Bi 110

MR CHIKONDE

BIOLOGY: This is the study of life and in relation to the environment.

Life can be in two forms;

1. Prokaryotes:
   - Single celled organisms.
   - Bacteria and Archea.
2. Eukaryotes
   - Both single celled and multicellular organisms.
   - Plants, animals, fungi, protista; single-celled organism.

CELL BIOLOGY

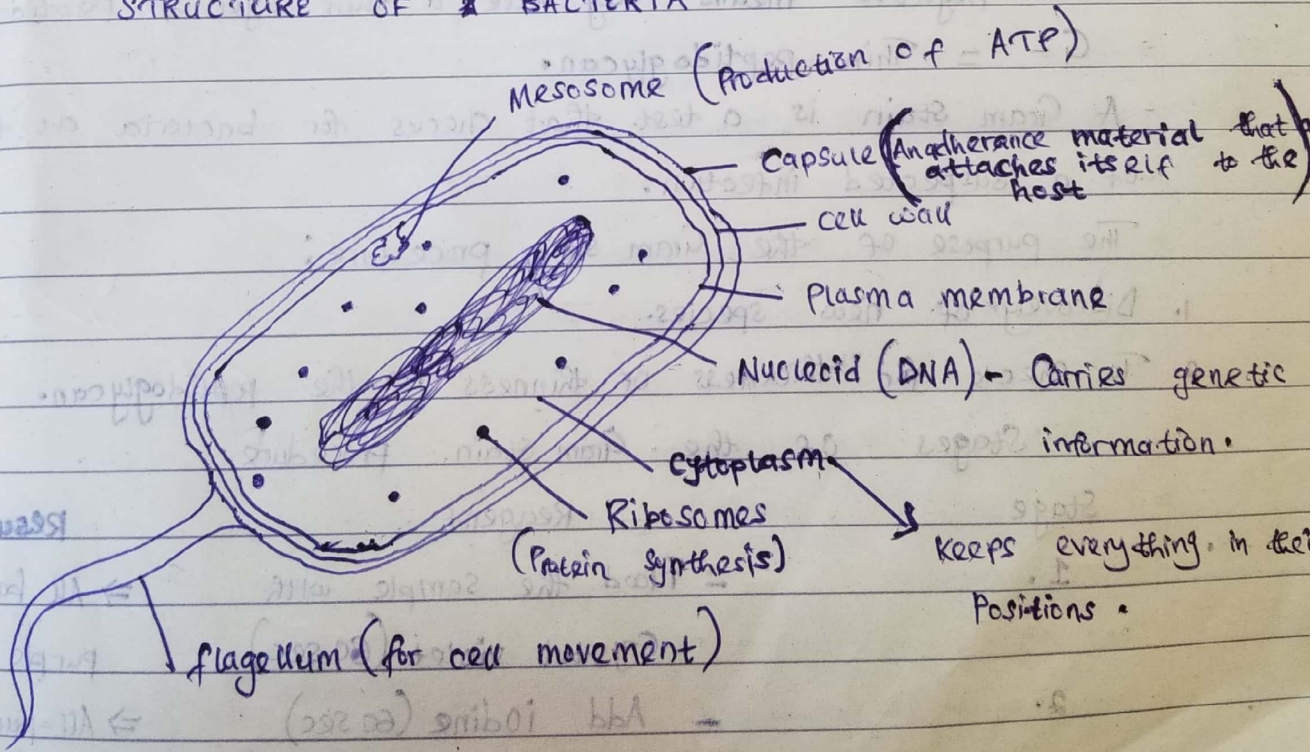
Cytology: the study of cells.

Theory of cells:

There are three principles

1. Cell is a basic unit of life (structure and function)
2. Cells come from the replication of already existing cells.
3. All biological organisms are made up of cells.

STRUCTURE OF A BACTERIA



Prokaryotes

→ Has no nucleus (instead they have a nucleoid)

→ Has a cell wall.

→ Has a capsule (which protects the cell & it attaches itself to the host)

→ Have a flagellum which allows the movement of the cell by using energy from ATP. (ATP production happens in mesosomes).

→ They have ribosomes (where protein synthesis takes place).

→ Presence of peptidoglycan which can be between the cell wall and the cell membrane.

Peptidoglycan is the combination of amino acids and carbohydrate.

Pepti → Proteins Glycan → carbohydrates.

It is found only in Bacteria and Not in Archea.

* Bacteria can either be Gram positive or Gram negative.

Gram positive means they have a thick layer of peptidoglycan.

G+ = Thick peptidoglycan.

Gram negative means they have a thin layer of peptidoglycan.

G- = Thin peptidoglycan.

A Gram stain is a test that checks for bacteria at the site of a saspected infection.

The purpose of the Gram stain procedure:

1. Discovery of new species.
2. To check for thickness or thinness of the peptidoglycan.

Stages of the Gram stain procedure

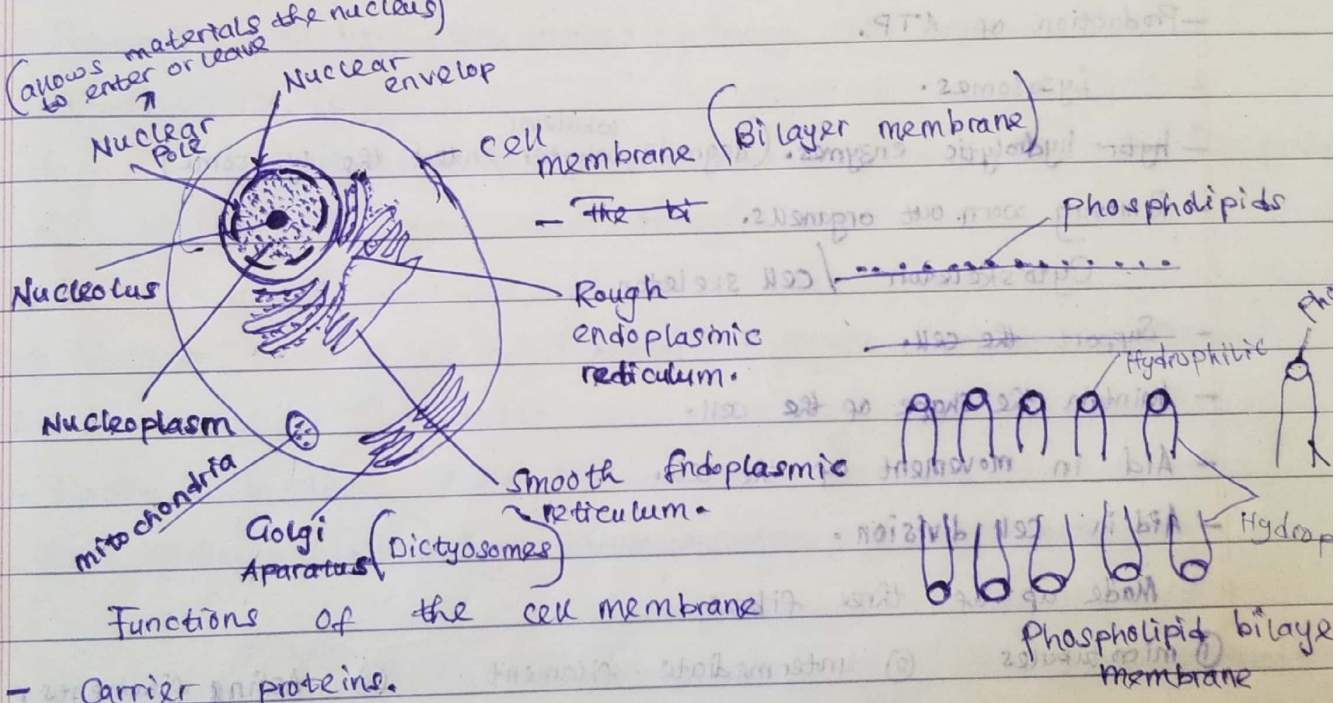
Stage	Reagent	Result
1.	- Flood the sample with Crystal violet (60 sec)	⇒ All bacteria is purple (dye)
2.	- Add iodine (60 sec)	⇒ All purple (Mordent)
3.	- Add alcohol (Decolorize) (20 sec)	⇒ G+ = Purple G- = Colourless
4.	- Add safranin (Counter stain) (1-2mins)	⇒ G+ = Purple G- = pink-red

Economic importance of prokaryotes

- Production of medicine e.g insuan.
- In decomposition.
- Beer production.
- Maintain carbon cycle by removing carbon-dioxide and retain it to the atmosphere.

Eukaryotes:

- Have a nucleus.
- Well elaborate endomembrane system. (Membrane bound organell)
- Reproduce sexually and assexually.
- Division is meosis / mitos.



Functions of the cell membrane

- Carrier proteins.
- Facilitated diffusion.
- Active transport : ~~carrier~~ receptor protein + ligand

Nucleus

- Nucleoplasm (Karyolymph) : Stores nucleic acid (DNA/RNA)
  : Site for replication
  : Stores chromosomes.
- Nucleolus : production of rRNA. Synthesis of proteins.
  rRNA (ribosomal Ribonucleic acid)

Endocytosis

Mitochondria and chloroplasts have their own DNA & Ribosomes.

Semi-autonomous

Rough ER
- Contains Ribosomes.
- Synthesis of proteins.

Smooth ER
- Synthesis of lipids and sugars.
- Storage of calcium ion.
- Detoxification. (making harmful material less harmful).

Golgi apparatus (Dictyosomes)
- Collect, modify and transport modified substances.

Exocytosis is the process by which ~~things~~ / substances ~~move~~ moved ~~from one to another~~ or movement of substances out of the cell. ~~cell~~ cell.

Synthesis and transportation of synthesized material to sites that require the materials.

Exocytosis is the process by which substances move out of the cell.

Mitochondia
- Production of ATP.

Lysosomes.
- ~~hydr~~ hydrolytic enzymes. (degrade ~~whatever~~ whatever enters the lysosome)
- Removing worn out organelles.

Cytoskeleton / cell skeleton
- Support the cell.
- Maintain the shape of the cell.
- Aid in movement of the cell.
- Aid in cell division.

Made up of three fibres.

① microtubules ② intermediate filament ③ Acting filaments.

Plant cells:

Endosymbiosis theory:

The mitochondria & chloroplasts existed on their own as prokaryotes, then they were swallowed up by the Eukaryotes.
- They have their own DNA.
- They are semi-autonomous.
- Own ribosomes.

The mitochondria and chloroplast split into two by binary fission.

PARTS THAT DIFFERENTIATE ANIMAL & PLANT CELL

Plant cells:

⇒ Chloroplasts: this is a site where starch is produced. (sugars)

Photosynthesis

H_2O + light

(site where photosynthesis takes place)

Thylakoid disks ↗ stack of thylakoid disks is known as Granum.

⇒ Cell wall:

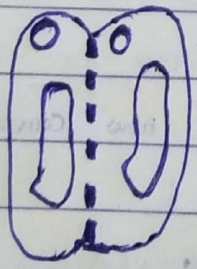
* Presence of cellulose which makes primary cell wall.

Cellulose: Elasticity

: Lignin (Lignified cell wall) makes secondary cell wall. Also provides the mechanical ~~strain~~ strength.

⇒ Vacoule: made up of H_2O + inorganic + organic substances. (cell sap)

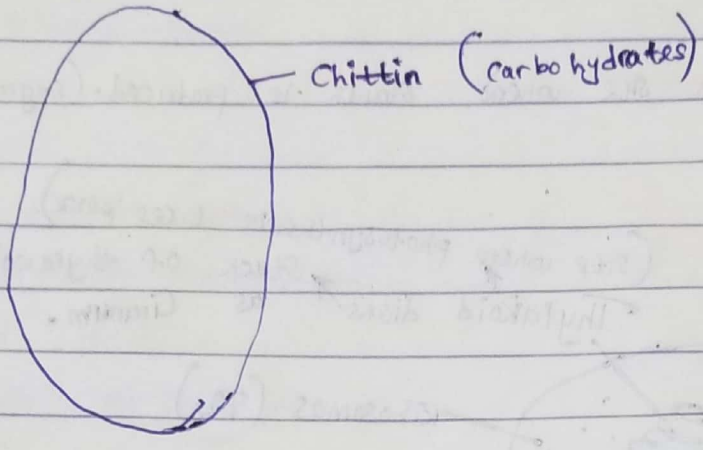
- Also called a ~~tonoplast~~.
- Function is to remove toxic substances from the cell.
- Stores anthocynin / pigmenting substances which gives colour. ~~to the plant~~



~~- Mixture passes through~~ plasmodesmata. (found in plant

- Minute passages — OR —

fungi cells



CELL DIVISION:

This is the process by which cells devide.

Prokaryotic cell division

- Simple / binary fission.
- Reproduction.

Eukaryotic cell division

- Not simple ; mitosis & Meosis
- Growth, replacement of cells, reproduction

Prokaryotic cell division

- Simple division
- Circular DNA (NO chromosomes)

* DNA polymeraze (Engymes)

Responsible for DNA replication. (making copies of DNA)

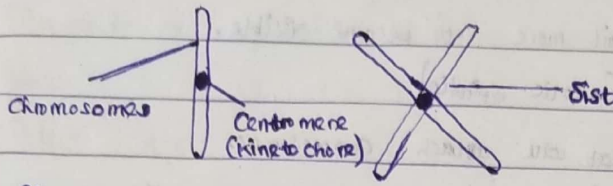
- It has a starting point & end point.
- The replication is bidirectional.
- The cell grows so as to accomodate the new component.

* Septation : formation of a septum.
* ftsZ : filamentous ~~tumor~~ temperature sensitive protein Z.

Responsible for formation of a septum. / facilitate the cell division in prokaryotes.

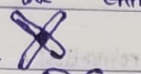
Eukaryotes

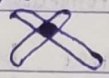
- Chromosomes : thread-like structures that contains DNA.



Chromosomes contain about 40% DNA & 60% Histones.

Classify chromosomes based on the ~~chromosomes~~ centromere.

① Metacentric – at the center. 

② Acrocentric – towards the end. 

③ Telocentric → towards the extreme end. 

Human body has 46 chromosomes. 23 paired chromosomes.

Categorized into 2 : 22 pairs – autosomal & 23rd pair – sex chromosomes.

Chromosomal condensation (coiling)

Chromosomes contain about 40% DNA & 60% Histones.

↓

Nucleosome.

the DNA is negatively charged because of the presence of PO_4^-

- Histones are ~~certain~~ positively charged because it contains proteins known as lysine & glycine
- A bunch of Nucleosomes form solenoid.

Nucleosome → Solenoid → Chromatin loops → Chromosome

Mitosis

* One cell → two daughter cells that contain the exact amount of DNA / chromosomes.
* Replacement of cells & Growth.

Stages:

① Interphase :

Gap_0 – G_0 – quiescent stage meaning no activity.

Gap_1 – G_1 – The cell grows in size so as to accomodate organeles ~~organelles~~ that are going to be Produced

Synthesis (S) phase : DNA replication / replication of chromosomes

Gap_2 – G_2 – Cell reproduces organelles & making cell ready for mitosis.

Mitosis is an equational process meaning the number of chromosomes does not change.

② Prophase :

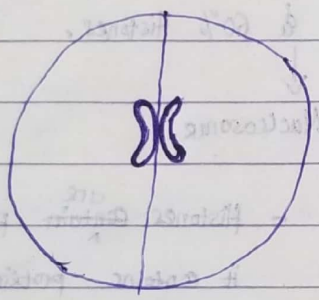
- Chromosomes condense or they coil more to become visible.
- Formation of mitotic apparatus (mitotic spindle) ← contains microtubules that will attach chromosomes.
- Nuclear membrane breaks down & exposes the chromosomes to the cytoplasm.

③ Metaphase :

- Microtubules attach to sister chromatids.
- Chromosomes moved to the center by congression.
- Microtubules attach to individuals chromatids. (to prevent Aneuploidy)

Aneuploid has two types : Trisomy (more than the required chromosome) & monosomy (less than the required chromosomes)

- Metaphase plate : devides the chromatids into two equal halves/parts.



④ Anaphase :

- Sister chromatids separate.
- Cdc, 20 (enzyme) cleaves the protein that holds the sister chromatids.
- pulling the chromosomes to the poles.

⑤ Telophase :

- Mitotic spindles disassembles.
- Formation of the nuclear membrane. (By the endoplasmic reticulum)
- Cytokinesis : division of the cytoplasm into two.

Karyotype : Number of chromosomes — Karyogram : Diagram of chromosomes

Number — 23 pairs.

Centromere position

Shape - or size

Karyokinesis : Separation of the nucleus.

Meiosis

- Reproduction.
- Daughter cell contain half the number of chromosomes as the parent cell.
- Uses Germline cells.
- ~~Repro~~ Reduction process.

Stages in Meiosis.

- It has two stages.

① Meiosis I & ② Meosis II

Interkinesis: A stage between two meiotic stages.

Meosis I

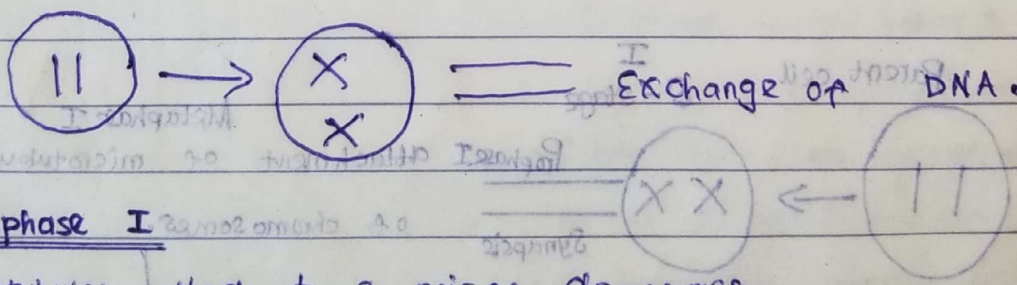
Interphase I

- G_0, G_1, S, G_2

At S stage there's a lot of DNA replication.

Prophase I

- formation of the spindle app apparatus.
- Chromosomes condense and become visible.
- Nuclear envelope break down.
- Synapsis occurs: pairs of chromosomes lie side by side forming: Tetrad or Bivalent or homologous chromosomes.
- When they lie side by side, they exchange DNA.
- All the chromosomes will have a different genetic makeup which brings about variation. (Genetic Recombination)



Metaphase I

- Microtubules attach to a pair of chromosomes.
- Chromosomes are moved to the centre.
- Chromosomes align at the metaphase plate.

Anaphase I :

- Pairs of chromosomes separate.

Telophase I :

- Pairs of chromosomes are pulled towards the poles.
- Disappearance of the spindle apparatus.
- Formation of the nuclear membrane.
- Cytokinesis takes place if the daughter cells have the same number of chromosomes as the parent.

MEIOSIS II

Interphase II

- $G_0, G_1 G_2$ (Has no synthesis ie No DNA replication).
- Duplication of organells.

Prophase II

- No Synapsis.

Metaphase II

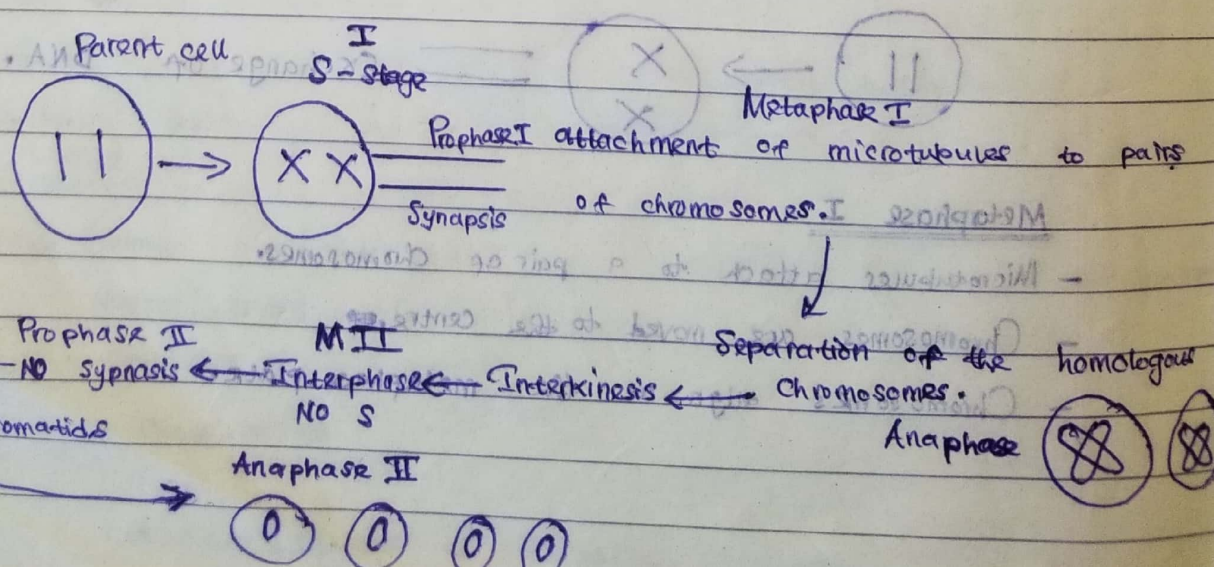
- Microtubules attach to individual chromatids.

Anaphase II

- Individual chromatids separate.

Telophase II

- Nuclear membrane formed.
- Disassembling of the spindle apparatles.
- Cytokinesis occurs.



Macromolecules

- These are large molecules that contain atoms sharing electrons by grouping or combining. Eg proteins, lipids, Nucleic acids, sugars etc.
- Formed by polymerization. (polymers) which is made up of monomers.

Carbohydrates / sugars ~~$(C_nH_{2n}O_n)$~~ $(C_nH_{2n}O_n)$

1. Storage carbohydrates (Starch & Glycogen)
2. Structural. (Cellulose & Chitin)

- Release energy by combustion.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP \text{ (ENERGY OR HEAT)}$$

- Store energy in their carbon structures.

Monosaccharides (simple sugars)

- These are the simplest sugars which cannot be split into too.

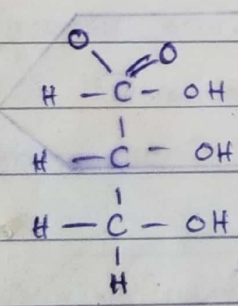
Trioses → 3 Carbon sugars.

Pentoses → 5 Carbon sugars.

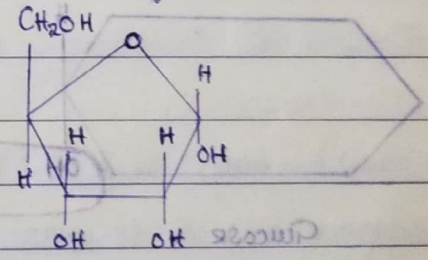
Tetroses → 4 Carbon sugars.

Hexose → 6 Carbon sugars.

Triose structure



Pentose ring structure



Two types of Pentose sugars.

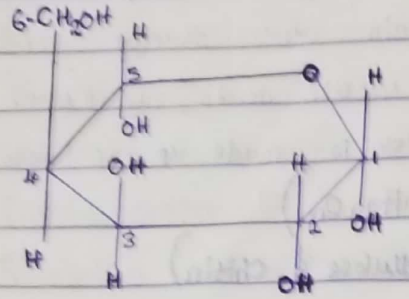
① Ribose sugars. (found in RNA).

② Deoxyribose sugars. (found in DNA).

Their difference is at 2'

* At 2' the ribose sugar has OH & Deoxyribose has H.

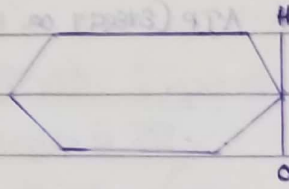
Hexose (6 carbon sugars)



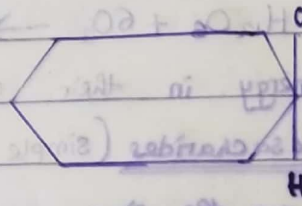
Isomers of Glucose are

* Galactose & fructose.

α glucose



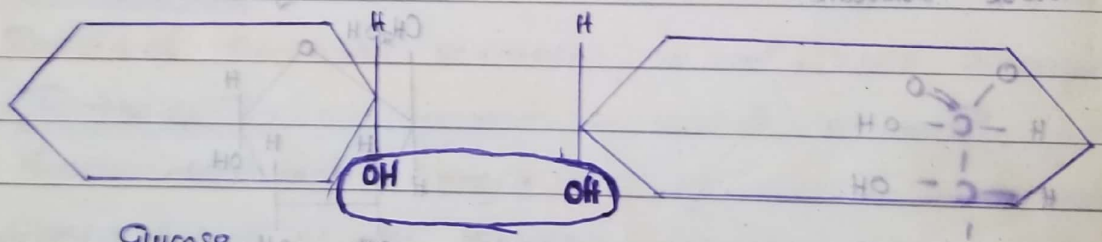
β glucose



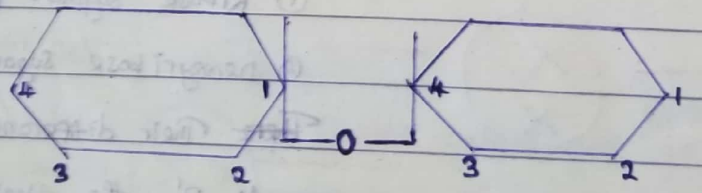
When two monomers join they form Disaccharides

Disacharides

- Transport molecules.
- Act as reservour of glucose.
- Formed through condesation (dehydration) reaction.



Glucose + fructose



Glycosidic link

α → 1, 4 Glycosidic linkage

1. α Glucose + α Glucose ⇒ α-1,4 Glycosidic linkage } Condensation (Dehydration)
α Glucose + α fructose ⇒ Sucrose

1. $C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$

α-1,4 Glycosidic linkage → Glucose + Glucose
$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$ } Hydrolysis.

POLYSACHARIDES: These are long chains of sugars.

Storage:

* Starch * Glycogen.

Structural:

* Cellulose * Chittin.

* Starch:

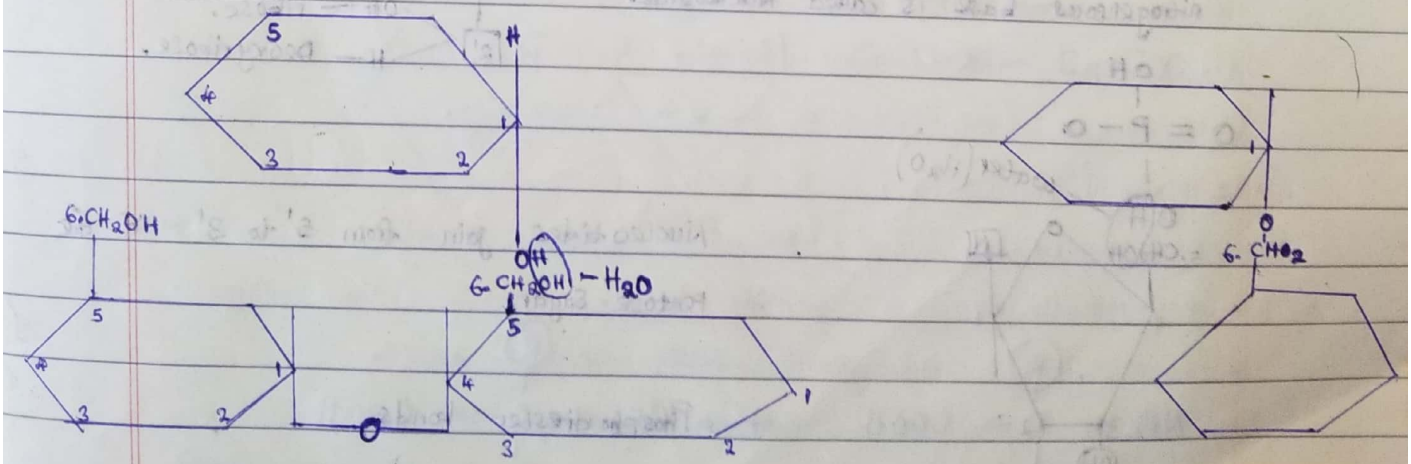
Divided into two i.e ① Amylose ② Amylopectin

① Amylose:

- In any potato, there is 20% of amylose.
- Subunits are linear or unbranched chains.

② Amylopectin:

- 80% in potato starch.
- Highly branched. Because it has α-1,4 & α-1,6 (Two linkages)



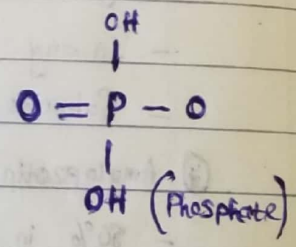
* Glycogen $\alpha-1,4$ & $\alpha-1,6$
- Highly branched

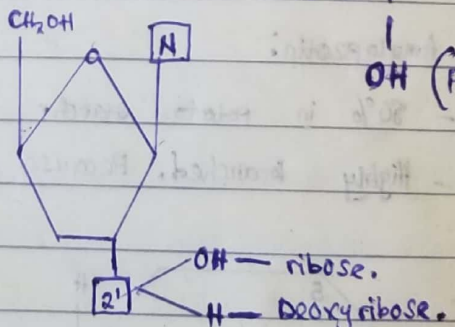
* Cellulose $\beta-1,4$
- Linear.
- Cannot be digested by human beings.

* Chittin
- found in fungi & anthropods / crustaceans.
- Contan $\beta-1,4$ glucose.
- When cross linked with amino acids it forms a tough resistant structure used as the exoskeleton in crustaceans (crabs).

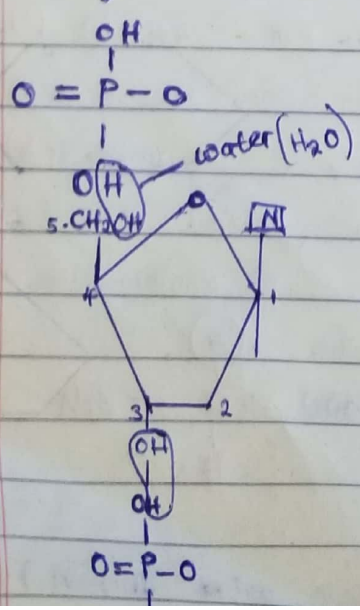
Nucleic acids
- Information carrying molecules. (DNA / RNA)
- Part of inheritance molecules.
- Made up of nucleotides.
- they carry out genetic information that determines the structures and physiological processes in the nature of organisms.

Nucleotides ① made up of of a pentose sugar.
② Nitrogenous base.
③ Phosphate groups.





The combination of a sugar and a nitrogenous base is called Nucleoside.



Nucleotides join from 5' to 3' of the Pentose Sugar.

Phosphodiester bonds.

DNA & RNA

① Nitrogeneous base.

ⓐ Purines : large double ringed molecules found in both RNA & DNA

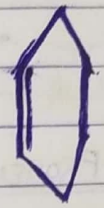
(A) Adenine (B) Guanine (G)

ⓑ Pyrimidines : Smaller single ringed molecules.

ⓐ Cytosine (C) — Both DNA & RNA

ⓑ Thymine (T) — DNA only.

ⓒ Uracil (U) — RNA only.



Base Pairing

G-C
T-A } DNA only (No uracil)

G-C
A-U } RNA only (No Thymine)

CENTRAL DOGMA OF MOLECULAR BIOLOGY

DNA Replication

A T G A A A C T T C G C
T A C T T T G A A G C G ← Copy

Transcription : Converting from DNA to RNA

RNA Replication

T A C T T T G A A G C G
A U G A A A C U U C G C

mRNA (messenger RNA)

Translation : Converting RNA to Proteins.

A U G A A A C U U C G C

methimine lysine

tRNA (transfer RNA)

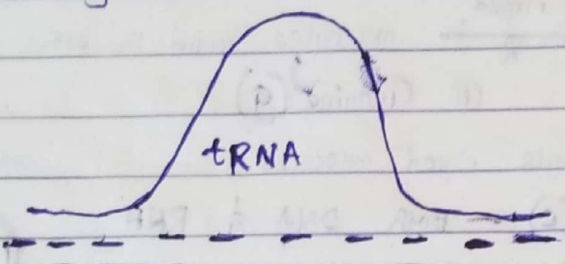
rRNA (Ribosomal RNA)

Replication
Transcription
Translation } Central dogma of molecular Biology.

mRNA brings messages from DNA to Ribosomes during translation.

rRNA is a housing where translation takes place.

tRNA Carry ~~ribosomes~~ amino acids to ribosomes during translation.



PROTEINS

- Made up of 21 essential amino acids. - Contain nitrogen.

functionality:

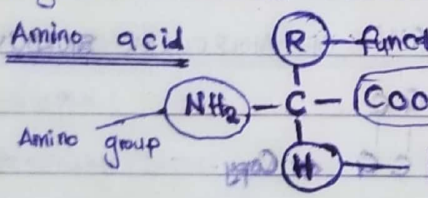
Enzymes: In catalytic processes.

Hormones:

Haemoglobin

- they have NH_2 & COOH on both ends.

Amino acid

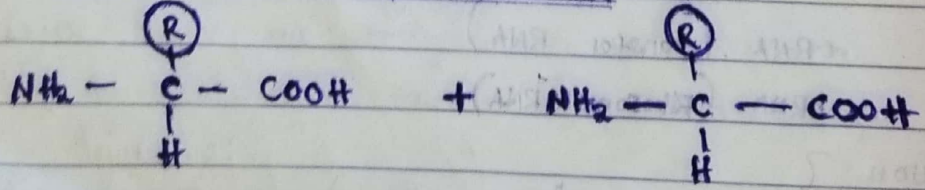


- the functional group gives properties to amino acids.
- functional group determines the charge and the chemistry of amino acid

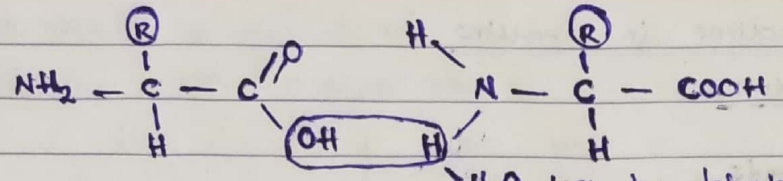
functional Groups

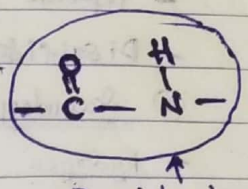
1. Non-polar — R — CH_2 or CH_3.
2. Polar ~~and uncharged~~ — OH.
3. Charged — R — acids / bases.
4. Aromatic (also non polar) — R — Carbon ring.
5. Special function: R - each amino acid in this group has its own properties.

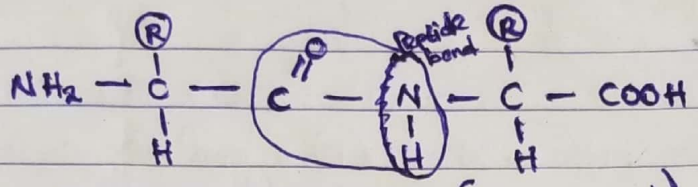
formation of a peptide bond:



Essential amino acids refers to those necessary for construction of proteins in the body.







Strand of amino acids (linear strand)

Levels of protein organization:

① Primary structure:

- Linear strand of amino acids.

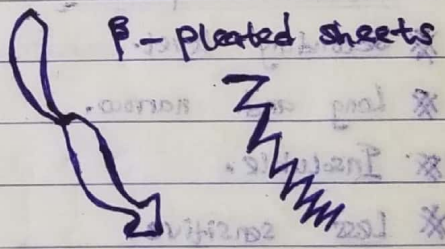
② Secondary structure:

- Amino acids starts to fold.

When they fold, they form α-helix & Beta pleated sheets.

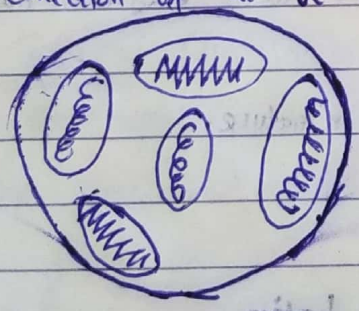
α-helix

β-pleated sheets



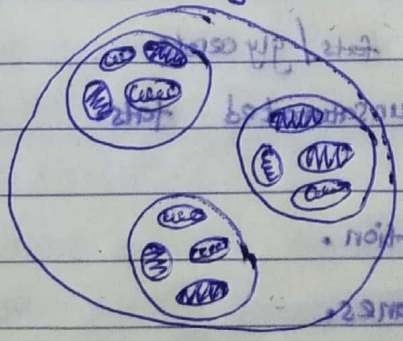
③ Tertiary structure:

- Collection of α-helix and β-pleated sheets.



④ Quaternary structure:

- Collection of tertiary structures.



Bonds / interactions in proteins

① Primary structure.
- Peptide bonds.
- Disulfide bonds.

② Secondary structure.
- hydrogen bonds.
- Peptide bonds.
- Disulphfide bonds.

③ Tertiary structure and Quartenary structures.
- Hydrophobic.
- hydrogen bonds.
- Ionic bonds.
- Van der waals bonds.
- Disulpide bonds.

fibrous proteins:
* Secondary level.
* Long and narrow.
* Insoluble.
* Less sensitive.
* Structural in nature e.g fibrin, keratin, actin, Elastin.

Globular proteins:
* Tertiary and Quartenary level.
* Rounded and spherical.
* Soluble.
* More sensitive.
* Examples are Enzymes, haemoglobin, Insulin,
* functional in nature.

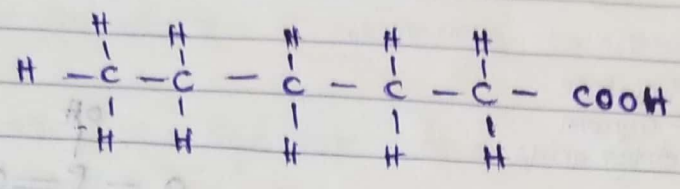
LIPIDS:
- Hydrophobic in nature. (non-polar): Water hating.
- Store more energy in their C-C bonds than sugars.
- Excess sugars are converted to fats / glycerols.
- They are divided into saturated & unsaturated fats.

functions:
- Shock absorbers.
- Thermal regulation.
- Insulation.
- Form membranes.

Types of lipids: (i) Phospholipids (ii) fats and oils (triacylglycerol & fatty acids. triglycerides). (iii) Steroids (cholestrol) (iv)

(1) Saturated (storage) fats:

- All the bonds are filled.



- Hydrolysis of fats gives rise to fatty acids and glycerol.
- Hydrogenation hardens the fats.

Examples:

(1.) Essential fats: found around vital organs e.g brain, nerve cells.
- Play major role in hormone regulation eg hormones that regulate fertility, vitamin absorption and temperature regulation.

(2.) Sub cutanous fats: found under the skin.
- For insulation and temperature regulation.

(3) Visceral fats (belly fats): Stored in the abdomen.
- found around major organs: liver, heart, kidneys, intestine and pancreas.
- They play a major role in separating the organ. (Ensures that there is some distance between parts and organs of the body).

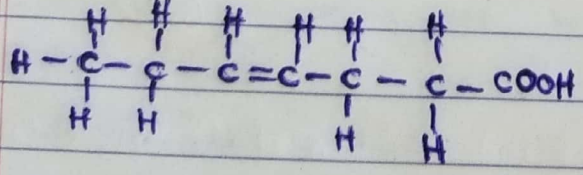
(2) Unsaturated fats:

- Contain a double bonds in their carbon - carbon bond.

Types:

(1) Monounsaturated fats.

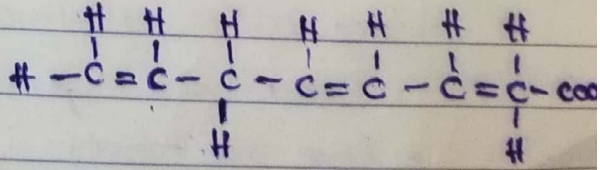
- One C=C bond.



- Low melting point.

(2) Polyunsaturated fats.

- Many C=C bonds.



- Very low melting point.

Classification of lipids.

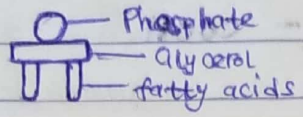
1. Glycerolipids:

- Presence of a sugar.
- Contain bulk storage of animal fat.
- Mostly found in nature as triglycerides.

2. Glycerophospholipids:

* Phosphate * Glycerol * fatty acids

- used in the formation of membranes.



MICROSCOPY

- This is a field that deals with different types of microscopes.
- Microscope is a device

- Magnification is the ratio of an image to object.

Magnification = $\frac{\text{image}}{\text{object}}$ Ratio = $\frac{100}{20}$ = X5

- Total magnification: this is a product of the ocular lenses and the objective lenses.
- Resolution: this is the minimum distance that distinguishes the separation of closely located objects. Also known as Resolving power

Resolution = $\frac{0.5\lambda}{NA}$ where NA is the ability of a microscope to bend light passing through it. (Numerical Aparture) Also ⇒ n sin θ.

⇒ The shorter the wavelength the greater the resolution.

⇒ The greater the resolution the greater the magnification.

CATEGORIES OF MICROSCOPY

1. Light microscopy.
2. Non-Light & microscopy.
3. Electron microscopy.

1. LIGHT MICROSCOPY: uses visible light.

* Have a bright field: Dark image against bright background
* Dark field: Bright image against dark background.

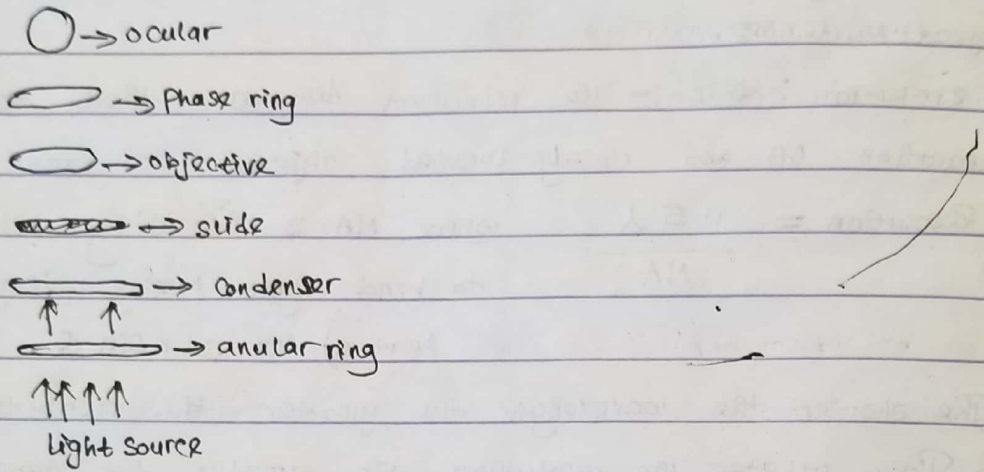
- used to view prokaryotes because it contains stained samples.
- The importance of dark and light field is to improve visibility or contrast.

* Differencial interference contrast (DIC)

- Uses two beams magnified from one source.
- Uses prisms.
- Creates an image by detecting different refractive indices.

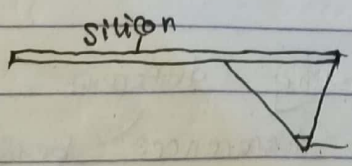
* Phase contrast: Introduces phase differences between parts of the

light so as to enhance the outlines of the sample.
- Used to view unstained specimen.
- Used to study live organisms.
- It uses an annular ring and a phase ring.
- The undeviated light will strike the phase ring and the deviated light will miss the phase plate.



* Confocal Scanning laser microscope.
- Uses laser.
- Thick samples.
- One or more lasers illuminate on one plane of focus at a time and an image is recorded.
- A complete image is constructed by combining all the captured img

2. NON- LIGHT (PROBES)
- They have high resolution.
(a) Atomic force microscope.
- Views the specimens at molecular or Atomic level.
- It uses a stylus metal with a diamond tip.
- Uses contact probing which moves the diamond tip back and forth.
-



⑥ Scanning Tunneling microscope.

- Uses an ultrafine tungsten tip.
- There is no contact
- It contains an electron cloud that interacts with the surface of the specimen.
- Used to view specimens at molecular level and atomic level.

3. ELECTRON MICROSCOPE:

- An electron source.
- Scan system.
- Lens system.
- Detector.
- Highest resolution.

Stages: how they work

TEM
Transmission
Scanning Electron
microscope

SEM
Scanning Elec
Microscope.

GENETICS

- Heredity and variation → characteristics
  ↓
  Inheritance
- GENE: Short sequence of DNA that codes for a specific protein.
- ALLELES: Variants of genes/ an expression of a gene.

Gene	Allele
- Codes for a specific protein.	- Express themselves in terms of colour, eye colour, hair type.
- A gene can have one or more alleles.	- Responsible for diverse features.

Dominance:

Expression: over powers other alleles.

* For dominance, we use capital e.g B for ~~blank~~ black.

Types of dominance:

1. Co-dominance:

- Both alleles express themselves.
- When both alleles of a pair are expressed, resulting into both traits visible in an organism.

Example

Black chicken cross or interbreeds with a white chicken when both are dominant, results in a checkered chicken.

	W	W
B	BW	BW
B	BW	BW

2. Incomplete dominance:

- Dominant allele masks the effects of a recessive allele, but not completely.

Eg White Black

WW WW

↘ ↙

Ww

MENDELIAN GENETICS:

- A branch of biology that deals with biological characters (traits) and their inheritance pattern.

⁂ Hybridization : Crossing of two organisms which are genetically different in order to get a hybrid.

- A technique that measures the degree of genetic similarly between pools of DNA.
- Used to determine the genetic factors / distances between the two organisms.

Laws of Mendel

(1) Law of segregation: individual organism carry pairs of alleles for each trait. When an organism makes gametes, each gamete recieves only one allele (gene). Also known as Monohybrid trait.

(2) Law of independent assortment: Seperate genes for seperate traits are passed independently of one another from parents to offsprings. The genes should not affect each other as they are passed from parents to offsprings. Also known as a Di-hybrid trait / cross.

Father × Mother

Tt Bb × Tt Bb

	TB	tb
TB	TT BB ①	Tt Bb #①
tb	Tt Bb #②	tt bb ①

3:1 → Phenotype

1:2:1 → Genotype

Dominant gene refers to the genes responsible for the expression of the dominant character.

Recessive gene refers to the genes responsible for the expression of the recessive character.

MENDEL'S EXPERIMENT

- Pea experiment:

→ Round – Yellow × Wrinkled – Green

RR YY × rr yy

Phenotype → RY RY × ry ry

	ry	ry
RY	Rr Yy	Rr Yy
RY	Rr Yy	Rr Yy

F_1 Generation (Progeny)

Rr Yy × Rr Yy

Round – Yellow

	Y	y
R	RY	Ry
r	rY	ry

	RY	Ry	rY	ry
RY	RRYY ①*	RRYy ②*	RrYY ③*	RrYy ④*
Ry	RRYy ⑤*	RRyy ①#	RrYy ④*	Rryy ③#
rY	RrYY ⑥*	RrYy ⑧**	rrYY ①	rrYy ②
ry	RrYy ⑦*	Rryy ②#	rrYy ③	rryy

rryy → Wrinkled – green

9 : 3 : 3 : 1

9 : Round – Yellow

3 : Round – Green

3 : Wrinkled – Green

1 : Wrinkled – Green

LETHAL GENES

- Cause death to organisms that carry them.
- They are expressed in recessive form.
- They are usually as a result of inheritance / mutation.
- They impair the biochemical function of organisms.
- If expressed it kills immediately or after birth.

Eg 1. Cystic fibrosis: affects the nerve cells, lungs, sweat glands.
2. Sickle cell anaemia: Affects the red blood cells
3. Tay sachs diseases: Affects the brain cells
4. Huntingtons: Symptoms progress until death. (it affects the Vertebral Column.)

TAXONOMY

- Field of biology that deals with identification, describing, naming and classifying organisms.
- Nomenclature / naming: the process of assigning names to organisms.

Why do we assign names to organism?

- To avoid descriptive features. (to avoid describing that organism)
- Aids communication in science.
- Acts Names act as terms of reference.

Rules for Naming Organisms: (scientific name)

⇒ Genus name & Species name. (Taxons)

⇒ Typing: Italicised. ⇒ Handwritten: Underlined.

⇒ A Genum name should start with a capital and a species name should start with a small letter.

TAXONOMIC RANKS : TAXONS : HIERACHY

- A group of organisms that are classified as a unit in a taxonomic rank / hierachy.

Eg : Bees (Carpenter)

Domain → Eukarya.
Kingdom → Animal.
Phylum → Anthropoda.
Class → Insecta
Order → Hymenoptera
Family
Genus → Zylocopa
Species → Virginica

∴ Zylocopa virginica.

Domain	
Kingdom	King
Phylum	Phillip
Class	Came
Order	Over
Family	For
Genus	Good
Species	Soup

Specie: A group of organisms that are capable of interbreeding and produce viable offsprings.

↳ Continuity;

- Fertile gametes
- Fertilizing / forming Zygotes.

Biological Species Concept: ~~states that~~ refers to a concept a group of populations whose members are capable of interbreeding successifully and are ~~reproductive~~ reproductivly isolated from other groups.

Reproductive isolations: The inability of species to interbreed successfully with related species due to geographical, behavioural, physiological and genetic barriers

* If they do, they reproduce offsprings that are not viable and also ~~sterile~~ sterile offspring.

Types / ~~Examples~~ of Reproductive isolations:

1. Prezygotic isolation:

- Mechanical isolation: Copilation occurs but transfer of sperms does not take place.
- Temporal isolation: No mating because they are active at different times / seasons.

2. Post Zygotic isolation.

- Gamatic incompatibility: Gamete transfer occurs but no fertilization
- Hybrid breakdown: F_1 generation will survive but F_2 will not survive and will be inviable.

Problems in applying the Biological Species Concept: (BSC)

1. Single - celled Organisms: Because they reproduce asexually. (Cloning).
2. Variations.
3. Production of ~~big~~ hybrids; inviable hybrids / Not reproduce at all.

- General features
- Types
- How it is used
- Advantages & disadvantages.

Use elimination method to come up with a particular name.

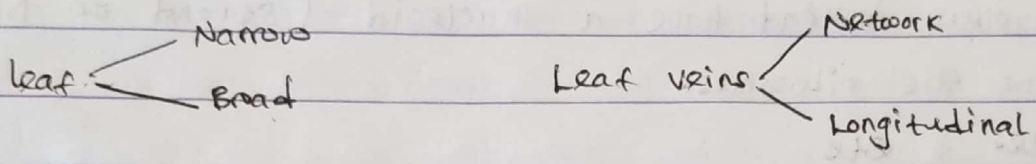
TAXONOMIC KEYS (BIOLOGICAL KEYS)

→ How they are used.

Characters – observable features.

Parts of organisms

Character state: Alternate parts of a character.



⇒ These are keys used to assign names to organism under study.

Couplets contains numbers.

Two types of keys:

1. Dichotomous (ii) Polyclave: Many options & it is easily computerized.

1. Dichotomous key has two options and very simple/easy.

-

DIVERSITY OF ORGANISMS

- Eukaryotes (fungi, animals — invertebrates / vertebrates, protists, plants)
- Prokaryotes (Archea, Bacteria).

PROKARYOTES

- These are organisms with a primitive nucleas.
- No nucleus instead have a nucleoid (strand of DNA).
- Contains 70s ribosomes.
- Capsule. etc

(i) ARCHEA.

- No peptidoglycan.
- More related to eukaryotes than bacteria.
- Lives in extreme environment.

Classification:

(1) Extreme halophiles: Salt loving organisms.

- They live in very (extreme) saline environment.
- They survive such environment because they synthesize osmoprotectants (compatible solutes).
- These balance the internal and external osmotic pressure by making the two solutions isotonic.
- And they also survive because of the presence of potassium.

The other name for halophiles is Crenarcheota.

(2) Methanogens (Euryarcheota)

- They produce methane.
- They are anaerobic.
- Found in fish ponds, termines, ruminants.
- Breakdown cellulose from plant materials.
- They use ammonium ions (NH_4^+) as source of energy.
- They produce methane from H and CO_2.

(3) Extreme thermophiles (Karacheota)

- Found in extreme ~~hot~~ hot environments. like hotsprings.
- They contain ~~extremozymes~~. extremozymes.

- They survive that because of their chemical composition.
- Ethers are present which contain the hydroxyl group.
- Metabolise Sulpher and mostly anaerobic.

(ii) BACTERIA:

Type ⇒ *Cyanobacteria. ~~*True bacteria.~~

⇒ Sometimes called Blue-green algae.

⇒ They contain phycobilins and chlorophyl (a).

⇒ Photosynthetic bacteria.

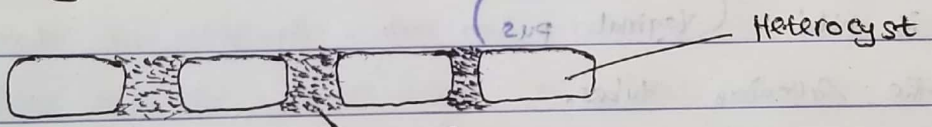
(i) Phycoerythrin (red).
(ii) Phycocyanin (green). } Phycobilins (types)

⇒ ~~Autotrophic bacteria~~. (they produce their own food).

⇒ Commonly found in ponds, lakes, moist soils, swimming pools, woodland floors.

⇒ They exist as chains in filamentous form.

⇒ They are also buoyant.



Mucilagenous sheath:

- Made up of carbohyphates
- Sticky substance that binds the cells together.

Heterocyst:

- No Chlorophyll.
- Phycobilins
- Nitrogen fixation.

HABs:

- Harmful Algae Blooms
- When they form clusters they produce toxins.

1. Hepatoxins — liver
2. Dermatoxins — skin
3. Neurotoxins — Brain

Type ✱ TRUE BACTERIA (COMMON BACTERIA)

Classification:

(1) Cell wall composition (G+ or G-)

(2) Modes of feeding (Autotrophic and heterotrophic).

Autotrophic ⇒ Make their own food.

Chemohet ✱ Chemoautotrophs: Contain elements nitrogen and sulpher.

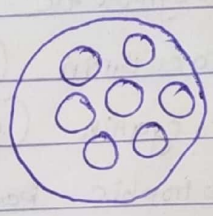
Heterotrophic ⇒ Depend on other organisms for survival.

✱ Hologoic ▮ meaning they depend on dead organisms.

✱ Parasitic meaning they cause harm to the host.

(3) According to shape:

(i) ⇒ Coccus (spherical or round in shape)



- Form chains (Streptococci)
- Form clusters (Staphlococci)
- In pairs (Diblococci)

Example of coccus bacteria is Gonorrhea caused by N. Gonococcal.

- Sexually transmitted diseases (STI)

✱ Affects the urethra (urethral infection)

- Pus.
- In women it mild (vaginal pus)
- It affects the fallopian tubes.
- For ~~man~~ men it attacks the ~~epip~~ epididymis leading to ~~if~~ infertility.
- Gonococcal conjuctivitis.

(ii) ⇒ Bacillus (rod shaped without flagella)

- Causes Anthrax.

(iii) ⇒ Vibrios (comma shaped or kidney shaped)

- Flagella on one end.
- They cause Cholera. (water borne disease caused by ~~chot~~ vibrio cholera)
- Severe diarrhoea: - Affects water absorption in the intestines.

~~Vibrios~~

Spirals

- Affects the Bowels (structures that absorb water from food)
- Produces toxins which affect the Bowels - outpouring of water into the intestine.

(iv) ⇒ Spirals (corkscrew)

Spirillum	Spirochaetes
- Rigid spiral structure	- flexible spiral bacteria
- Has a flagella on both sides	- Endoflagella
- Mostly aquatic	- Found inside bodies of organisms.
- Campylobacter (Campylobacteriosis)	- Treponemal pallidum

Example of Spiral bacteria is Syphilis.

SYPHILIS

- Sexually transmitted infection.

Stages:

(1) Primary stage:

- Single sore / multiple where infections occured.
- Sores are usually firm and round.
- Sore last for 3-6 weeks and heals without treatment.

(2) Secondary stage:

- Skin rash, sores in the mouth, vagina or anus.
- Can also be on the palms / bottom of the feet.
- Rash may not itch.

(3) Latent stage:

- You can carry the syphilis for 10-30 years without any symptom.

(4) Tertiary stage:

- This stage affects the heart and, blood vessels & the brain (nervous system)

(1) Neurosyphilis (Brain) (2) Ocular Syphilis (Eyes) (3) Oto syphilis (Ears)

(v) Filamentous
- Cells do not seperate.
- They cause NoCardosis.

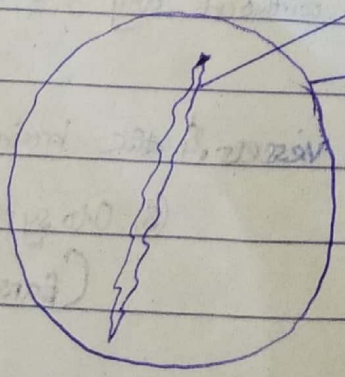
(vi) Stacked bacteria
- Create extentions of cell woall.
- Harmless.

(vii) Budding bacteria.
- Harmless.
- They are budding bacteria because of the reproduction type.
- Reproduce by budding.

Economic importance of bacteria

VIRUSES

- Neither prokaryotes nor eukaryotes.
- No classification system.
- Refered to as particles because they cannot replicate on their own (they need a host)
- They are not cells. (they lack protoplasm)
- No ribosomes.
- No metabolism.
- They can either be RNA viruses (single stranded.), DNA viruses (mostly double stranded.) or retroviruses.
- They have spikes / attachment proteins.



The virus can either be:
- linear
- Circular

} Single or double stranded.

Functions of the protein coat:

- To protect the viral genome.
- Attachment to host cells.
- Packages the enzimes that are responsible for replication.

* A virus can also be termed as virion or virulence.

⇒ Some viruses contain a lipid bilayer.

⇒ Host specific / tissue specific eg:

1. Bacteriophage (Bacteria)
2. Mycovirus (fungi)

SUBVIRAL PARTICLES

- Smaller than viruses.

Prions	Viroid
- Infects animals.	- Infects plants.
- No genetic material	- No protein coat
- Proteins (Beta & alpha)	- Genetic material.

MECHANISM OF VIRAL INFECTION

1. Lytic cycle: It kills the host cell.
2. Lysogenic cycles: The cell survives.

LYTIC	LYSOGENIC
1. Attachment (Binding): uses spikes.	1. Attachment (Binding): uses spikes.
2. Penetration (fusion): Injection of nucleic acid.	2. Penetration (fussion): Injection of nucleic acid.
3. Synthesis (replication): Making many copies of its viral genome and aminoacids	3. Integration: Viral DNA becomes part of the host DNA.
4. Assembly: Viral genome and viral protein assemble into immature viruses.	4. Propagation:
5. Release:	- Viral genome will be present in each divisions.
- New viruses emmerge.	5. Induction: Waiting for a suitable environment

Viral diseases:

(1) Small pox
(2) Chicken pox
} Caused by a double stranded RNA.

(3) HIV – Retrovirus

- Contain reverse transcriptase.
- Sexually transmitted diseases (infections)
- Sex, Sharing sharp objects.

* Targets the immune system.

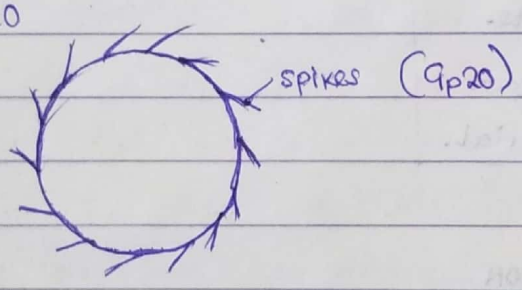
Symptoms

- Swelling of the lymph nodes.
- Night sweats, muscle aches, fatigue, mouth ulcers.

HIV cycle

(1) Attachment:

- GP20



(2) Penetration:

- Facilitated by endocytosis.

(3) Synthesis

- Reverse transcriptase converts HIV RNA to DNA.
- Integration: Integraze enzymes allows HIV DNA to integrate into the host DNA.
- Replication: HN makes copies of its DNA, Proteins and RNA.

(4) Assembly: HIV proteins and RNA move to the surface of the cell membrane, where they are assembled into immature viruses.

(5) Release:

- Mature viruses emmerge.

COVID-19 (SARS - COV- 2)

* Severe Acute Respiratory Syndrome.

- Targets the respiratory system.

Symptoms:

- Severe flu, cough, loss of taste or smell.
- Difficulty in breathing.
- Severe fatigue.

Stages:

(1) Attachment : Spikes (glycoprotein spikes)

(2) Penetration : facilitated by spikes and the fusion protein.

- ACE 2 is cut so that the fusion protein is attached.
- Facilitated by endocytosis (RNA is injected)
- Recognizes the RNA as its own.
- uses polymerase and ribosomes to produce more copies of RNA or proteins.

(3) Assembly: RNA or proteins move to the surface of the cell membrane where they are assembled into immature viruses.

(4) Release:

- Mature viruses emmerge.

Eukaryotes

(1) Protists:

- Lack cell specialization or organization.
- Single - celled./ multicellular specialization.
- Asexually and sexually.
- Mostly found both in water, dump places and the bodies or organisms.
- Heterotrophic and autotrophics.

Common protists

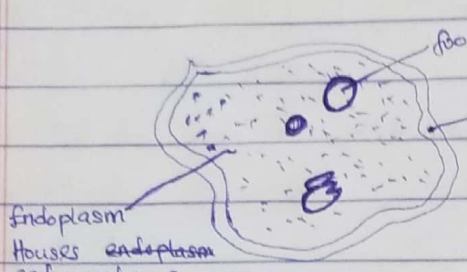
(1) Animal like protists:

- Have features similar to those of animals.

* Sarcordinas - Amoeba

- Pseudopod (podia) - false foot.

- They have a flexible cell membrane.



food vacuoles:

- Contains digestive enzymes.
- food is digested.

Contractile vacuoles:

- Osmoregulation.
- Pump out water from the amoeba.

Poor Conditions:

- They for cysts. (hard protective ~~tissues~~ layer)

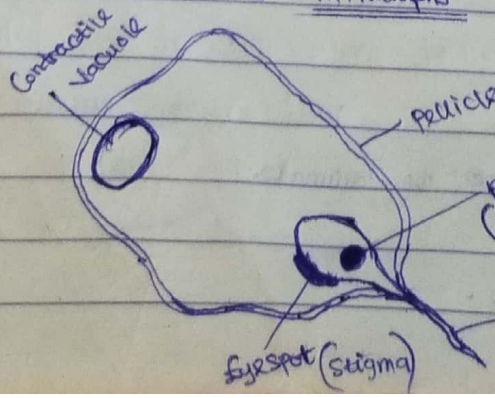
In humans, they cause amoebic dysentry.

Zoo flagellata: mastigophora

- They move with the aid of a flagella.
- Mostly found in fresh water, saline water
- Mostly parasitic.
- E.g euglena.

Euglena:

- Either heterotrophic or autotrophic.
- They contain Chlorophyll. (stored in the pyrenoids).
- The sugar formed is known as paramylon.
- They are called ~~mixed~~ mixotrophs because of the mixed feeding.



eyespot: ~~Detect~~ light

Photoreceptor: Decides whether to move towards light or away from light.

- Light detected by the eyespot is focussed on the paraflagella body which in turn gives direction for propulsion.

Pellicle

- Flexible membrane that supports plasma membrane.
- Microtubules helps to change shape.
- Supports the plasma membrane.

Phylum Sporozoa:

- Form spores.
- They move with the aid of the host organism.
- eg a plasmodium. (parasite): Has two vectors i.e the mosquito and human being
- Both female and male mosquitoes feed on nectar.
- Female need blood because in nectar there is insufficient proteins. (egg formation).

Plasmodium Cycle:

(1). Infected mosquitoes injects the parasite into the blood stream as it feeds. (Because the parasite is found in the salivary glands)
- Infected into the blood stream as sporozoites.

(2) Sporozoites move to the liver.

(3) After 5 to 16 days, sporozoites grow, divide, mature and transforms into thousands of parasites in form of merozoites.

(4) Merozoites move from the liver into the blood stream to attack the ~~already~~ red blood cells.

(5) Merozoites devide asexually producing more merozoites.

(6) Some merozoites in infected blood develop into gametocytes.

(7) When a mosquito bites an infected person they ingest gametocytes.

(8) While in the gut of a mosquito, red blood cells burst to release gametocytes, which further develops to form plasmodium gametes. (male & female)

(9) Male and female gametes fuse to form a zygote called oocyst.

(10) After 5-8 days, the oocyst burst to release active sporozoites in the body cavity of the mosquito.

From there, they go to the salivary glands.

Sporozoites → Blood stream → liver → blood stream (merozoites)

Gametocytes ← asexual reproduction ← red blood cells ← blood stream ↵

↳ Mosquito bite → injest gametocytes → gut → gametes

↓

Salivary gland ← Sporozoites ← oocyst

Importance of Protists:

- Some are disease causing, some are harmless.
- Part of the food chain in the ecosystem.
- Source of commercial products such as caragean.
- Source of medicine.
- Used in research.
- Mineral sources.

FUNGI (CHITIN)

- Either microscopic or macroscopic. → multicellular organisms.
  yiest (single-celled organism)
- Both sexual and asexual reproduction.
- Heterotrophic (No chlorophyll).
- Can be parasitic or holozoic.
- Release enzymes to a substrate.
- Digest food externally and absorb the digested food material.
- Cell division.

* Open mitosis. * Closed mitosis

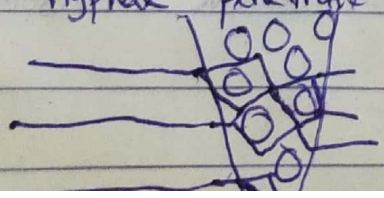
↓ Nuclear membrane breaks. ↓ Nuclear membrane does not break.

* Mycorrhizae

⇒ Mutual / symbiotic relationship between fungi and plant roots.

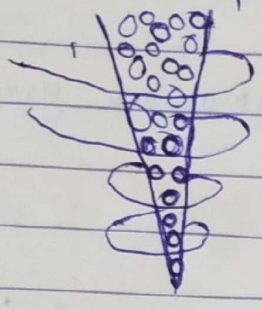
(1) Arbuscular mycorrizae

- Hyphae penetrate through the plant roots.



② Ectomycorrhizae:

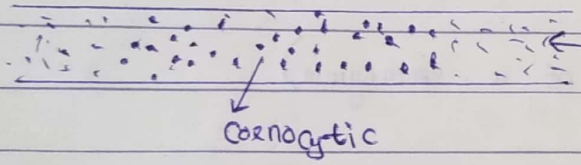
- Go around the plant roots.



TYPES OF FUNGI

① Lower fungi:

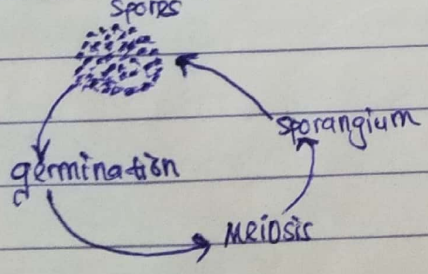
- Unsegmented hyphae / septa (separates the somatic cells from the reproductive structure



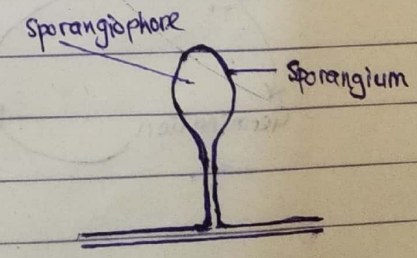
※ Zygomycetes:

- Zygospores.
- Rhizopus.
- Mostly decomposers.
- Both sexual and asexual reproduction.
- They contain unsegmented hyphae.

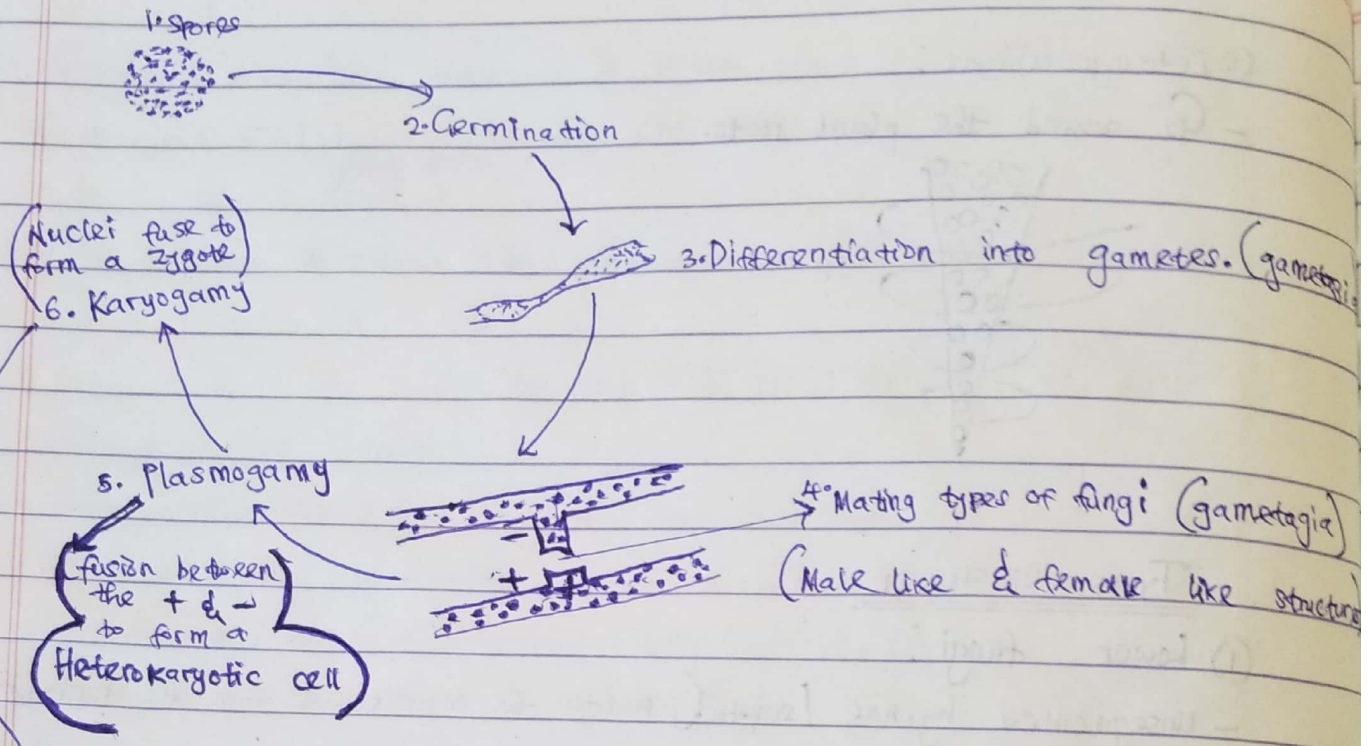
Asexual Reproduction:



Structure of a Rhizopus

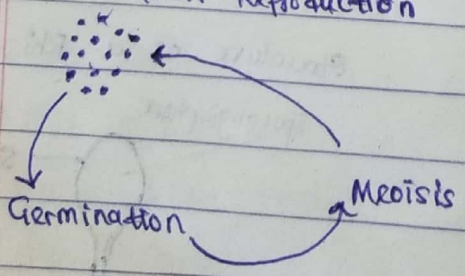


SEXUAL REPRODUCTION (under favourable conditions)



Oomycetes:

- Also called water ~~molds~~ molds.
- Attack plants & fish grills.
- Spores are called zoospores / oospores.
- ~~Sapb~~ Saplozena.



SEXUAL REPRODUCTION

Spores

↓

Germination

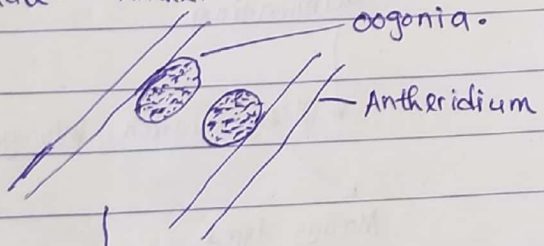
↓

Differentiation into gametogia.

↓

female – oogonia

Male – Antheridium



↓

Plasmogamy – fussion of the plasma membrane cytoplasm.
(Heterogamy)

↓

Karyogamy – Formation of a Zygote.

↓

Meiosis

↓

Release of spores. (Genetically different spores from Parent cells)

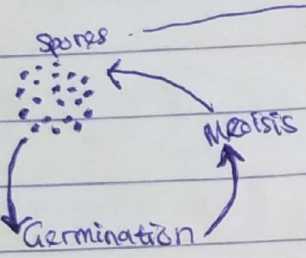
HIGHER FUNGI

- Segmented hyphae. (mushrooms) (Basidiocarps)

① Basidiomycetes:

- Mostly microscopic & parasitic
- They develop a spore bearing structure called basidium.
- Each basidium bears four spores.

* Fruting body is above ground whereas my celia is below the ground.



Germination

↓ Differentiation into gametagia.

Mating types
(+ −)

↓ Plasmogamy (fusing the cytoplasm)

↓ Karyogamy (Formation of a Zygote)

↓ Meiosis

↓ Four spores

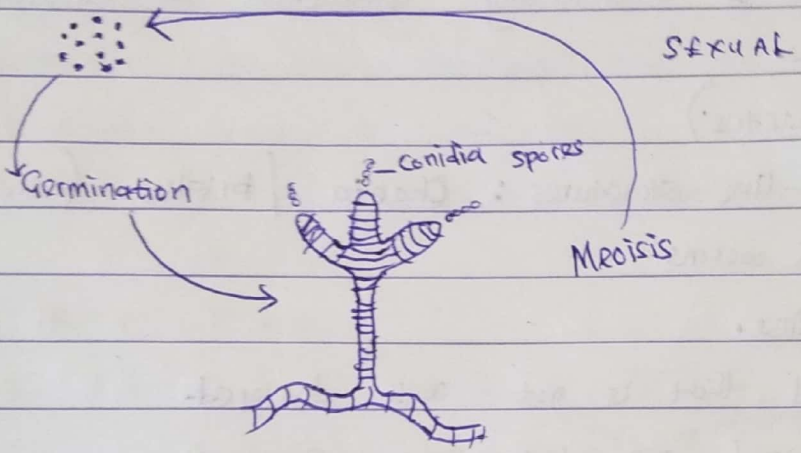
↓ Spores.

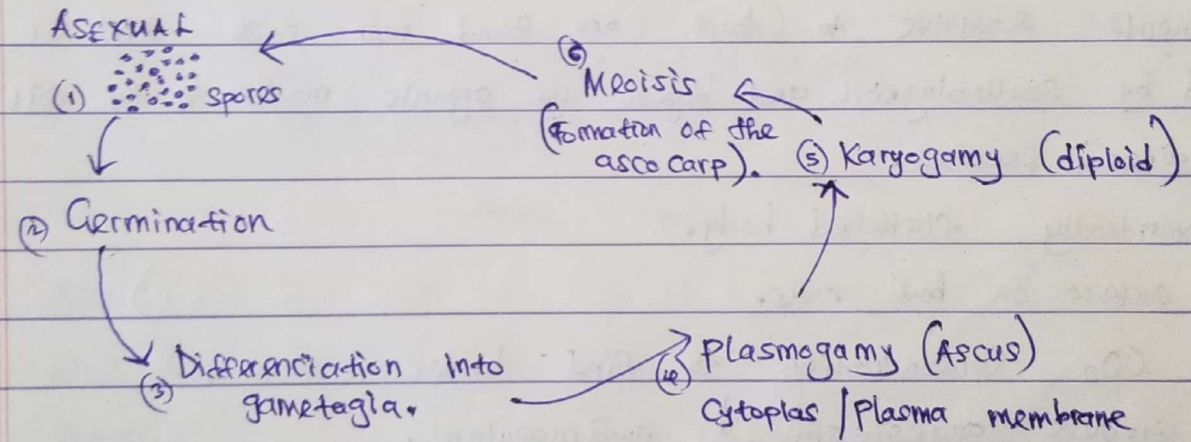
(2) Ascomycetes:

→ Sac like structures known as Ascus.

- Mostly decomposers.
- Segmented septa.
- Both sexual & Asexual.
- They produce Conidia — a sac that bears spores.

Sexual (fragmentation / Budding yiest / Aspergillus).





Ascogamy - female
Antheridium - male

Importance of fungi

1. Medicine — Antibiotics.
2. Food. — Mushrooms.
3. Decomposers.
4. Industry (Brewing / baking).
5. Research.

ANIMALIA:

Divided into two:

(i) Vertebrates (ii) Invertebrates. (have no vertebral column & spinal cord)

Divided into 9 main phyla.

(1) Annelida: segmented worms.

- Mostly marine.
- They have a cylindrical body that appear like a series of rings seperating the segments.
- Move by means of alternating contraction of circular and longitudinal muscles.

(a) Polychaeta (Polychaetes)

- Possess paddle-like structures: Chaeta / bristles. (used for locomotion)

(b) Oligo Chaeta: earth worms

- Fresh water bodies.
- They have a head that is not well developed.
- Possess body comprised of 100 - 175 segments.
- Segments sensitive to touch are found near each end of the worm
- Feed by swallowing soil and digest the organic matter in the soil.

(c) Hirudinea: Leeches.

- Dorsventrally flattened body.
- Have suckers on both ends.
- Uses CO_2 concentration to find hosts.
- They produce anaesthesia & anticoagulant.

(2) Nematoda: Unsegmented worms. (Eg filiard worms that causes Elephantiasis. & Ascaris Lumbricoides.)

- Mostly parasitic.

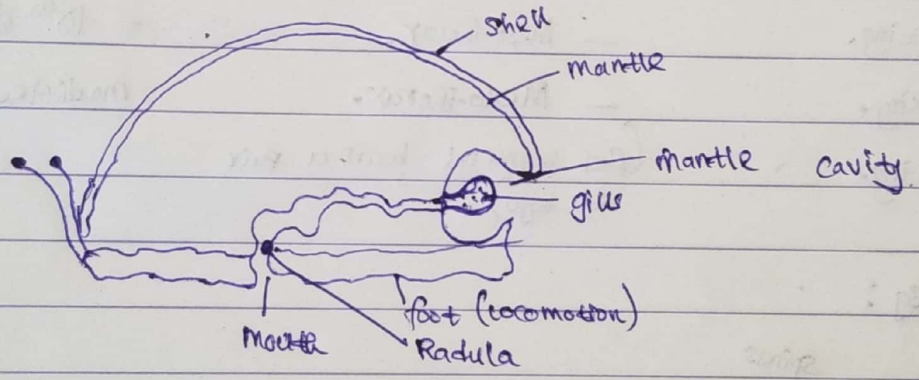
Platyhelminthesis: flat worms.

- Tape worms; blood flukes — Schistosoma
  bilhazia

Life cycle of schistosoma

(1) Cercaria released by the ~~eatt~~ snail. (free swimming in the water).
(2) Penetrate your skin.
(3) Shade off the forked tail and become schistosomulae.
(4) Migrate to the hepatic portal vein and mature into adults.
(5) Paired worms migrate to the mesentric venues of the bowels/ rectum and lay eggs.
(6) Eggs discharged through urine and stool.
(7) Eggs hatch releasing miracidia.
(8) Miracidia penetrates the ~~eatt~~ snail tissue and becomes sporocyst.
(9) Sporocysts change to cercaria.
(10) Released from the snail as cercaria.

(3) Mollusca : Snails.



Shell:
- Head and foot retraction.

Mantle:
- Shell & body cavity.
- Secretes Calcium carbonates that is used in the formation of the shell.

Mantle Cavity:
- Respiratory chamber - gills.
- Pumps water for filter feeding.

Radula:
- used for chewing. - feeding organ with teeth made of Chitin.
- Located inside of the mouth.

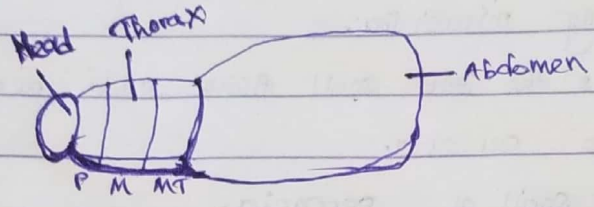
- Predatory molluscs use it to drill holes in shells of prey.

(4) Anthropoda:

- Possess a hard exoskeleton used for muscle attachment.

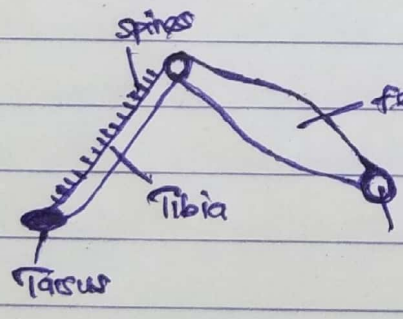
Class Insecta:

- Sometimes called hexapoda.
- Six legs.
- Segmented into head, thorax and domen.



Head:	Thorax	Abdomen
Mouth parts	- Prothorax.	- Contain 11 segments.
- Chewing.	- Mesothorax.	- 10th & 11th segments are
- Sucking.	- Metathorax.	modified.
- Piercing.	(Each segment bears a pair of legs).	

Leg:



Orders: (orders of insects)

- There are 28 orders.

(1) Coleoptera: eg beetles.

- Fore wings are hardened.
- Hind wings are soft and used for flying.

(2) Diptera: eg mosquitoes & houseflies.
- Mouthparts modified into piercing and sucking.
(3) Hymenoptera: eg Bees & wasps.
- Constricted abdomen.
- Their 10th & 11th segments are modified into stings.
(4) Isoptera: eg Termites.
- Some are edible (insoa)
(5) Lepidoptera: eg butterflies and moths.
- Some are edible.
- Harm to fields.
(6) Othoptera: eg grasshoppers.
- Long horned grasshoppers.
- Short horned grasshoppers.
- Mostly edible.
- Cause harm to the field. (eg locusts)