.
- 2) concⁿ of O₂ and CO₂.
- 3) concⁿ of waste products.
- 4) concⁿ of water, salt & other electrolytes.
- 5) Vol. and pressure.

★ Pathways that alter homeostasis

→ Homeostasis is maintained through a series of control mechanisms or the body suffers various illness or disease.

- When the cells in the body begin to malfunction, the homeostatic balance becomes disrupted.

- Disease & cellular malfunction can be caused in 2 basic ways:

- i) deficiency (cells not getting all they need)
- ii) toxicity (cells being poisoned by things they don't need)

★ Extrinsic homeostatic system:

regulated by nervous system & endocrine glands.

➤ Nervous system depends on sensors in the skin or sensory organs to receive stimuli → transmit message to spinal cord or brain → processed & transferred to effector system such as muscles or glands → affects the response to stimulus

➤ Endocrine system involves a chemical component to the reflex.

Sensors send msg. → endocrine effector (parathyroid)
makes parathyroid hormone (PTH)

→ PTH is released in blood when blood calcium levels are low.

* Intrinsic homeostatic system

- involves only one organ and tissue.
- When muscles use more O₂ and also produce more CO₂, intrinsic controls cause dilation of blood vessels allowing more blood into those active areas of the muscles.
Eventually, the vessels will return to "normal".

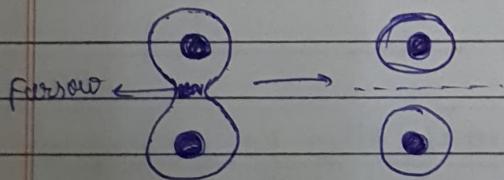
Cell Division

* Prokaryotic cell Division



(FISSION)

- Cell grows, replicates it's genetic material & divide into 2 single-celled complete entities.
- * Cytokinesis: division of cytoplasm.
- In animal cell, constriction develops and finally divides the cell into two daughter cells.



* cell furrow method:

* Eukaryotic cell Division

(more complicated)

- cell division don't depend on environmental cues of a single cell rather than on the needs of the whole organism.

- Cells have many chromosomes, so process of replication & segregation are not that simple.
- have a clear nucleus whose division is essential prior to cell division.
- In case of plants, cell wall is also there, so cytokinesis is diff. from animals.

MITOSIS

- identical daughter cells
- Asexual / somatic cells
- growth & repair

MEIOSIS

- daughter cells with half the genetic content.
- gametes
- sexual reproduction
- variation

* MITOSIS (from notes) (ishita)

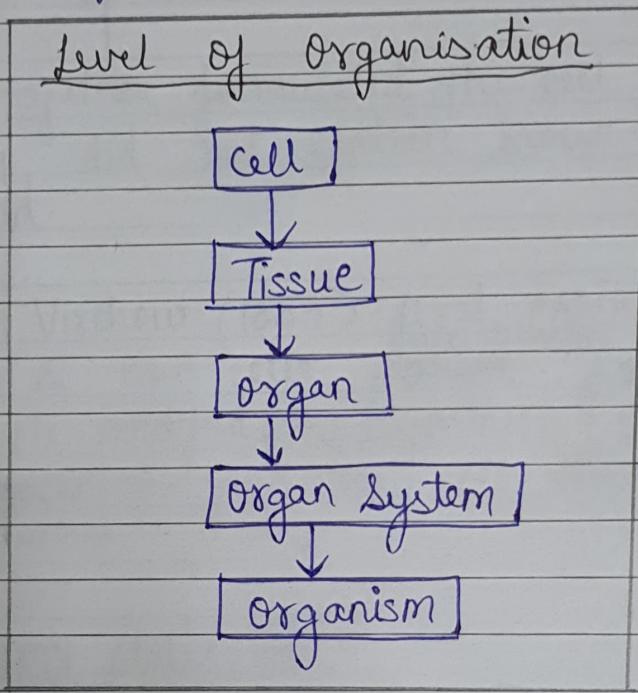
* MEIOSIS (" " ")

Stem cells and their applications (BYJU'S website)

Unit-1

CELL BIOLOGY

- Cell is the smallest basic unit of life that is responsible for all of the life processes.



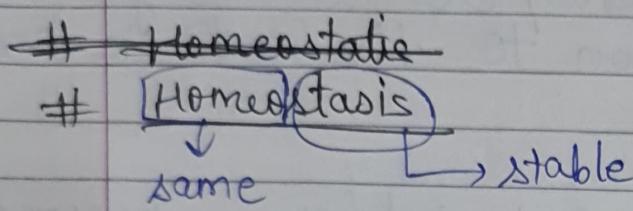
- The study of cells from its basic structure to the functions of every cell organelles is called cell biology.
- ★ Eutrophication → algal bloom (in stagnant water)
- Cells are the structural, functional & biological unit of all living beings.

Bio

- About cell
- Cell Theory
- Classification of living organisms
- Prokaryotes & Eukaryotes
- Plant cell & Animal cell
- Cell organelles
- ~~Nucleus~~ Nucleus (Central dogma of life)
- Cell division (Mitosis & Meiosis)
- Cell Differentiation
- ~~Stem~~ Stem cell & Applications
- Genetic Algorithm

- ① Cell Theory & Classification
- ② Diff b/w → (i) Prokaryotes & Eukaryotes
 (ii) Plant cell & Animal cell
- ③ Cell organelles →
 - Nucleus
 - Mitochondria
 - ER
 - Golgi Apparatus
 - Cell Membrane
- ④ Cell division → Learn with diagram
- ⑤ Cell Differentiation → MCQ
- ⑥ Homeostasis → 1 long ques

- ⑦ Stem cell & applications → long ques.
- ⑧ Genetic Algorithm.

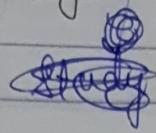


balance

→ when there is stability & balance b/w internal & external environment → Homeostasis

- Balance of →
 - Nutrients
 - ~~gases~~
 - Water
 - Cell volume
 - waste material must be expelled out to avoid toxicity.

genetic Algorithm (John Holland)



defn

- The transfer of gene / characteristics from one generation to the next is known as Heredity.
- Study of Heredity & Variations is known as genetics.

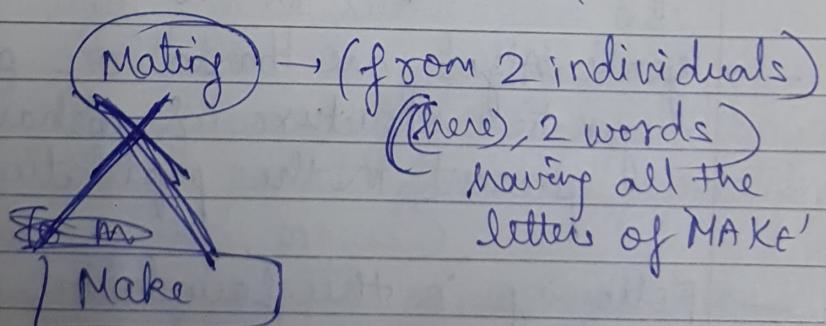
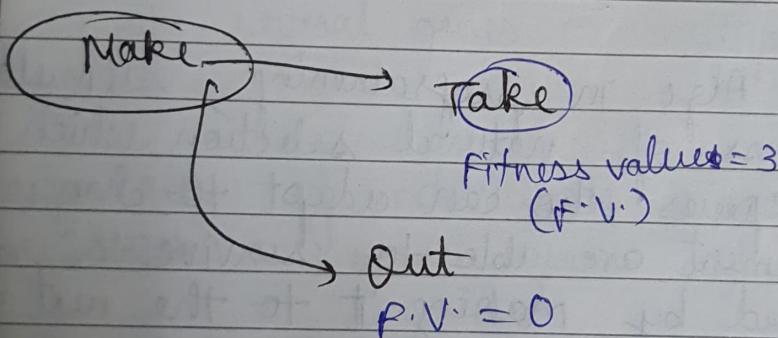
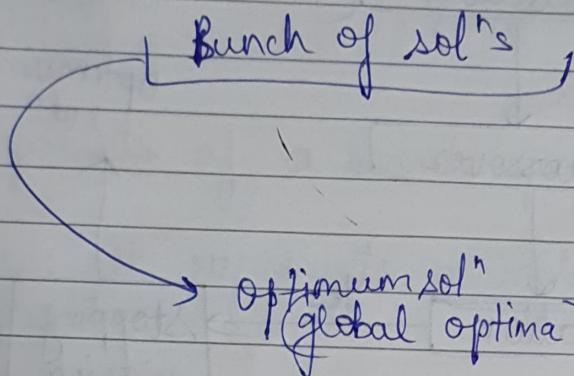
* Phenotype → Brown eyes → Externally raise diff sha hair.
 * genotype → Gene - makeup for a particular characteristic

AACITCTC

- ① Genetic Algo was given by John Holland
- ② " " is the abstraction of real biological evolution.
- ③ Used in artificial intelligence & machine learning
- ④ Already so many sol's are present but we have to find out the optimum solⁿ (global optimum) optima).
- ⑤ Mainly focuses on optimisation

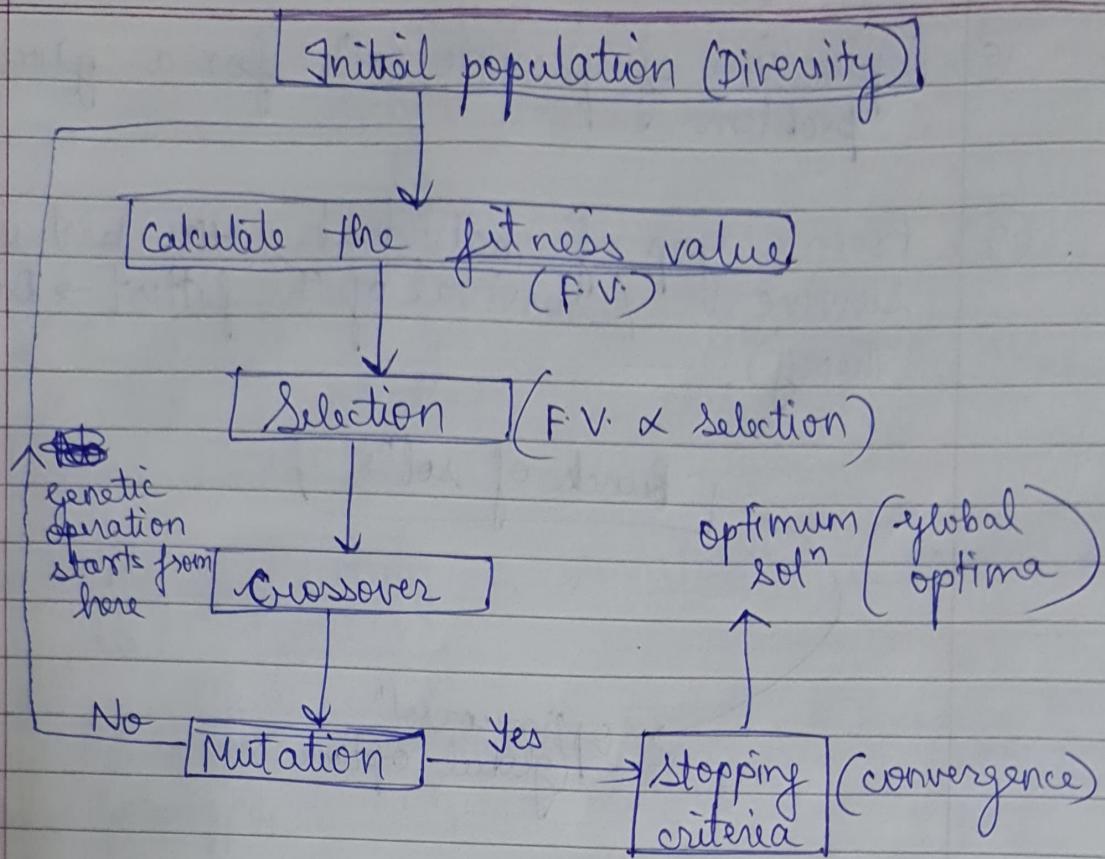
⑥ Population of possible solⁿs for a given problem.

⑦ from a grp of individuals, the best will survive (survival of the fittest \rightarrow Darwin's Theory).



Flowchart (GAP)

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- genetic Algo in programming stimulate the process of natural selection which means those species who can adapt to changes in their environment are able to survive & reproduce followed by making it to the next generation.
- genetic Algo's are based on an analogy with genetic structure & behaviour of chromosomes present in the population.
- Following is the foundation of genetic algo's based on this analogy:-
 - Individual in population compete for resources & mate.

- (ii) Those individuals who are successful (fittest) then mate to create more offspring than others.
- (iii) Genes from the fittest parent propagate throughout the generation, i.e. sometimes parents create offspring which is more fit.

components of a search space in genetic algo

- ① Gene: It represents a single solⁿ to a problem.
- ② Chromosome: Chromosome (individual) is composed of several genes or multiple similar genes.
- ③ Population of individuals is maintained within ~~such~~ a search space - all solⁿ's.
- ④ The whole algo can be summarised as:
- Randomly initialised 'n' population.
 - Determine the fitness of the population.
 - Select the fittest parent from the population (F.V. & selection process).
 - Crossover and generate a new population.
 - Perform mutation on the new population.
 - Repeat the process until the ~~stopping~~ creates the stopping criteria (global optima)

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* Advantages of Genetic Algo :-

- ① Doesn't require any derivative info (which may not be available for many real-world problems).
- ② Genetic Algo is faster & more efficient as compared to the traditional methods ~~(algo)~~
- ③ Provides a list of good sol's & not just a single solⁿ for a particular problem.

* Disadvantages of Genetic Algo :-

- ① Genetic Algo's are NOT suited for all problems, especially problems which are complex and for which derivative info is available.
- ② F.V. is calculated repeatedly which might be computationally expensive.
- ③ Being stochastic, there are no guarantees on the optimality or the quality.

BIO
UNIT-2

Importance of non-covalent interactions, →

- (i) hold together 2 strands in DNA
- (ii) stabilise secondary & tertiary structures of proteins.
- (iii) enable enzyme-substrate binding.
- (iv) antibody-antigen association.

4 categories of macromolecules in Organisms.

- (i) Carbohydrates
- (ii) Lipids
- (iii) Proteins
- (iv) Nucleic Acids.

[C: H: O]

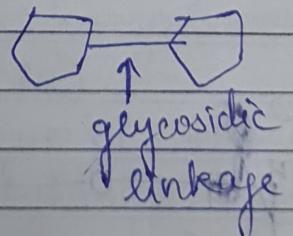
Carbohydrates ($C_nH_{2n}O_n$) → 1:2:1

→ organic molecule / biomolecule / macromolecule

→ provide fuel to our body.

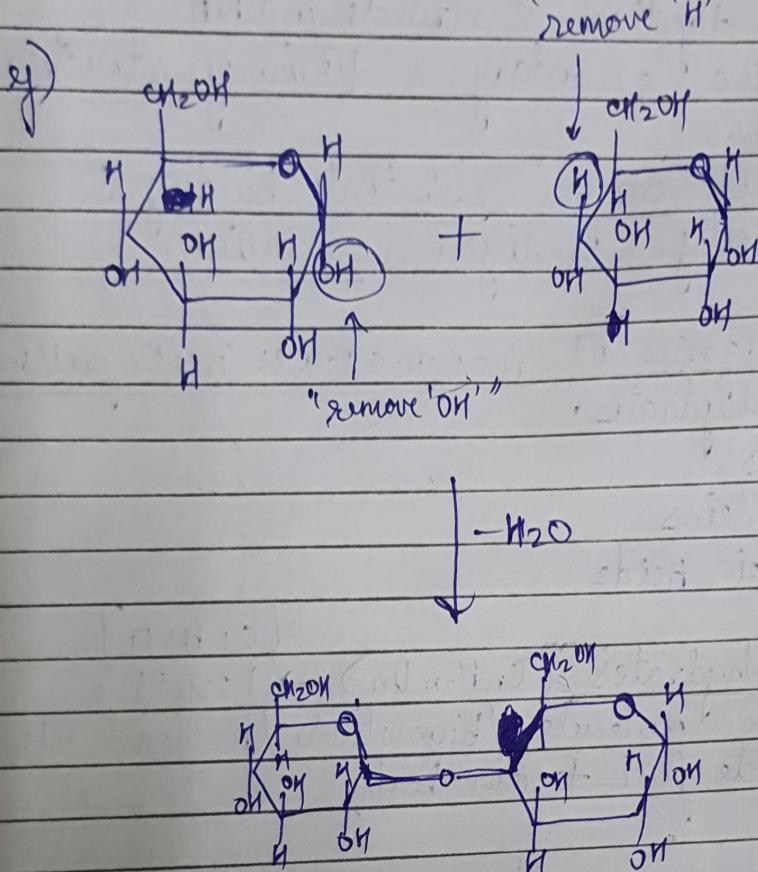
* Sources: → • small sugar molecules in soft drinks
• large starch molecules in rice, wheat, pasta & potatoes.

* Saccharides: →



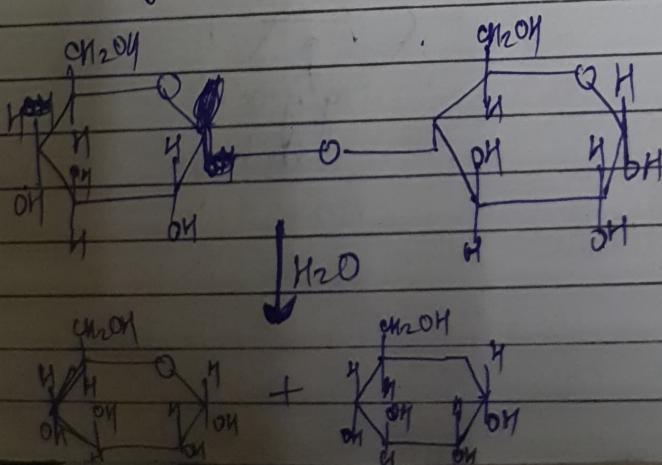
Monomers:

* Linking Monomers: → cells link monomers by a process called condensation or dehydration (removing a water molecule)



* Breaking Down Polymers

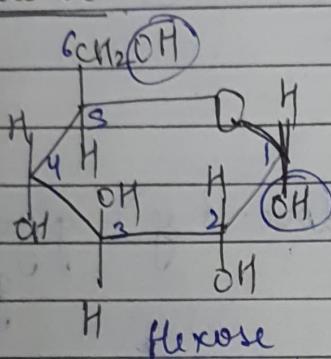
Cells break down macromolecules by a process called hydrolysis (adding a molecule of water)



* Monosaccharides

- called simple sugars
 - include galactose, fructose & glucose
- ↓
same molecular formula ($C_6H_{12}O_6$)
but different structure

① Glucose



- If 'OH' on opp. side of C₁ and C₆ → α-glucose
- If 'OH' on same side of C₁ and C₆ → β-glucose.

* functions & occurrence of Carbohydrates

- They are abundantly found.
- They serve as fuel for the body.
- Main source of energy for all living organisms
- They may be simple carbohydrates or modified (glycolipids & glycoproteins).
- They are structural components of nucleic acids (DNA, RNA).
- Cell wall is made up of cellulose, which is made up of carbohydrates.
- They contain C, H and O in the ratio ~~2:1:2~~ 1:2:1 (Empirical formula → $C_6H_{12}O_6$)
- They are made up of simple fundamental units called saccharides (Greek word meaning sugar) (sweet in taste)

- Non-digestible carbohydrates serve as dietary fibres → agar-agar, pectin.
- They serve as lubricants in the body as they contain hyaluronic acid.
- They help in building immunity.

► Classification of Carbohydrates

1) Monosaccharides

→ sweet in taste

→ simple sugar

for → aldehyde → aldose → ej) glyceraldehyde
glucose
ribose

for → ketone → ketose → ej) di-hydroxy acetone
(DHAC)
ribulose, fructose

→ sol^b in water.

2) Disaccharides (2 saccharide units)

→ sol^b in water

→ They are crystalline

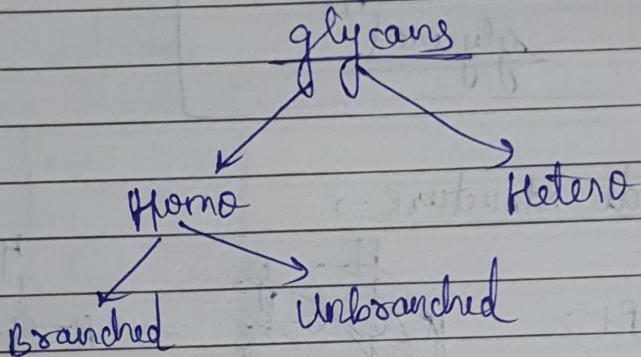
ej) Maltose & sucrose.

3) Oligosaccharides (made up of less than 10 or 20 saccharide units)

→ free existence is NOT found.

ej) glycoproteins - glycolipids, rafinose
(3 saccharide units), maltose
(3 glucose units), fructose
(3 maltose units)

- 4) Polysaccharides (more than 20 saccharide units)
- insol^b in water (NOT sol^b in water)
 - not sweet in taste
 - They have high molecular weight
 - They don't show properties of aldehydes or ketones.
 - Also known as glycans



Lipids

- hydrophobic → "water-fearing"
(Do not mix with water)
- includes fats, waxes, steroids & oils.

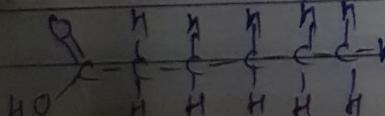
Fats

- store energy
- help to insulate the body
- cushion & protect organs.

Types of Fatty Acids

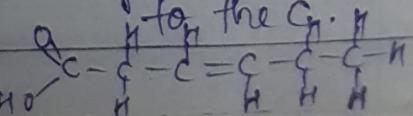
Saturated

- single bond
- max. no. of H-atoms bonded to the C.



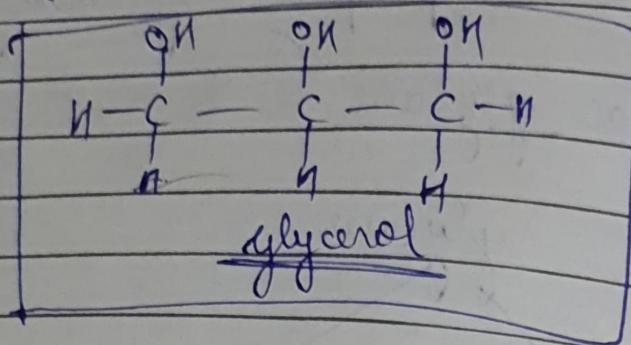
Unsaturated

- double bond
- less than the max. no. of H-atoms bonded

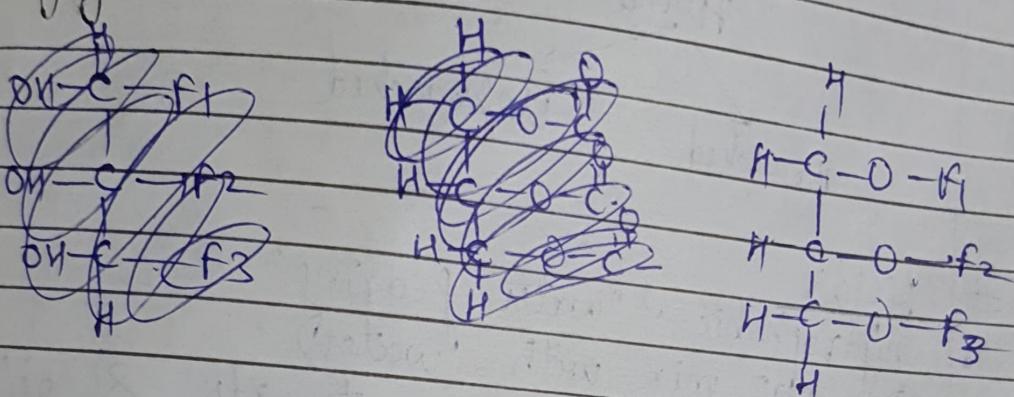


4) Triglyceride

- monomers of lipids
- composed of glycerol & 3 fatty acid chains
- glycerol forms the "backbone" of the fat.



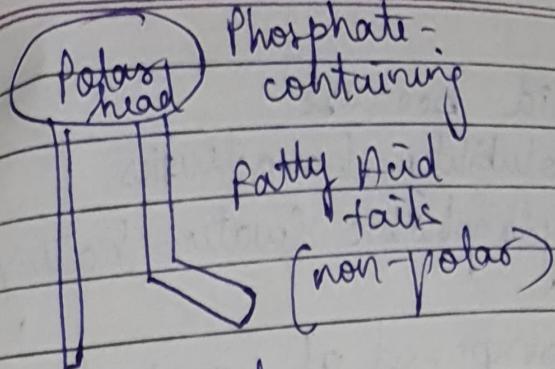
Triglyceride structure →



f1 → Fatty Acid chain 1
 f2 → Fatty Acid chain 2
 f3 → Fatty Acid chain 3

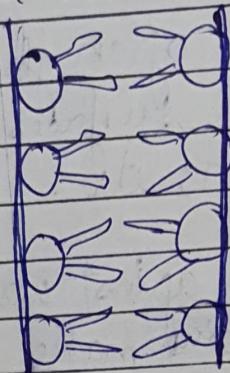
* Lipids & cell membrane

- cell membranes ~~are~~ are made up of lipids called phospholipids.
- Phospholipids have a head that is polar & hydrophilic (water-loving → attract water)
- Phospholipids also have 2 tails that are non-polar and hydrophobic (water-hating → don't attract water)



① Phospholipid

② Cell Membrane : [(Plasma-Membrane)



★ Steroids

- The carbon skeleton of steroids is bent to form 4-fused rings.
- ~~cholesterol~~ cholesterol is the "base steroid" from which our body produces other steroids.
- Testosterone & ~~Estrogen~~ Estrogen are also steroids.

③ Synthetic Anabolic Steroids ; →

- They are variants of testosterone.
- Some athletes use them to build up their muscles quickly.
- They can pose serious health risks.

* Waxes

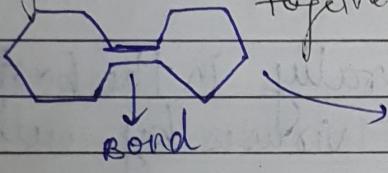
- Wax is a lipid because
 - non-polar solubility characteristics.
 - extremely hydrophobic (water-hating) properties
- Waxes are composed of a single highly-complex alcohol ~~alcohol~~ joined to a long-chain fatty acid in a typical ester linkage.
- Imp. structural lipids often found as protective coating on surfaces of leaves, stem, hair, skin; etc.
- provide effective barrier against water loss and in some situations make up the rigid architecture of the complex structure such as the honeycomb of the beehive.
- serve a commercial use as well; furniture-polish, automobile coating compds, and floor finishes.

Enzymes (Proteins)

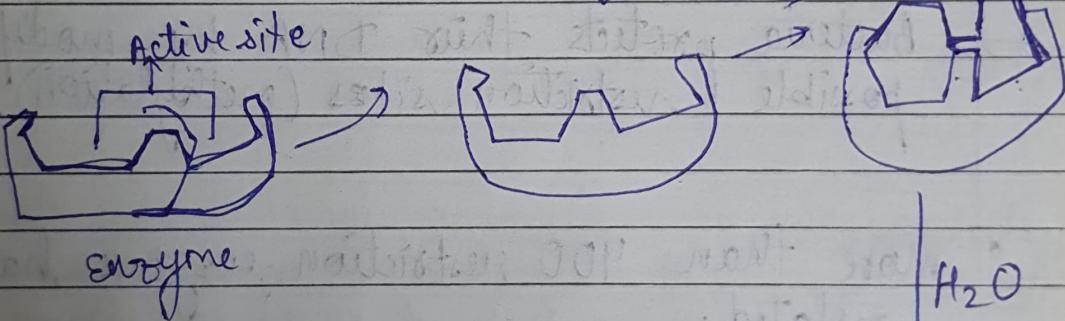
- Most enzymes are proteins (tertiary and quaternary structures).
- Act as ~~not~~ natural catalysts to accelerate rate of rxn (10^{16} times over uncatalysed rates!)
- Not permanently changed in the process (reusable)

- Specificity → specific for what they will catalyse i.e. only the desired reaction occurs
- protein works under mild conditions.
- Name ends in -ase
 - Sucrase
 - Maltase
 - Lactase

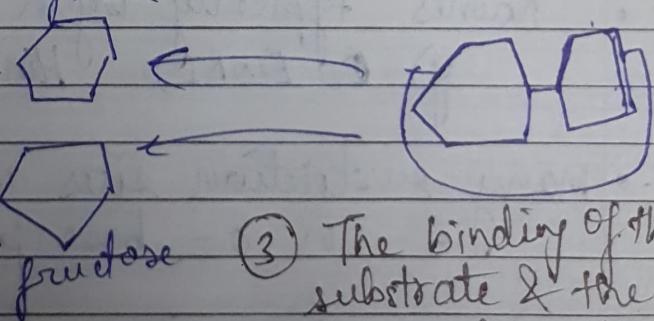
① The substrate sucrose contains glucose & fructose bonded together.



② The substrate binds to the enzyme forming the enzyme-substrate complex.



④ Products are released and the enzyme is free to bind other substrates



③ The binding of the substrate & the enzyme places stress on the glucose-fructose bond & the bond breaks.

★ Restriction Enzymes (R.E.)

- recognise specific base-pair sequences in DNA called restriction sites and cleave the DNA by hydrolysing the phosphodiester bond.
- ~~cut the DNA~~
- cut occurs b/w 3' carbon of the first nucleotide & the phosphate of the next nucleotide.
- restriction fragment ends have 5' phosphates and 3' hydroxyls.

★ Bacteria:

- most RE(s) occur naturally in the bacteria.
- protect bacteria against viruses by cutting-up viral DNA.
- bacteria protects their DNA by modifying possible restriction sites (methylation).

- More than 400 restriction enzymes have been isolated.
- Names typically begin with 3 italicized letters.
e.g.) EcoRI, HindIII, BamHI.
- Many restriction sites are palindromes of 4-, 6-, or 8-base pairs.
- short restriction site sequences occur more frequently in the genome than long restriction site sequences.

Applications of recombinant DNA technologies

Pharmaceutical Products

- Insulin
- Vaccine sub-unit
- DNA of vaccines against malaria, influenza, etc

Gene therapy

- replacing defective or missing gene with normal gene.

Gene Silencing

- target specific genes and degrade it.

Hormones

- Cells in multicellular organisms communicate with each other to coordinate their growth and metabolism through hormones.
- Hormones carry info from the sensor cells that sense changes in the environment to the Target cells, that responds to the changes.
- tend to coordinate various metabolic processes in the body.

Examples:-

- ★ Insulin,
- protein hormone
- secreted by Beta cells in islets of Langerhans in Pancreas.
- major hormone that regulates blood glucose level.
- hydrophilic hormone → act via membrane receptors on target cells
- Main target cells: Adipose tissue & skeletal muscles
- Lack of insulin causes increase in blood sugar level called diabetes.

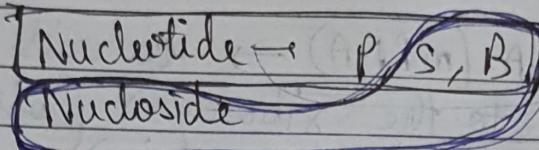
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Glucagon:-

- produced by Alpha cells in pancreas
- insulin counter-regulatory hormone
- increase blood glucose level from low to normal.
- acts mainly in the liver to stimulate the breakdown of glycogen to ~~glucagon~~ glucose, which is then released in the blood.
- production of glucagon is stimulated by:-
~~hypoglycemia~~
- (i) Hypoglycemia (low glucose level in blood) → increased absorption of amino acids in blood (occurs after a protein-rich diet)
- (ii) High blood glucose level → inhibits the production & release of glucagon.

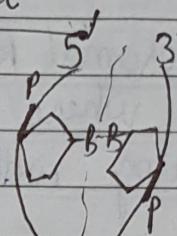
Nucleic Acids

- polymers of nucleotides.
- store heredity information
- contain information for making all the body's proteins.
- Two types exist → DNA and RNA.

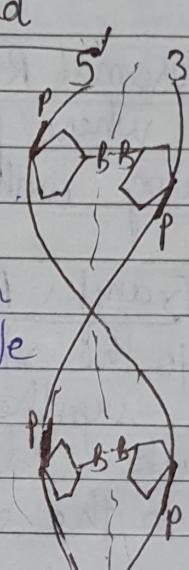


★ DNA → Deoxyribonucleic acid

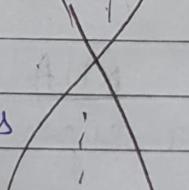
- Backbone of DNA is made up of sugar and phosphate.



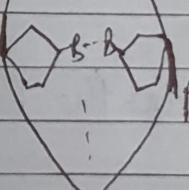
- Two strands of DNA join together to form a double helix



- Both strands of DNA are anti-parallel.



- Nucleotides form long chains called DNA.



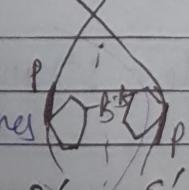
- Each DNA nucleotide has one of the following bases:-

- Adenine (A)] Purines

- Guanine (G)] Purines

- Thymine (T)] Pyrimidines

- Cytosine (C)] Pyrimidines



* RNA \Rightarrow Ribonucleic Acid

- Ribose sugar has an extra -OH or hydroxyl group
- It has the base Uracil (U) instead of Thymine (T)

■ 3 types of RNA :-

1) Messenger RNA (mRNA) \rightarrow carries genetic information to the ribosomes (blueprint for the construction of proteins).

2) Ribosomal RNA (rRNA) \rightarrow construction site where proteins are made.
 \rightarrow along with protein, makes up the ribosomes.

3) Transfer RNA (tRNA) \rightarrow transfers amino acids to the ribosomes where proteins are synthesised.
 (truck delivering the proper amino acid to the site at the right time).

RNA

- has a sugar ribose.
- contains the base Uracil (U).
- single-stranded.

DNA

- has a sugar deoxyribose.
- contains the base Thymine (T).
- double-stranded.

Proteins

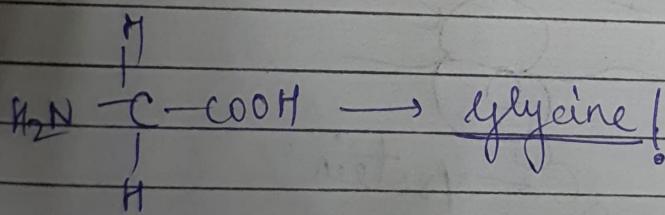
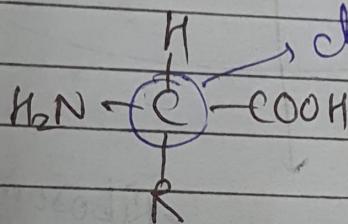
Date / /
Page No.

Proteins → hydrolysis peptides → hydrolysis amino acids

- Polymers of monomers called amino acids.
- Proteins are made of amino acids linked together by peptide bonds.
- All proteins are made up of 20 diff. amino acids linked in diff. orders.

- Proteins used to →
 - build cells (Building-blocks of body)
 - act as hormones & enzymes

chiral ($\text{if } R \neq H$)



* Protein synthesis

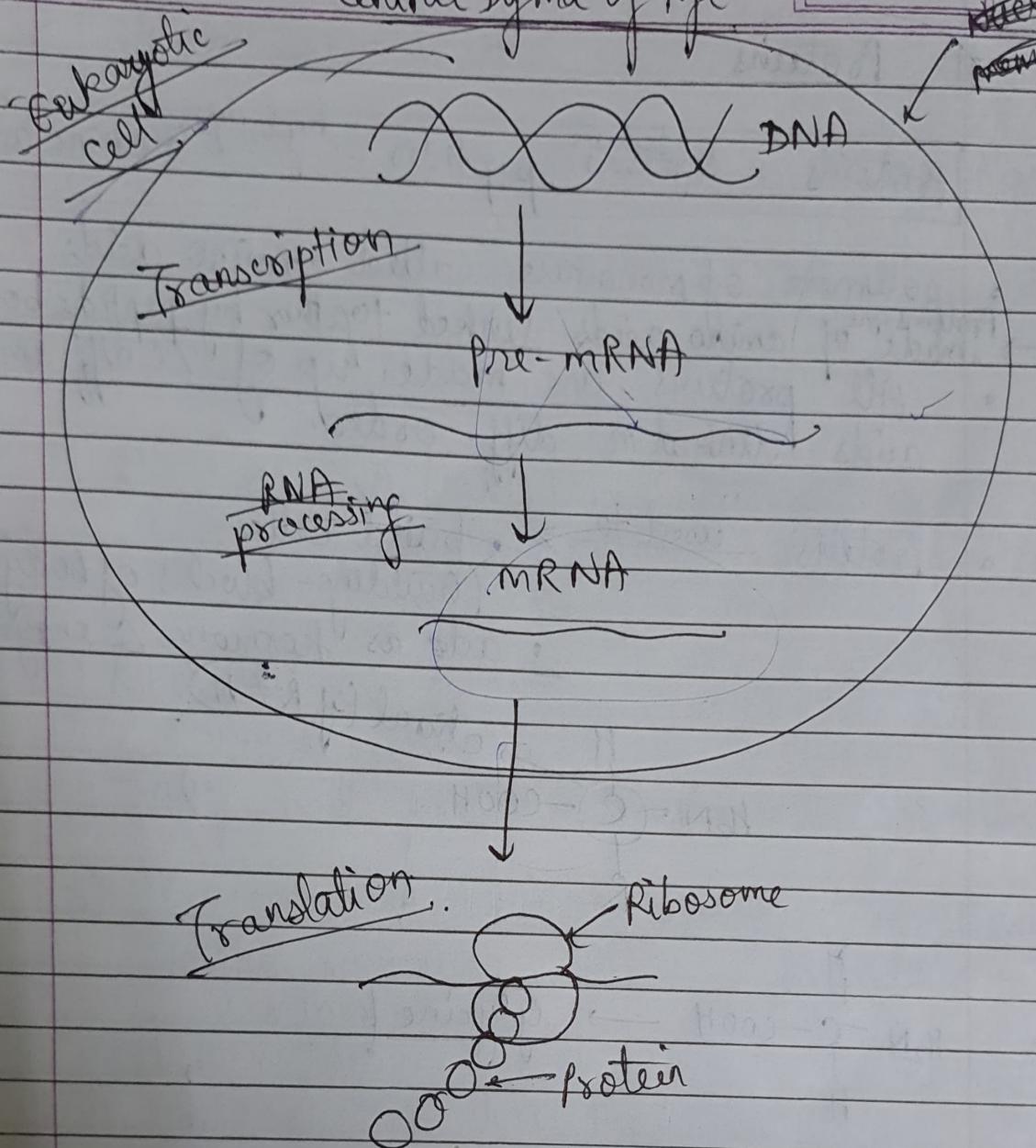
- 2 phases: Transcription & Translation
- mRNA must be processed before it leaves the nucleus of eukaryotic cells.

(P.T.O.) →

Central Dogma of life

Date / /
Page No. _____

nucleus
nucleolus
membrane



- * In prokaryotic cells → directly mRNA is formed through transcription.

~~pre-mRNA~~

+

- * Gene → segment of DNA that codes for the amino acid sequence in protein is called gene.

* Classification of Proteins:-
Based on chemical nature, structure, shape & solubility

1) Simple Proteins

- fibrous
- Keratin
- Collagen
- globular
- Globulin
- Albumin

2) Conjugated Proteins → combined with non-protein parts.
e.g. Nucleoprotein, Phosphoprotein.

3) Derived Proteins → derived or degraded products of simple & conjugated proteins.

Primary-Derived
Metaproteins

Secondary-Derived
Peptides

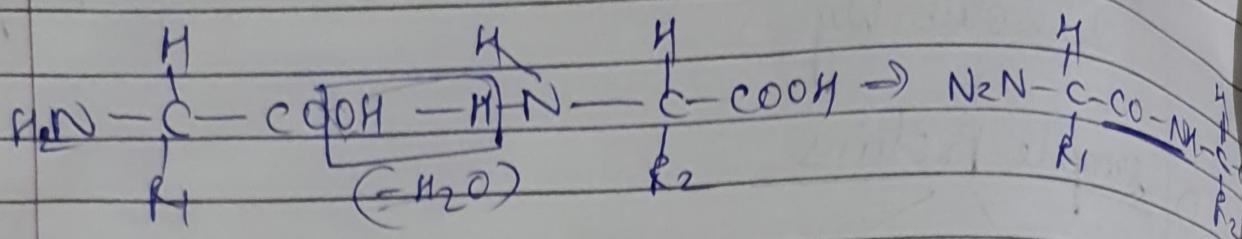
~~Globular Proteins~~
Fibrous

~~Fibrous Proteins~~
Globular

- long & narrow
- structural fn
- e.g.) → collagen (~~bone~~ muscle & skin)
→ keratin (hair, nails)

- round & ball-shaped
- metabolic fn.
- enzymes or antibodies
- e.g.) Haemoglobin

* Peptide Bond Formation :-



* Structure of a protein

1) Primary → Amino acid sequence joined by peptide bonds.

2) Secondary

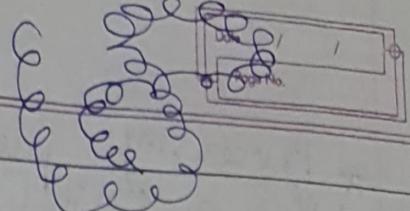
α -Helix

β

β -pleated

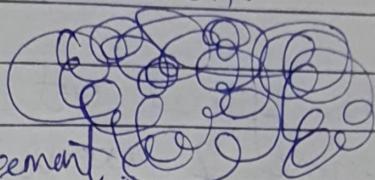
- | | |
|--|--|
| • Right-hand coiled rod-like structure. | • Sheet-like structure. |
| • H-bonds b/w polypeptide chains. | • H-bonds b/w beta-strands. |
| • -R grops of amino acids are oriented outside of the helix. | • -R grops are directed to both inside & outside of the sheet. |
| • can be a single chain. | • can't exist as a single beta-strand. |
| • has only one type. | • can be (hel, antihel) or mixed. |
| • prefers → Ala, Leu, Met etc. | • prefers → Val, Cys, Tyr , Tyr, etc |

3) Tertiary



- 3-D conformation
- types of interactions:
 - Electrostatic forces
 - Van der Waals forces
 - H-bond
 - hydrophobic interaction.

4) Quaternary



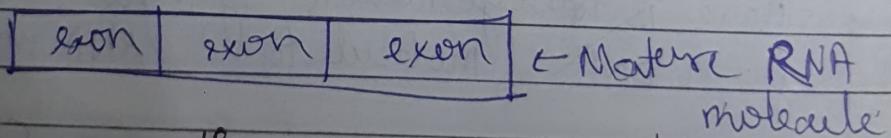
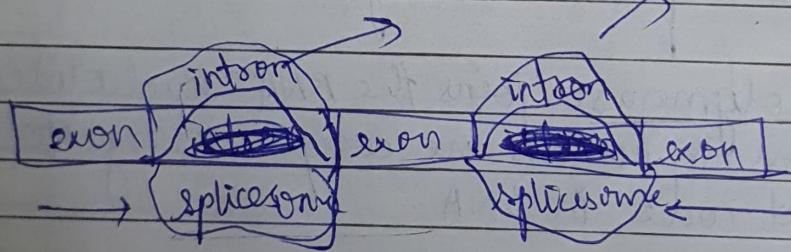
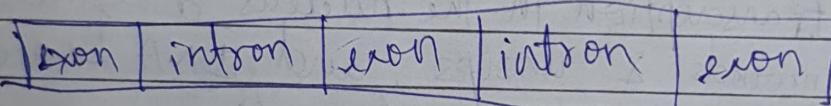
- spatial 3-D arrangement
- same type of interaction/forces as in tertiary.
e.g. Haemoglobin.

Transcription

- During transcription in the nucleus, a segment of DNA unwinds & unzips, and DNA serves as a template for m-RNA formation.
- RNA polymerase joins the RNA nucleotides so the codons in m-RNA are complementary to the triplet code in DNA.
- There is transformation of info in the nucleus from DNA molecule to RNA molecule.
- only 1 DNA strand serves as the template.
- Starts at promoter DNA (TATA Box)
- Ends at terminator DNA (stop).
- When complete, pre-RNA molecule is released.

- ★ Processing pre-mRNA
 - Also occurs in the nucleus
 - pre-mRNA → exons & introns
 - ↓
 - code for proteins
 - do not
 - introns spliced out by ~~splicesome~~ splicesome enzyme & exons are joined.
 - end product → matured RNA molecule that leaves the nucleus to the cytoplasm.

pre-RNA molecule



- AUG → methionine or start codon
UAA, UAG, UGA → stop codons.

Translation

→ Synthesis of proteins in the cytoplasm.

- Involves the following:-
 1) m-RNA (codons)
 2) t-RNA (anticodons)
 3) ribosomes
 4) amino acids.

- 3 steps:-

- 1) Initiation: start codon (AUG)
- 2) Elongation: amino acids linked through peptide bond.
- 3) Termination: stop codon (UAA, UAG, UGA).

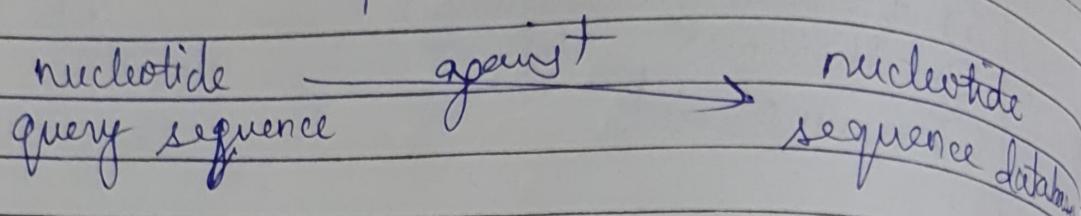
BLAST (Basic Local Alignment Search Tool)

- Developed by Stephen & Altschul in 1990.
- BLAST finds regions of similarity b/w biological sequences
- The ~~protein~~^{program} compares protein or nucleotide sequences to sequence databases & calculates the statistical significance.
- used to infer functional & evolutionary relationships b/w sequences as well as help to identify the members of gene families.
- BLAST algo is fast, accurate & web-accessible.
- Software can be accessed by the NCBI website.

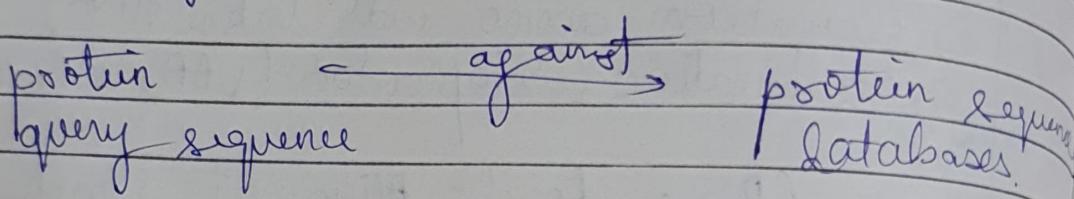
→ Info Retrieval System

* 5 different types of BLAST-tools:

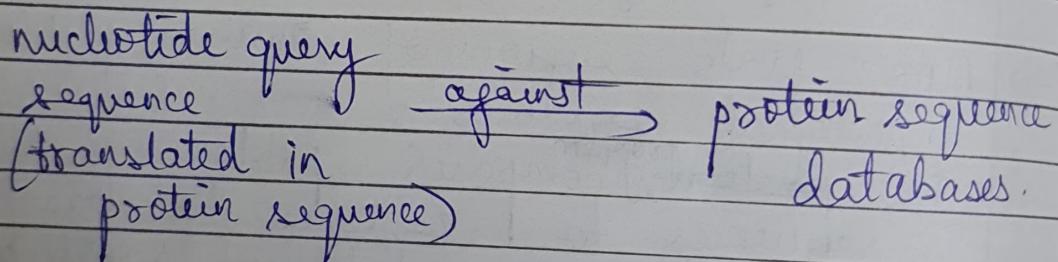
1) BLAST-n → compares nucleotide



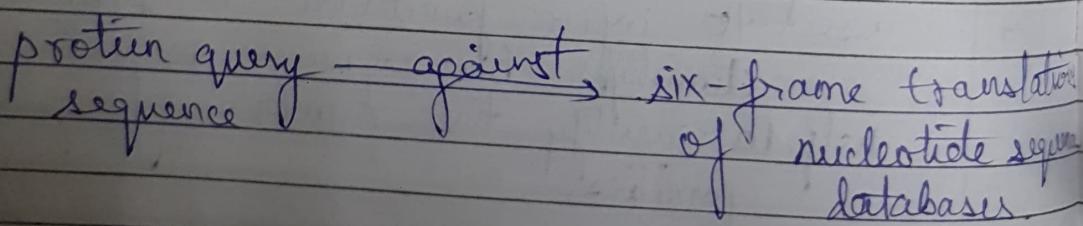
2) BLAST-p



3) BLAST-x



4) t-BLAST-n



5) t-BLAST-x

translated nucleotide query sequence

translated nucleotide sequence databases.

* Applications

- Homology searching
- Species identification
- Establishing phylogenetic relations
- DNA mapping & comparison.

UNIT-5

Body Defenses; Overview

► Physical → skin
epithelial linings
cilia

► Chemical → acids
mucous
lysozymes

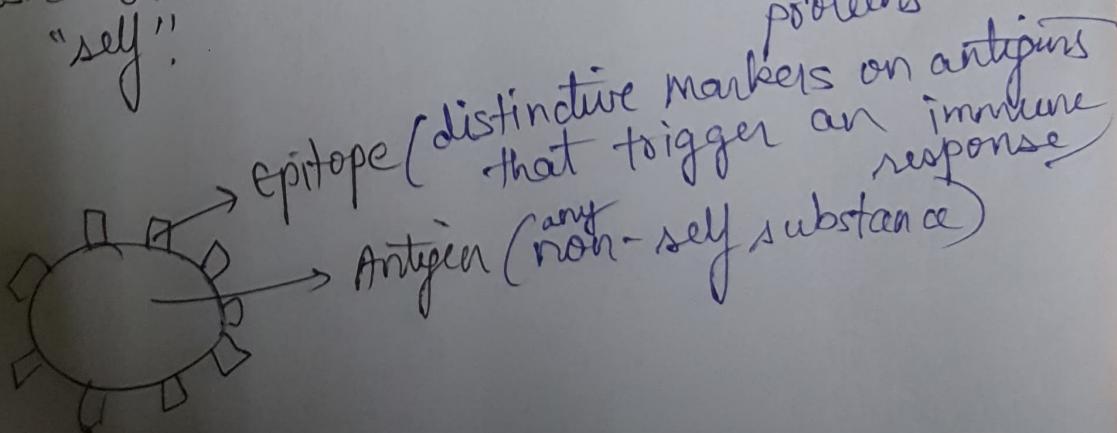
► Steps in immune defense

- Detect invader / foreign cells
- Communicate alarm & recruit immune cells
- ^{suppress or} Destroy invaders.

success of immune system → depends upon ability to discriminate b/w foreign cells (non-self) & host cells (self)

→ our immune system coexists peacefully with other cells of the body in a state called self-tolerance:

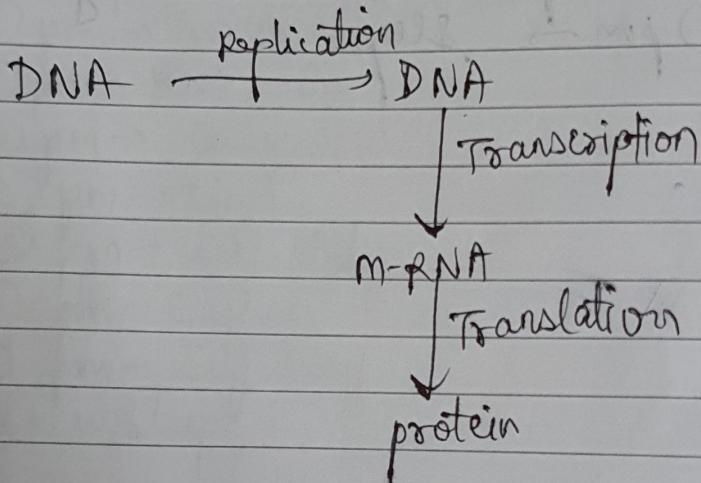
* set of unique markers on human body that distinguish ourselves as "self". → MHC proteins (major histocompatibility complex proteins)



BIOLOGY# BLAST (Basic Local Alignment Search Tool)

- Developed by Stephen Altschul in 1990.
- Information Retrieval System.

Central Dogma (Center for all body activities)



* There are 5 different types of BLAST tools:-

- 1) BLAST-n →
It compares the nucleotide query sequence against nucleotide sequence databases.
- 2) BLAST-p →
It compares the query protein sequence with protein sequence databases.

3) BLAST - $\alpha \rightarrow$

- It compares the nucleotides query sequence (translated in protein sequence) against a database of protein sequences.

4) ~~BLA~~ $t - \text{BLAST} - \eta \rightarrow$

- It compares ~~the~~ protein sequence against the six frame translations of a database of nucleotide sequences.

5) $t - \text{BLAST} - \infty \rightarrow$

- It compares the translated nucleotide query sequence against the translated nucleotide sequence database.

* Applications

- 1) Homology searching
- 2) Species identification
- 3) Establishing phylogenetic relations.
- 4) DNA Mapping & comparison.

BIOLOGY

Structural Databases

PDB

(Protein Data Bank)

CATCH

(Not in syllabus)

★ PDB

- It was established in 1971 by research collaborative for structural bioinformatics (RCSB).
- PDB contains the information about 3-D structures of the proteins.
- The structural info of the proteins can be determined by X-ray crystallography and or NMR spectroscopy methods.
- PDB is overseen by an organisation called World Wide PDB.
(www.wwpdb.org)
- Available at
 - (i) www.wwpdb.org
 - (ii) www.pdb.org
 - (iii) www.pdbj.org
- PDB allows searching the information regarding the structure, sequence, function, and also visualise, download and to assess the molecule.

- Each entry in the PDB is provided with a unique identification number called PDB ID.
- It is a 4 letter identification number which consists of both α-numeric characters.
- Without a proper tool, PDB file will be read as a text file that lists each atom and it's numerical coordinates in a 3-D space.

* Description of entries

- 1) Compound Name.
- 2) Author Name
- 3) Experimental Method
- 4) classification
- 5) Source
- 6) Primary citation
- 7) Deposition date / Release date.

★ PDB file format

- File contains 100's or 1000's of lines called records. Each record provides a different set of information like:

- i) Header: It contains file name, date of submission and the PDB ID of the molecule.
- ii) Title: It contains the title of the PDB entry.
- iii) COMPND: It includes the protein name.
- iv) Source: It contains the name of the organism from which the particular protein is obtained.
- v) KEYWDS: It contains the keywords that describes about the protein.



★ Applications

- 1) Prediction
- 2) Database Annotation
- 3) Analysis mining
- 4) Classification on the basis of structure & function

5) Comparison

6) Structure Refinement.

BIOLOGY

17/11/22

Unit - 2

- ③ ★ Carbohydrates
- ④ ★ Proteins
- ⑤ ★ Lipids
- ⑥ ★ Waxes

① ★ Chemistry in everyday life

② Disease & their causes

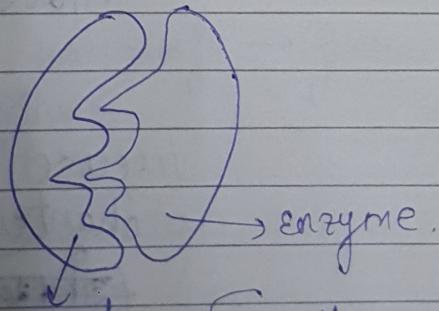
* Learning examples is very imp.

⑦ ★ Enzymes → Sources

: restriction endonuclease enzyme

Enzymes

- Biological catalysts.
- Enzymes increase the rate of rxn by 10^{16} times.



substrate

specific
(one-to-one-relation)

① Lock and Key Model

② Induced fit Model

(substrate fits molecule of conformational changes to the tail acc. to the enzyme)

BIOLOGY

Protein Visualising Tools

★ Tools

- RasMol ✓ (in syllabus)
- PyMol
- MolMol
- Chime
- Protein explorer.

1) Before computer visualisation software was developed, molecular structures were presented by physical models of metal wires, rods and spheres.

2) With the development of computer hardware & software technology & computer graphic programs were developed for visualising & manipulating the 3-D structures of the protein.

3) Molecular visualisation helps the scientists/bio-engineers to analyse the protein molecules.

★ Tools

- ✓ RasMol (in syllabus)
- ✓ PyMol
- MolMol
- Chime
- Protein Explorer.

RasMol

- Molecular graphics program intended for the visualisation of proteins and the related small molecules.
- It was created by Roger Sayle in 1992.
- This program is aimed at display, teaching and generation of publication-quality images.
- RasMol runs on a wide range of architectures and operating systems including Microsoft Windows, UNIX and VMS systems etc.

► RasMol features :-

This program consists of 2 windows:-

- 1) For the command-line
- 2) For providing the graphics.

- The program reads in a molecule co-ordinate file & interactively displays the molecule on the screen in a variety of colour schemes & molecular representations.

PyMol

- Molecular graphics system with an embedded python interpreter designed for real-time visualisation & rapid generation of high-quality molecular graphic images & animations.

Main features of PyMol :-

- 1) This program is able to produce high-quality graphics ready for publications.
- 2) It is able to create movies of the 3-D structures of proteins.
- 3) It also measures the bond-distances & angles b/w the 2 amino acids.
- 4) Structures can be sliced, diced and can be seen as a different ~~struc~~ structure.

* One protein, one true structure, 8 ways to look at it using a molecular visualisation tool.

pink colour → represent double bond

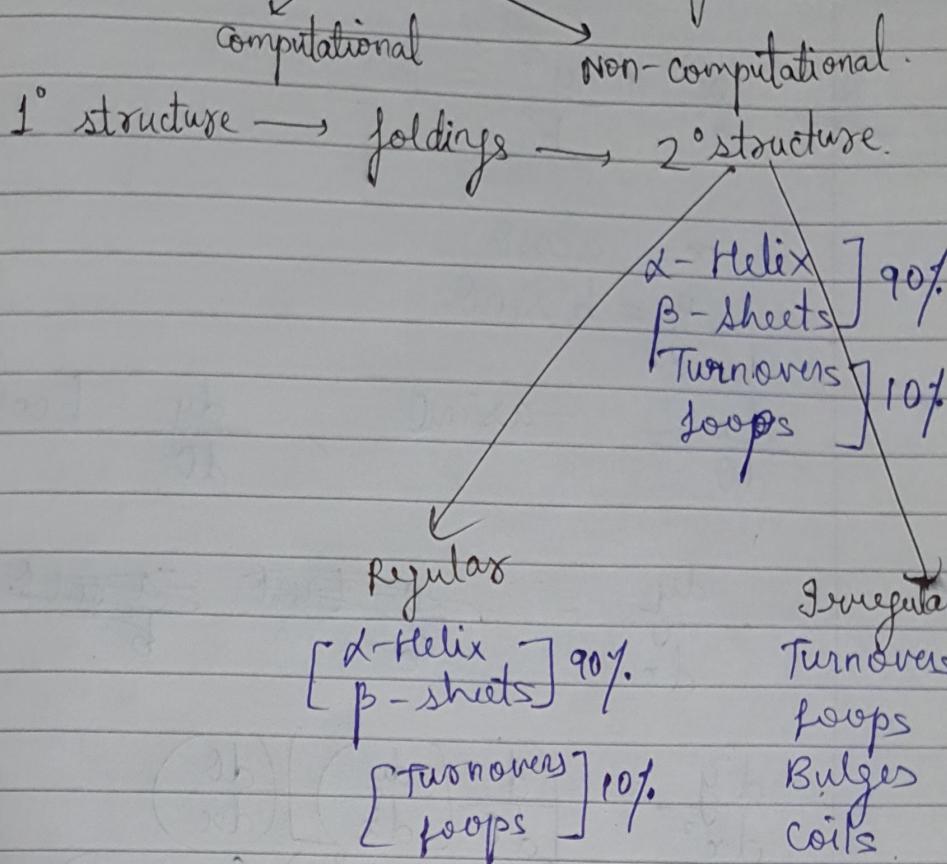
(i) bond-lengths
(ii) bond-angles
etc

• colour sequences

→ There are no. of models that have been used by these protein- visualising tools & some of them are as follows:

- (i) Ball-and-stick Model
- (ii) Space-filling Model
- (iii) Backbone-Model
- (iv) Ribbon (cartoon) - Model

Secondary Structure Prediction Algorithm



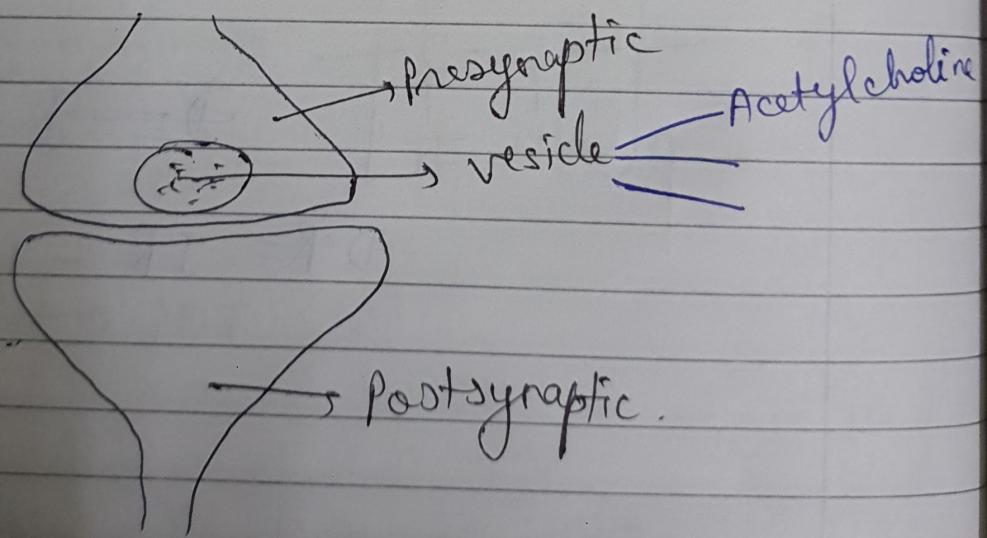
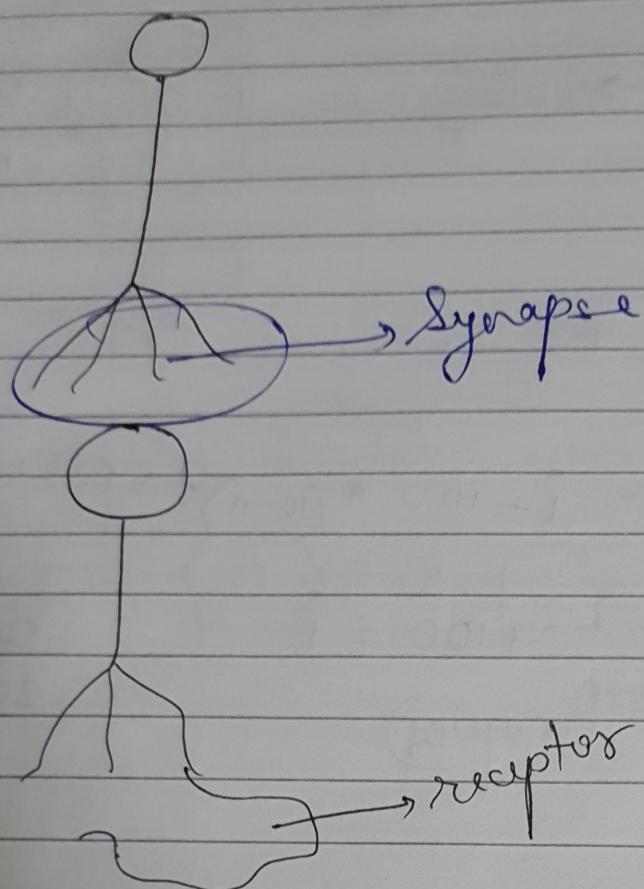
★ Chou-Fasman Algorithm

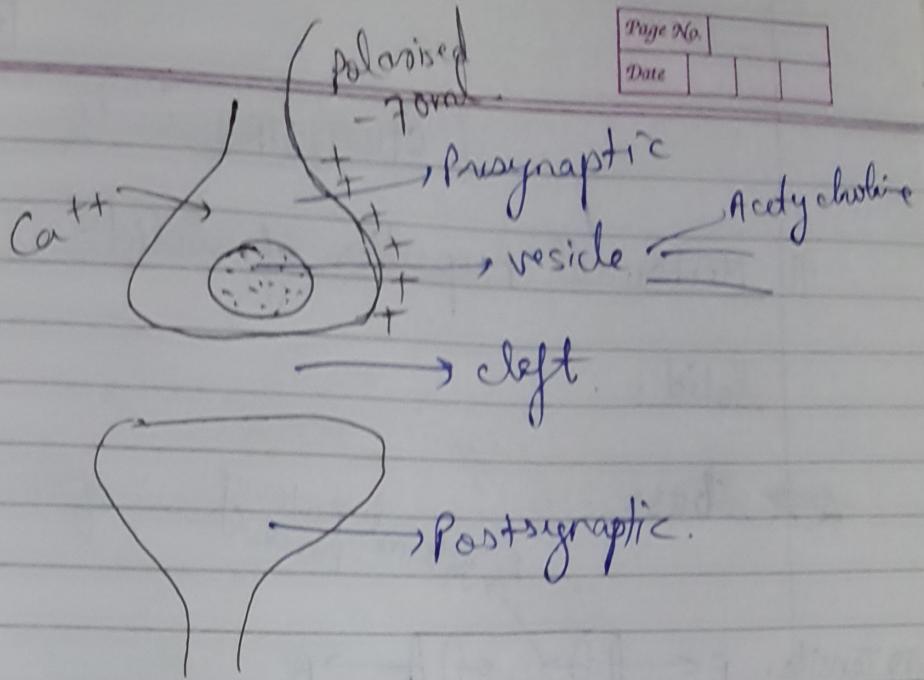
* Propensity value → Tendency of amino acids to convert into α -Helix, β -sheets, turnovers or ~~loops~~ loops.

20 amino acids ~~diff. arrangement~~ → diff. proteins

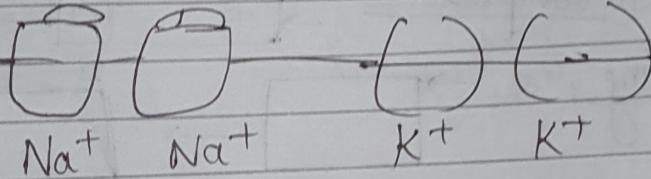
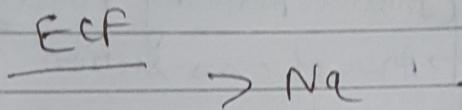
- 1) Chou-Fasman Method → 66.6% accurate
 - 2) Ab initio method
 - 3) Homology Modelling
- } → 33.4% results.

BIOLOGY



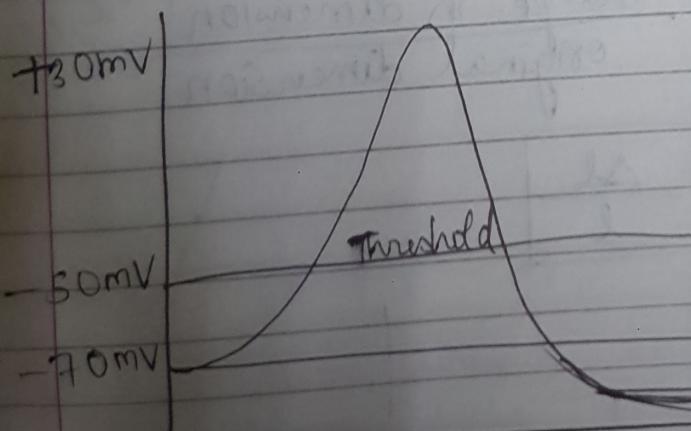
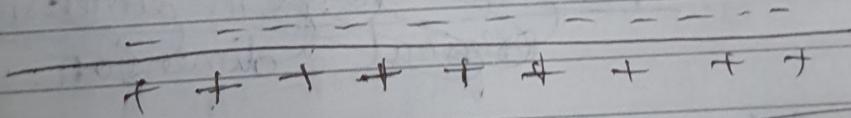


~~ECP~~



$\rightarrow \text{K}$

ICF



* Sympathetic \rightarrow
fight & flight

19/12/22

BIOLOGY

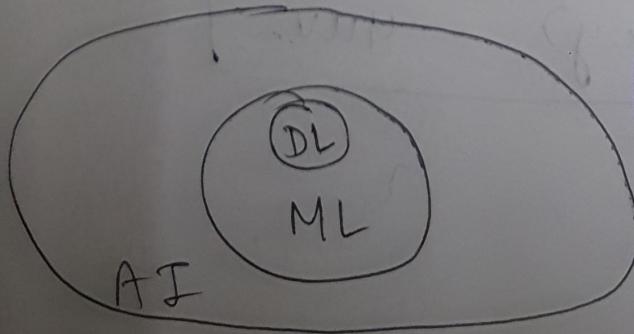
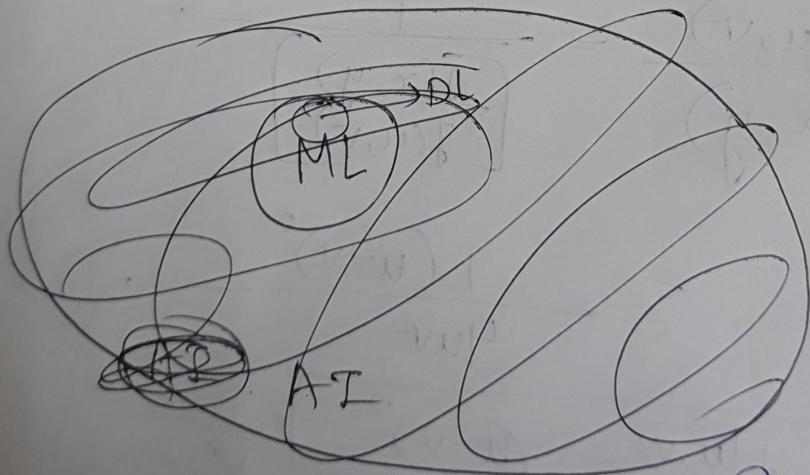
Pg → 134

glial cells; etc (with diagram)

- * Neurons
- * synapse & Action potential
- * Vaccination (Types of Vaccines)
- * Types of WBC's
- * Diseases of the Nervous system
- * Computer-Based Neural Networks
- * Immune System
- * Active & Passive immunity.

Machine learning

★ Statistics



DL → Deep learning
ML → Machine " "
AI → Artificial Intelligence ✓

* Applications of ML

* Data Mining

(KDD)

↓
knowledge discovery in
databases.

list of figures.

→ glial cells

→ Neuron

→ synapse

→ Action potential

→ Monocytes

5.2, 5.3, 5.7, 5.8,

5.10, 5.12