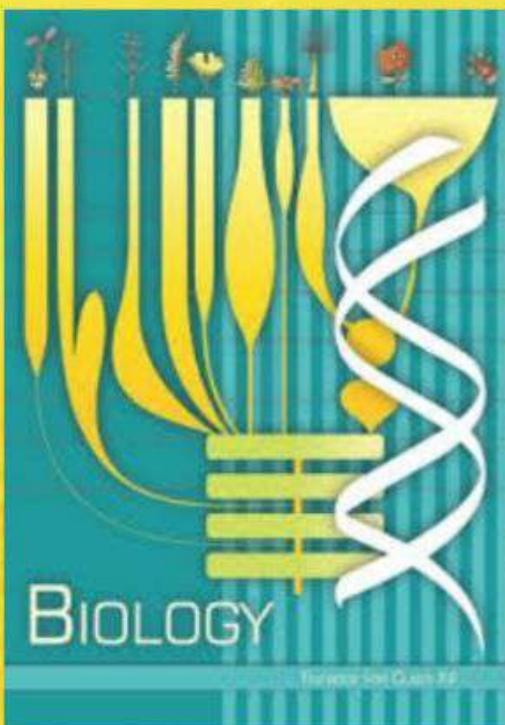


# NCERT-SMASHER

*exclusively for NEET*

- Fully handwritten
- Easiest language
- Flow chart & diagrams
- Totally ncert based
- Ultimate time saver



**Class  
12th (full)**

**: KV eDUCATION**

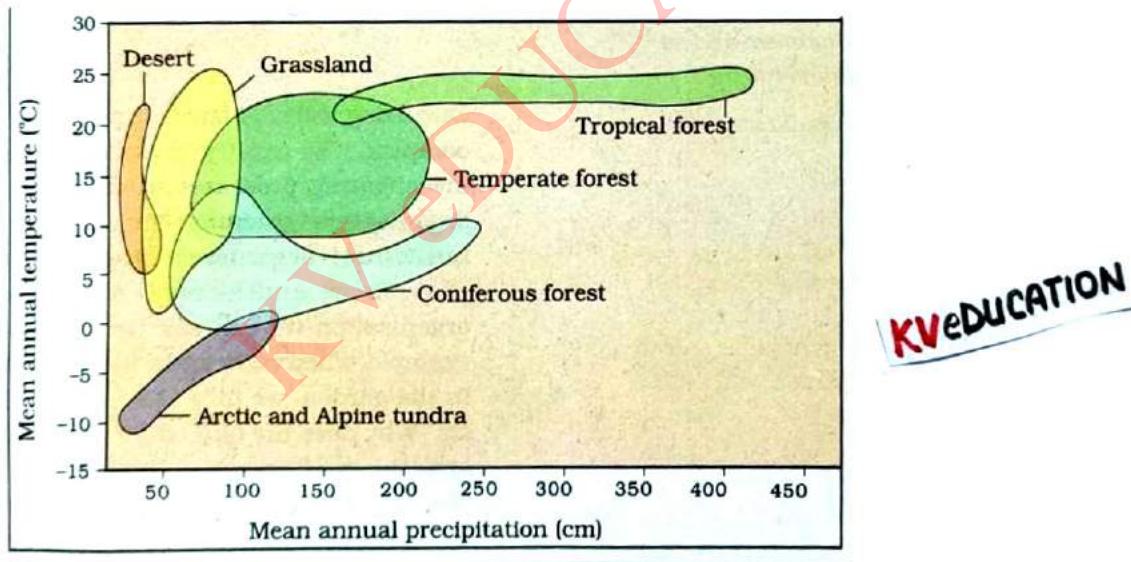
# ORGANISM & POPULATION

## **ECOLOGY**

Deals with the interactions among organisms and b/w the organism and its abiotic envt

Ecologically is basically concerned with 4 levels of biological organisation

- Organisms
- populations
- Communities
- Biomes



## **{NICHE}**

Each organism has an invariably defined range of conditions that it can tolerate, diversity in the resources it utilises and a distinct functional role in ecological system

## MAJOR ABIOTIC FACTORS

Temperature

Water

Light

Soil

KVeducation

## TEMPERATURE

Most **IMPORTANT** ecologically relevant environmental factor

### EURY-THERMAL

Few organisms can tolerate a wide range of temperature

### STENO-THERMAL

Majority of organisms are restricted to narrow range of temperature

Sub-zero

 Polar areas

$>50^\circ\text{C}$

 Tropical desert

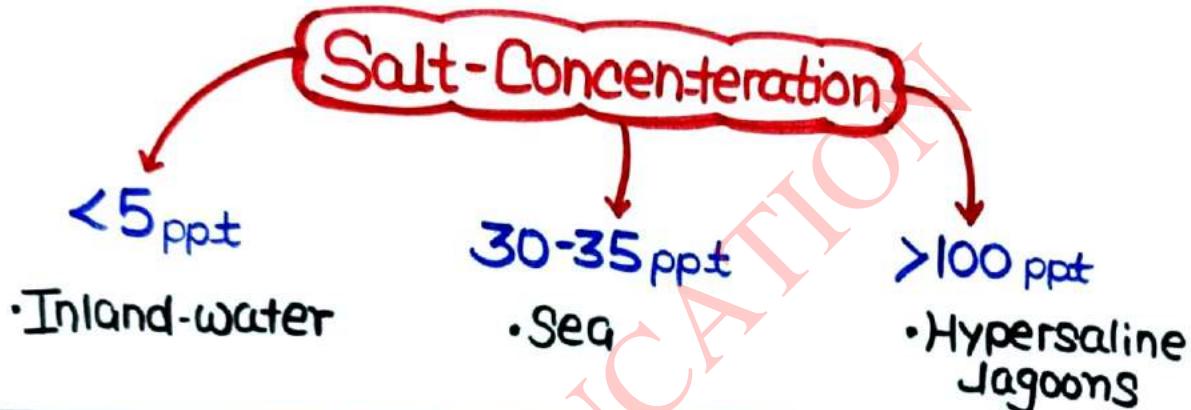
$>100^\circ\text{C}$

 Thermal-Springs and Deep sea hydro-thermal vents

# WATER

- Another most important factor
- Life on earth originated in water
- Life is unsustainable without water

Quality of water [Chemical compn, pH]  
is important



## SALT-CONCENTRATION

### EURY-HALINE

Can tolerate wide  
range of Salinity

### STENO-HALINE

Restricted to narrow  
range of Salinity

# LIGHT

## IMPORTANCE OF LIGHT

Photosynthesis

Photoperiodic requirement  
for flowering

Diurnal & Seasonal variations

# SOIL

## SOIL-CHARACTERISTICS

- Composition
- Grain Size
- Aggregation

determine

Percolation and water holding capacity of Soil

Soil characteristics along with parameters (such as pH, topography, mineral composition)

determine

Vegetation in that area

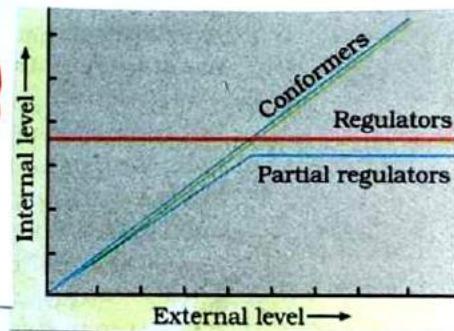
AQUATIC ENVIRONMENT

Sediment Characteristics

Type of benthic animals

## RESPONSE TO ABIOTIC FACTORS

- Regulate
- Conform
- Migrate
- Suspend



## REGULATORS

- Can maintain constant internal environment
- All Birds, All mammals, few lower vertebrates and few invertebrates

## CONFORMERS

- Can not maintain constant internal environment
- 99% of animals and nearly all plants

# Migration

- Organism can move away temporarily from the stressful habitat to more hospitable area and returns when stressful period is over
- example is, Migratory birds from siberia and other cold regions comes to Keolado National park (Bharatpur)

## Suspension

HIBERNATION → Winter sleep → Bears

AESTIVATION → Summer sleep → Some snails, fishes

DIAPAUSE → Stage of suspended development → Zooplankton

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## ADAPTATIONS

### COLDER CLIMATE MAMMALS

Shorter ear & limbs  
(ALLEN'S RULE)

### ALTITUDE - SICKNESS

Low Oxygen → Increased RBC Production

## DESERT-PLANTS

Thick cuticle on leaf

Deep stomata

Leaves  
↓  
Spines

## ARCHAEBACTERIA

Live in HARSH-HABITAT

## BEHAVIOURAL-MEANS

### DESERT LIZARD

Bask in sun, absorb heat

Move into shades when Temp. increases

## AQUATIC-SEAL

Thick fat layer (Blubber)

↓  
Reduce Heat loss

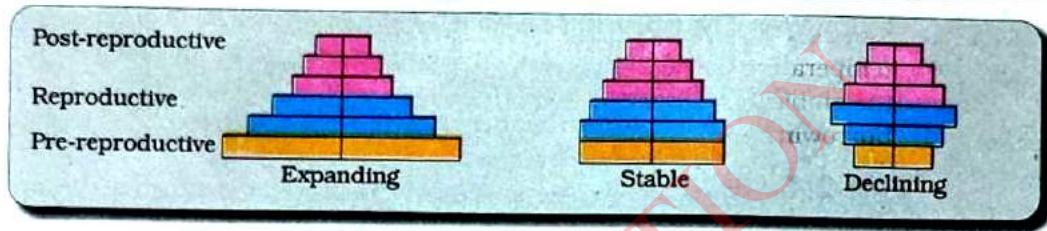
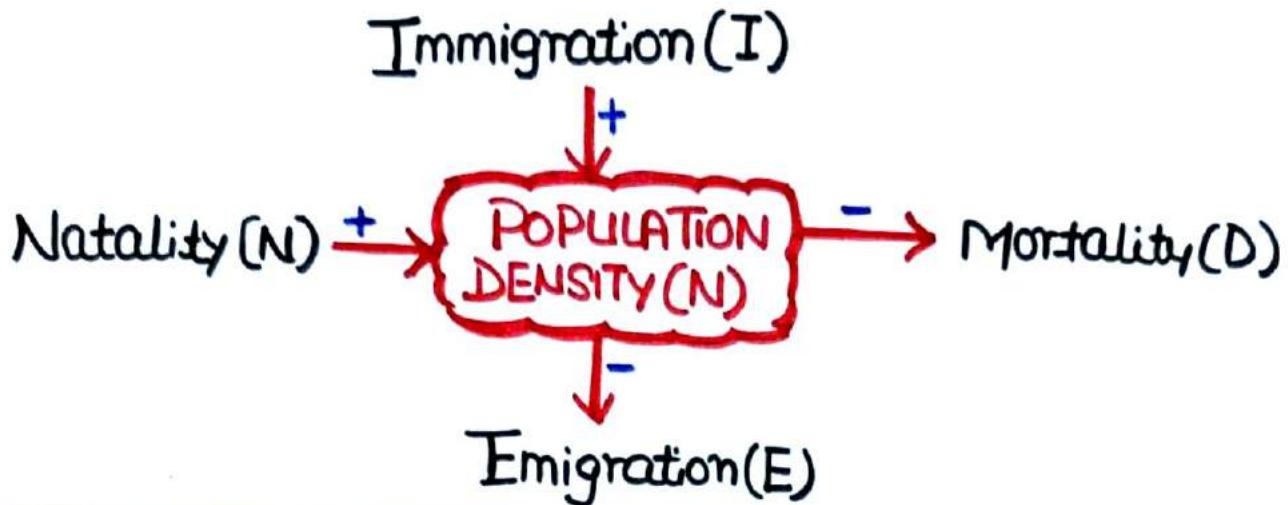
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**NATALITY** :- Number of births during a given period in the population that are added to initial density

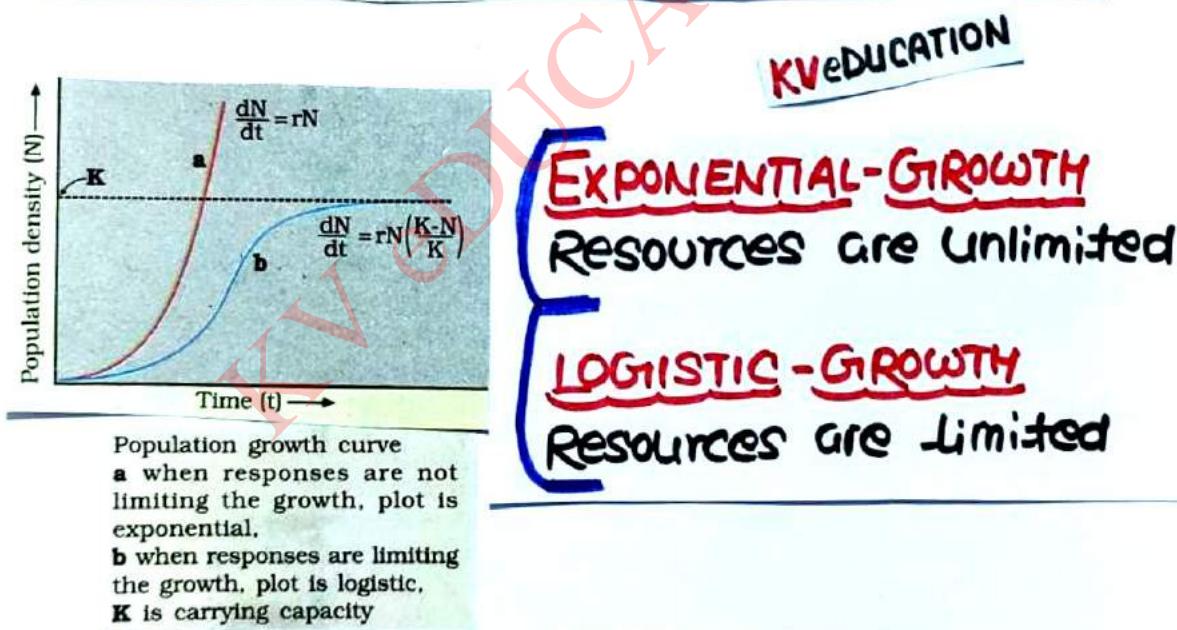
**MORTALITY** :- Number of deaths in the population during a given period

**IMMIGRATION** :- Individuals of same species came from elsewhere during time period

**EMIGRATION** :- Individuals who left the habitat during the time period



**Figure 13.4** Representation of age pyramids for human population



## EXPONENTIAL-GROWTH

$$N_t = N_0 e^{rt}$$

$N_t$  - population density after time  $t$

No. - population density at time zero

$r$  - intrinsic rate of natural increase

e - the base of natural algorithms

## LOGISTIC-GROWTH

$$\frac{dN}{dt} = rN \left[ \frac{K-N}{K} \right]$$

N - population density at time 't'

r - Intrinsic rate of natural increase

K - Carrying capacity

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## POPULATION-INTERACTIONS

INTERACTION	Species A	Species B
MUTUALISM	+	+
COMPETITION	-	-
PREDATION	+	-
PARASITISM	+	-
COMMENSALISM	+	0
AMENSALISM	-	0

## PREDATION



Prickly pear cactus introduced into Australia in early 1920's, it spreads to millions of hectares

Cactus feeding Moth (predator) was introduced to control Cactus

Predators also help in maintaining species diversity in a community

In rocky intertidal communities of American pacific coast the Starfish PISASTER is an important predator

When all the STARFISHES were removed from that area, more than 10 species of Invertebrates became extinct within a year [because of Interspecific comp']

IF predators overexploits its prey

prey might extinct and following if predators also extinct

This is the reason, why predators in nature are prudent (clever)

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## {ANIMALS-DEFENCE (against predators)}

Some species of Insects & Frog show camouflaged to avoid being detected easily

MONARCH-BUTTERFLY [distasteful] because of special chemical present in the body (Butterflies acquires this chemical during its caterpillar stage)

## PLANT-DEFENCE (against predators)

MORPHOLOGICAL & CHEMICAL defence

THORNS (Acacia, Cactus)  
are most common morphological means of defence

Calotropis produce highly poisonous cardiac glycosides (for cattle or goat)

Chemicals like Nicotine, Caffeine, Quinine, Opium,strychnine

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## COMPETITION

Generally believed that competition occurs when closely related species compete for the same resources that are limiting

But this is entirely NOT TRUE

Totally unrelated species could also compete for the same resources

eg. In shallow South American lakes, visiting flamingoes and Resident fishes compete for their common food [zooplankton]

Resources need not be limiting for competition to occur... feeding efficiency of one species might be reduced in presence of other species

Therefore, Competition is best defined as the process in which the fitness of one species is significantly lower in presence of other species

Abingdon tortoise  $\xrightarrow{\text{extinct due to}}$  Goat

Superior barnacles  $\xrightarrow{\text{excludes}}$  Inferior barnacles  
Balanus Chthamalus

### Gause's COMPETITIVE EXCLUSION PRINCIPLE

Two closely related species competing for the same resources can-not co-exist indefinitely and competitively inferior will be eliminated

(This may be true if resources are limiting, not otherwise)

### RESOURCE - PARTITIONING

Mechanism that promote co-existence rather than exclusion

2 species choose different time for feeding or different foraging patterns  
(eg. MacArthur shows 5 species of warblers)

## PARASITISM

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### ECTOPARASITES

Parasites that feed on the external surface of the host organism

Lice on humans

Ticks on dogs

Marine fish &  
ectoparasite  
copepods

Cuscuta [parasitic plant]  
on other plants

## ENDOPARASITES

Those that live inside the host body at different sites [liver, kidney, lungs, RBC]

The life cycle of endoparasites are more complex because of their extreme specialisation

PARASITIC BIRD lays egg in nest of HOST-BIRD

Both the eggs are same in resemblance, so Host bird incubates the egg of parasitic bird

BROOD-PARASITISM [eg. Cuckoo & Crow]

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## COMMENSALISM

Orchid on mango

Barnacle on whale

Cattle egret on Cattle

Sea-anemone on clown fish

## MUTUALISM

LICHEN  
(Fungi & Algae)

MYCORRHIZA  
(Fungi & plants)

PLANT & ANIMAL

FIG & WASP

# -ECOSYSTEM-

## ECOSYSTEM

Functional  
unit of  
Nature

Where living organisms  
interacts with  
surrounding environment

## ECOSYSTEM

Terrestrial → Forest, Desert,  
Grassland

Aquatic → Pond, Lake, River,  
wetland

Man-Made Ecosystem → Crop field, Aquarium

## STRATIFICATION

Vertical distribution of different species  
occupying different level is STRATIFICATION

Tree → Shrub → Herb & grass  
(Top) (2<sup>nd</sup>) (Bottom)

- FOREST -

## COMPONENTS OF ECOSYSTEM

- (i) Productivity
- (ii) Decomposition
- (iii) Energy Flow
- (iv) Nutrient-cycling

### GPP (by photosynthesis)

[Gross prim. productivity]

↓  $R$  (Respiratory loss)

### NPP (Available for consumer)

[Net prim. productivity]

↓ used by consumers

### 2P (produced by consumers)

[Secondary productivity]

### ANNUAL NET PRIMARY PRODUCTIVITY

Whole Biosphere

170 billion tonnes

Oceans (70% area)

55 billion tonnes

## FRAGMENTATION

Breakdown of detritus into smaller particles

## LEACHING

Water soluble inorganic nutrients go down into the soil and get precipitated as unavailable salts

## CATABOLISM

Detritus is converted into simple inorganic substance by action of Bacteria & Fungal enzymes

## HUMIFICATION

Accumulation of dark coloured amorphous substance called HUMUS that is highly resistant to microbial activity

## MINERALISATION

Humus further degraded & release of inorganic nutrients



## PRODUCERS

- All AUTOTROPHS [green plants]
- Also called CONVERTERS/TRANSDUCERS (they converts Solar energy → chemical energy)
- In Aquatic ecosystem, PHYTOPLANKTONS are the major autotrophs

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## CONSUMERS

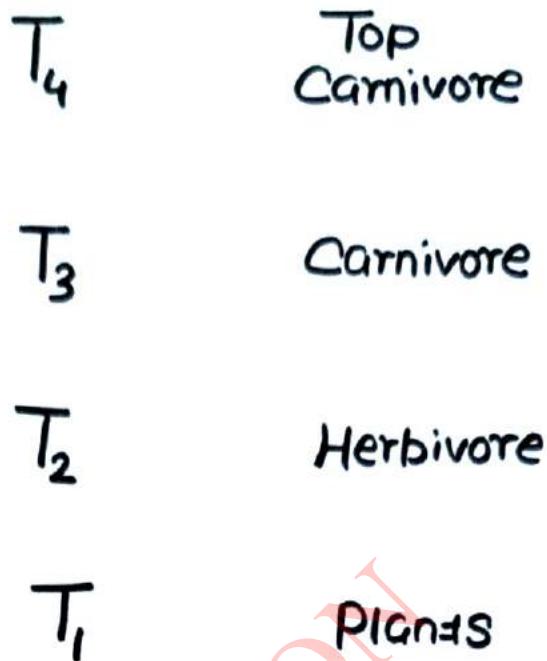
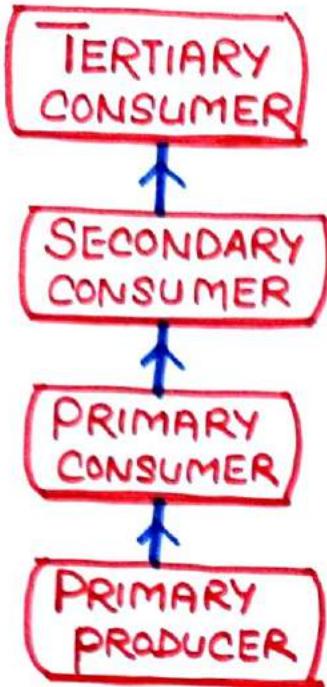
Macro  
Consumer  
(Mostly  
animals)

Micro  
Consumer  
(Decomposers)

## DECOMPOSERS

- Decompose the dead bodies of Producers & consumers
- Mainly BACTERIA & FUNGI

• Bac. & fungi → Release enzymes → Decompose into org. substance → Absorb (OSMOTROPHS)



## TROPHIC LEVELS IN ECOSYSTEM

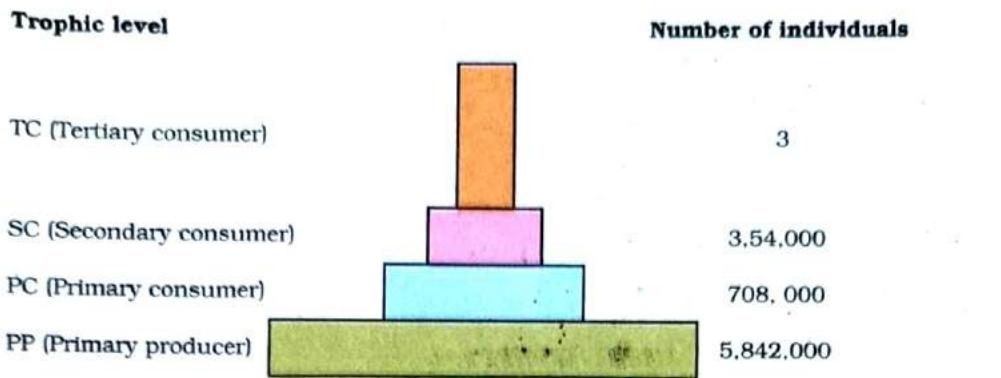
### **CHARACTERISTICS OF FOOD-CHAIN**

- Unidirectional flow of energy
- Shorter food chain  $\rightarrow$  Greater energy
- 10% energy is transferred to each trophic level
- Decomposers not included in food chain

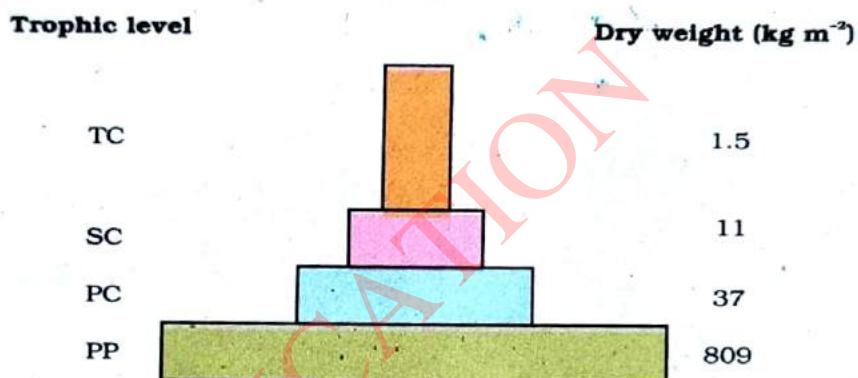
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### **FOOD-WEB**

- \* Many food chains are interlinked
- \* More complex = More permanent Food web & stable

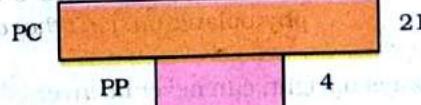


**Figure 14.4 (a)** Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants

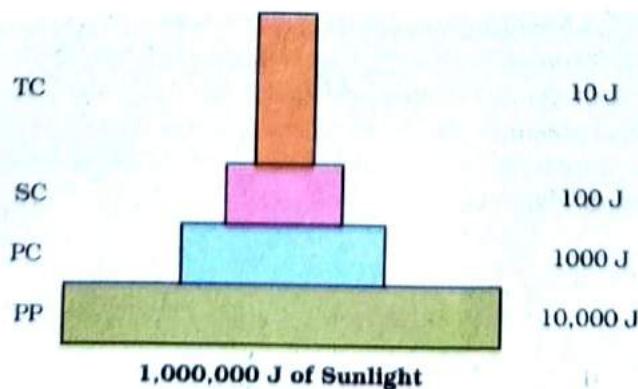


**Figure 14.4 (b)** Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels

248



**Figure 14.4 (c)** Inverted pyramid of biomass-small standing crop of phytoplankton supports large standing crop of zooplankton



**Figure 14.4 (d)** An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

## STANDING-CROP

Each trophic level has a certain mass of living material at a particular time, called as STANDING-STATE

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## STANDING-STATE

Amounts of nutrients (C, N, P, Ca) present in the soil at any given time



## ECOLOGICAL-SUCCESSION

Gradual & fairly predictable changes in the species composition of a given area

**SERE** → Entire sequence of communities that successively change in a given area

## SUCCESSION OF PLANTS

Hydrach  
Succession

Wet area → Mesic conditions

Xerach  
Succession

Dry area → Mesic conditions

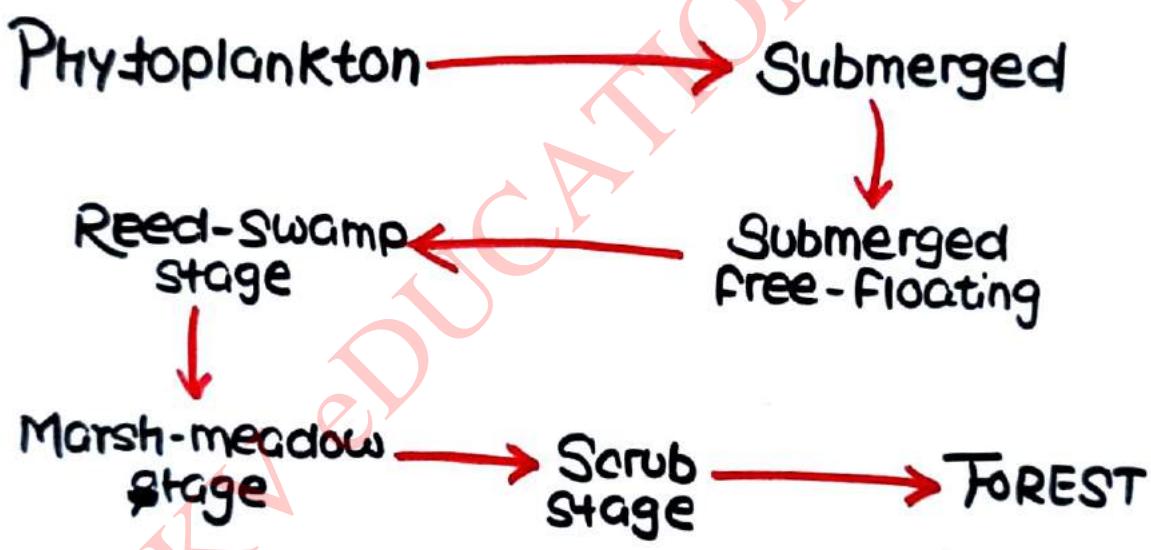
# SUCCESSION

## PRIMARY

- Starts in an area where no living organism are there
- Example - newly cooled lava, bare rock, newly created pond

## SECONDARY

- In area where ~~existing~~ natural biotic communities have been destroyed
- Example - Flooded area, Burnt Forest, Cut Forest  
**(Faster than primary)**



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## NUTRIENT or BIO-GEO CHEMICAL CYCLE

## GASEOUS

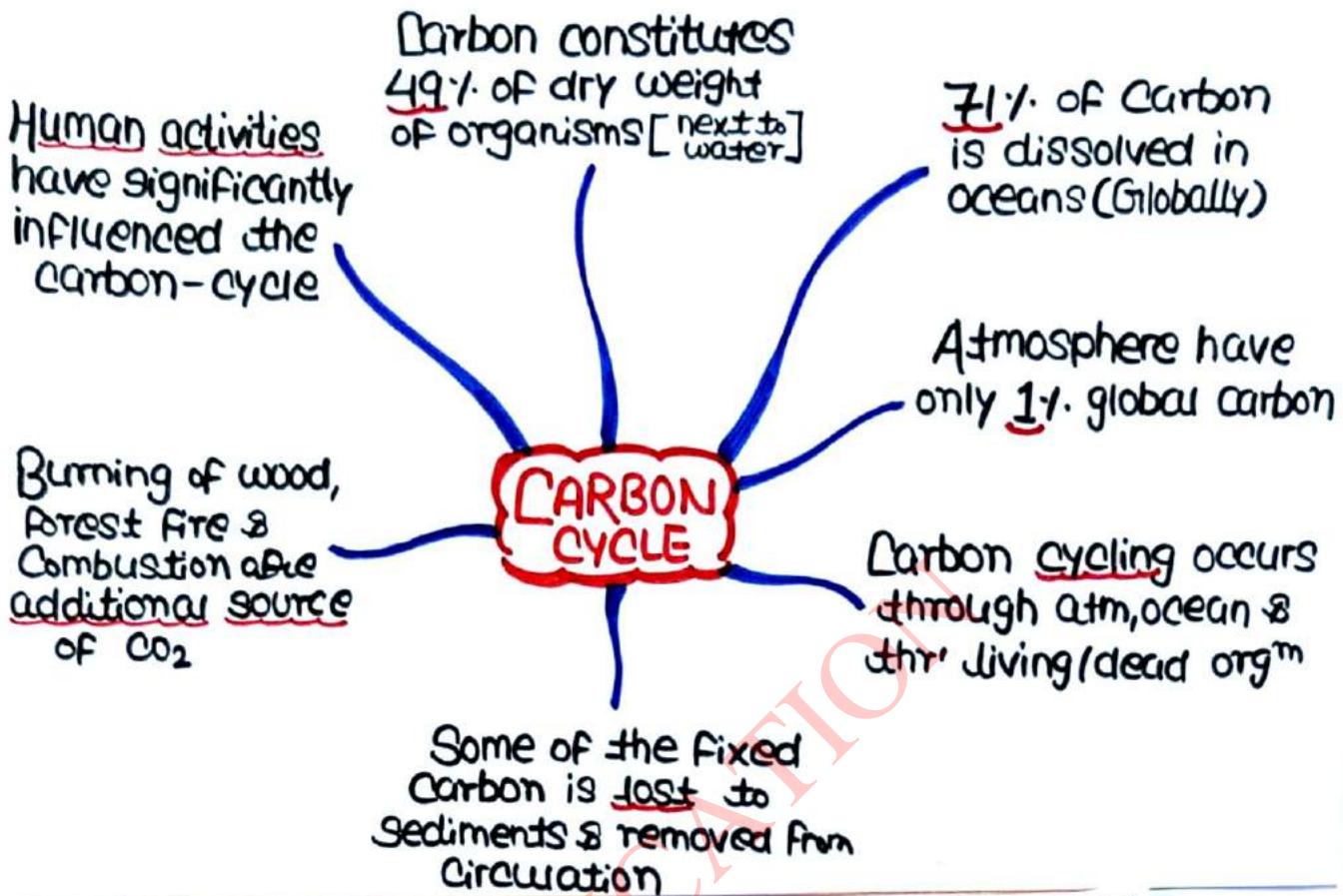
\* Reservoir is ATMOSPHERE

eg. Nitrogen cycle, Carbon cycle

## SEDIMENTARY

\* Reservoir is EARTH-CRUST

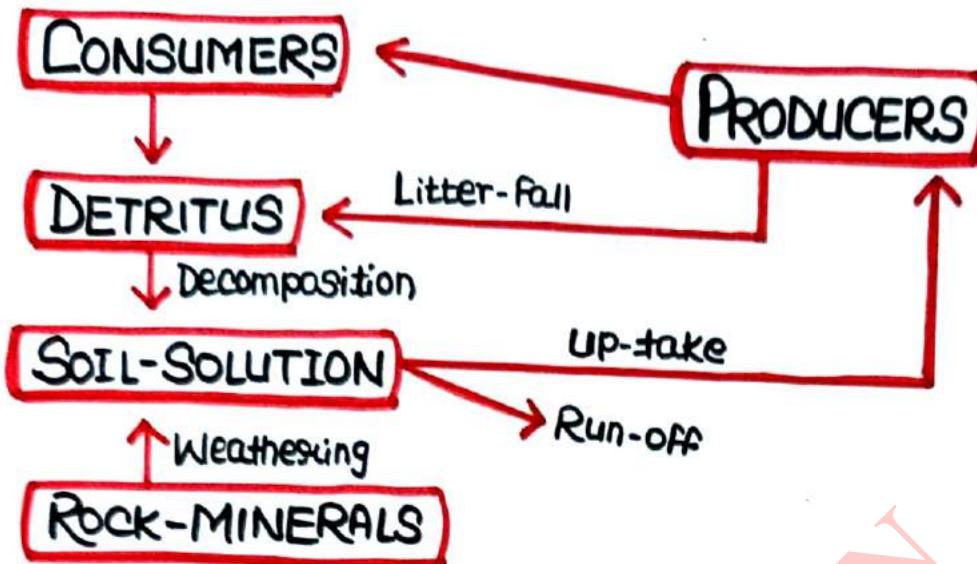
eg. Phosphorus, Sulphur cycle



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## PHOSPHORUS-CYCLE

- Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems
- Many animals also need large quantities of this element to make shells, bones and teeth
- Natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates
- When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants
- Herbivores and other animals obtain this elements from plants
- Waste products and dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus



## :- PHOSPHORUS-CYCLE in TERRESTRIAL ECOSYSTEM :-

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### Ecosystem-Services

Robert Constanza → puts price tags on Nature support → US \$ 33 Trillion/year

**TOTAL COST** → { 50% - Soil formation  
 <10% - Nutrient cycling & Recycling  
 6% - Climate regulation & habitat for wildlife

# BIODIVERSITY & ITS CONSERVATION

## BIODIVERSITY

Term popularised by  
**EDWARD-WILSON**

3,00,000 - Beetles

28,000 - Fishes

20,000 - Ants

20,000 - Orchids

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GENETIC      SPECIES      ECOLOGICAL

### GENETIC-DIVERSITY

- Rauwolfia-vomitoria (chemical-Reserpine)

→ Growing in himalyan ranges, different potency and concentration of different regions

- 50,000 genetically different strains of RICE (India)

- 1,000 varieties of Mango (India)

## SPECIES-DIVERSITY

Western ghats > Eastern ghats  
amphibian species diversity

## ECOLOGICAL-DIVERSITY

- India has greater ecosystem diversity than Norway  
desert, rain forest, mangroves, coral reefs, wetlands, alpine meadows

## TOTAL-SPECIES

IUCN  
\* 1.5 million

Robert May  
\* 7 million

IUCN  $\Rightarrow$  International Union for  
Conservation of nature  
and natural resources

Total Species  $\xrightarrow{70\%}$  Animals  $\xrightarrow{70\%}$  Insects

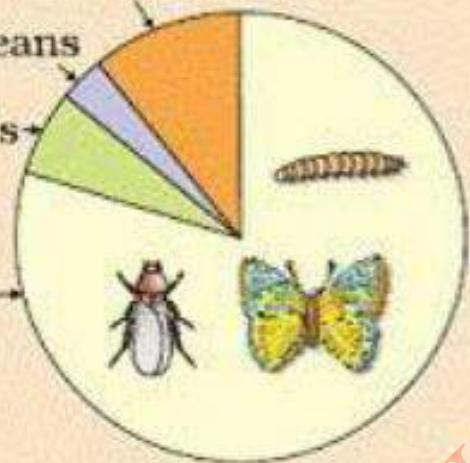
### Invertebrates

Other animal groups

Crustaceans

Molluscs

Insects



### Vertebrates

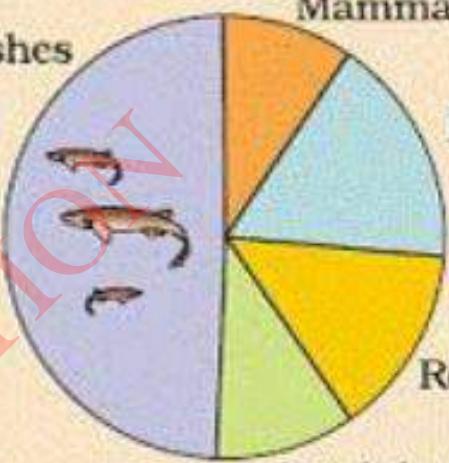
Fishes

Mammals

Birds

Reptiles

Amphibians



### Plants

Fungi

Mosses

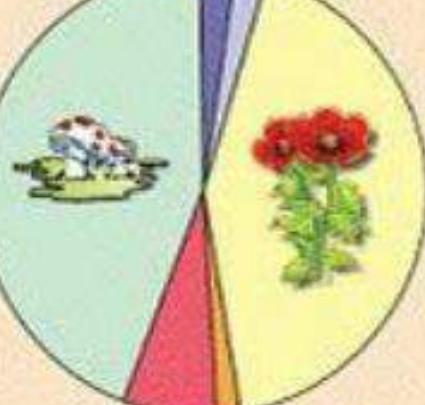
Ferns and allies

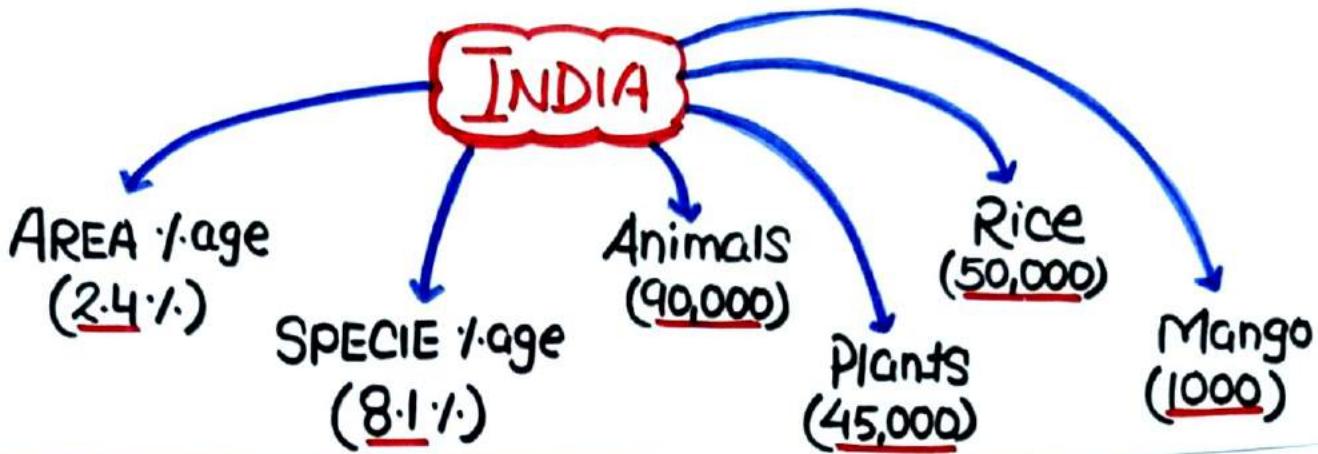
Algae

Lichens

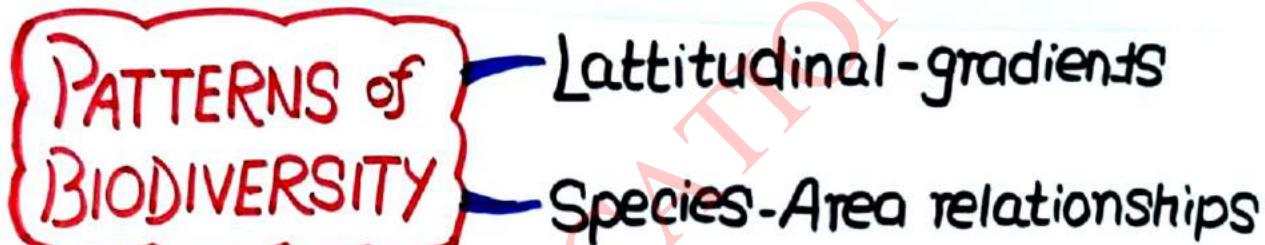
Angiosperms

Fungi

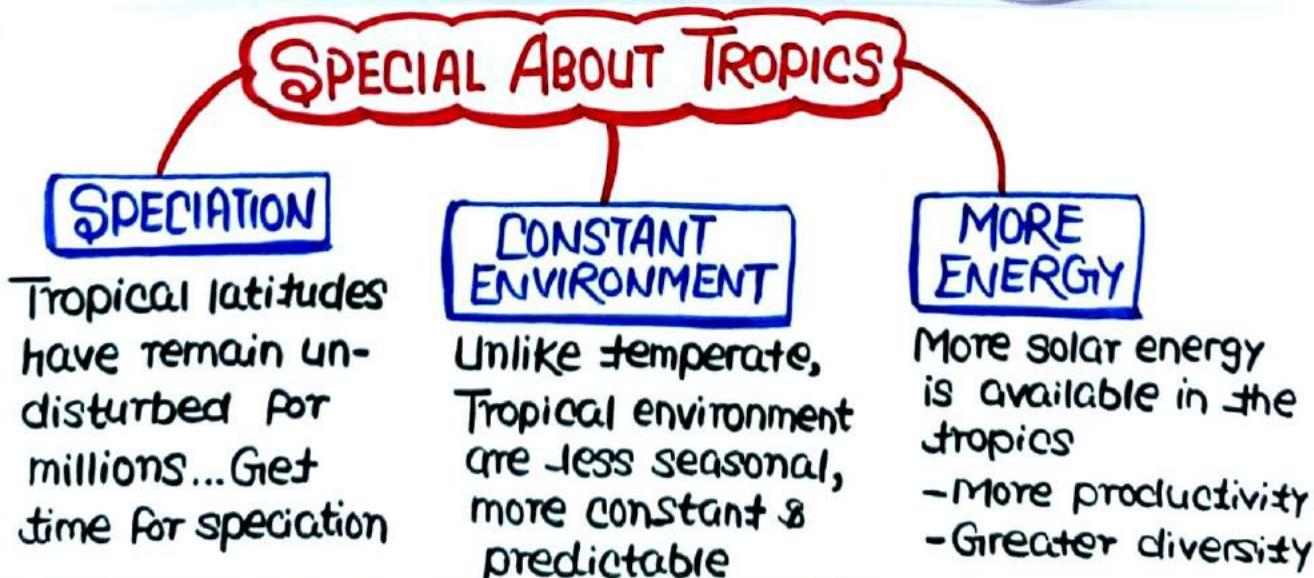




India is among 12 Megadiversity Countries

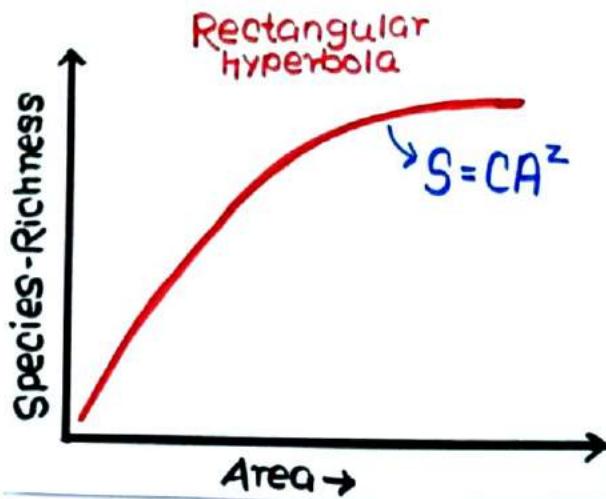


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## SPECIES-AREA RELATIONSHIP

Alexander von Humboldt  
(German)



{ S - Species richness | z - Slope  
 A - Area | c - y-intercept }

AREA  
 $z = 0.1 - 0.2$       { z }  
 VERY  
 LARGE-AREA  
 (entire continents)  
 $z = 0.6 - 1.2$   
 (much steeper)

Frugivores birds  
 and mammals in  
 tropical forests  
 of diff. continents  
 Slope is  
 $1.15$

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## IMPORTANCE OF SPECIES DIVERSITY

More Species = More Stability

## STABILITY

Less year to year variation in productivity

Resistant to disturbances (natural/man-made)

Resistant to alien species invasions

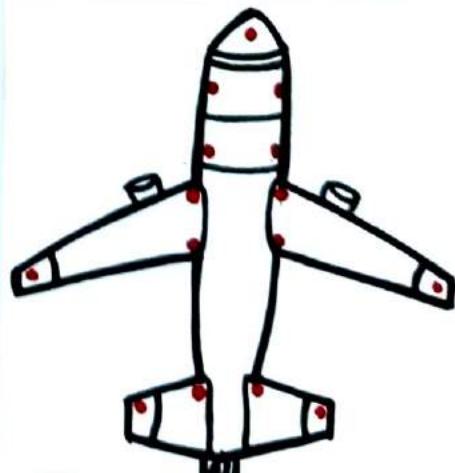
## { DAVID-TILMAN }

Area with more species → Less year to year variation → More productivity

## RIVET-POPPER HYPOTHESIS

Paul-Ehrlich

- Air-Plane - Ecosystem
- Rivets - Species
- Rivets on wings - Important species



## Cause of BIODIVERSITY-LOSS

Habitat-loss & Fragmentation

Over exploitation

Alien species invasions

Co-extinctions

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## HABITAT LOSS & FRAGMENTATION

Most important cause

TROPICAL-RAIN FOREST (ex.)

- past → > 14 %
- present → 6 %

AMAZON RAIN FORESTS  
(Lungs of the planet)

⇒ being cut for cultivating  
Soyabean crop or for  
grasslands for grazing

## OVER-EXPLOITATION

when NEEDS  
turns to GREED

EXTINCTION

- Stellar's sea cow
- passenger pigeon

## ALIEN SPECIES INVASIONS

\* 200 species of  
Cichlid fishes

extinct  
due to

Nile  
perch

[Lake Victoria  
(EAST-AFRICA)]

\* Indigenous ~~extinct~~  
Catfishes ~~due to~~ African  
Catfishes  
(Clarias gariepinus)

Our  
Rivers

\* Native ~~extinct~~  
Species ~~due to~~ Carrat grass (Parthenium)  
Lantana  
water-hyacinth

## Co-EXTINCTIONS

- FISH (obligatory parasite)
- Plant - pollinator mutualism

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>15,500  
(world-wide) → Facing threat  
of extinction

• Colonisation of pacific island (tropical) by humans  
led to extinction of 2000 native species of birds

• Acc. to  
IUCN → 784 species  
extinct  
(last 500 yrs) → • Vertebrate - 338  
• Invertebrate - 359  
• Plants - 87

12.1. of Birds

23.1. of Mammals

32.1. of Amphibians

31.1. of Gymnosperms

facing THREAT  
of extinction

Last 20 yrs → Disappearance of 27 species

Half of all the species might be wiped

→ in Next 100 yrs

## 'Sixth-Extinction' (in progress)

Human-Activities  
Sp. extinction  
100-1000 times fast

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- |                    |  |
|--------------------|--|
| • Dodo (Mauritius) | • Thylacine (Australia)                  |
| • Quagga (Africa)  | • Stellar sea cow (Russia)               |
|                    | • Sub-Sp. of Tiger (Bali, Java, Caspian) |

### Why should we Conserve-Biodiversity

NARROW

- Food, Wood, Fibres, Tannin, Resin, Dyes, Perfumes, Lubricants, Medicine
- (>25% of drug, 25,000 sp. of plants)

BROAD P<sup>2</sup>

- Pollination
- Photosynthesis  
→ 20% of total Oxygen from AMAZON-FOREST

ETHICAL

- Spiritually or philosophically

# BIOPROSPECTING

→ Exploiting molecular, genetic & species-level diversity for products of economic importance

How do we  
CONSERVE-BIODIVERSITY

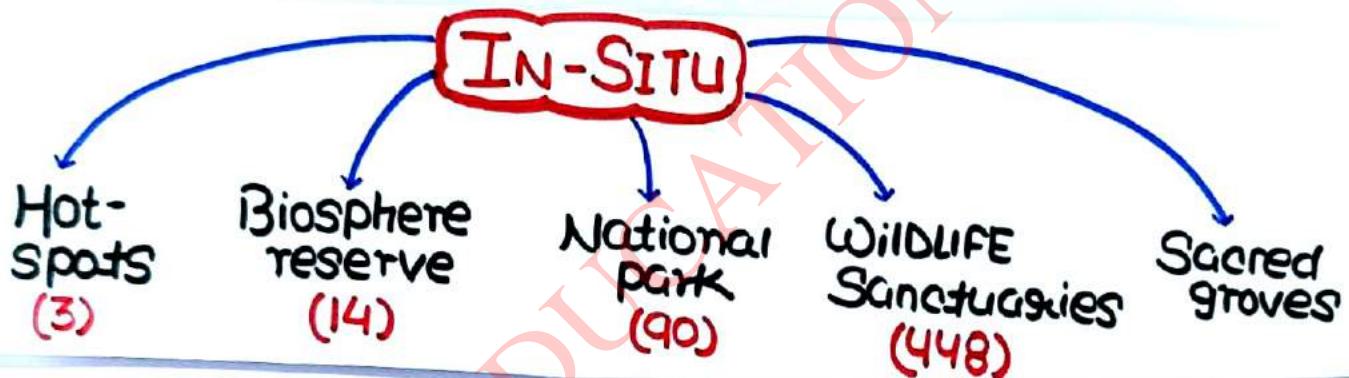
In-Situ

• On-site

Ex-Situ

• Off-site

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WORLD [25→34] , INDIA [3]

Indo-burma, Himalaya, Wes. ghat & Sri-Lanka

Species richness + High degree of ENDEMISM

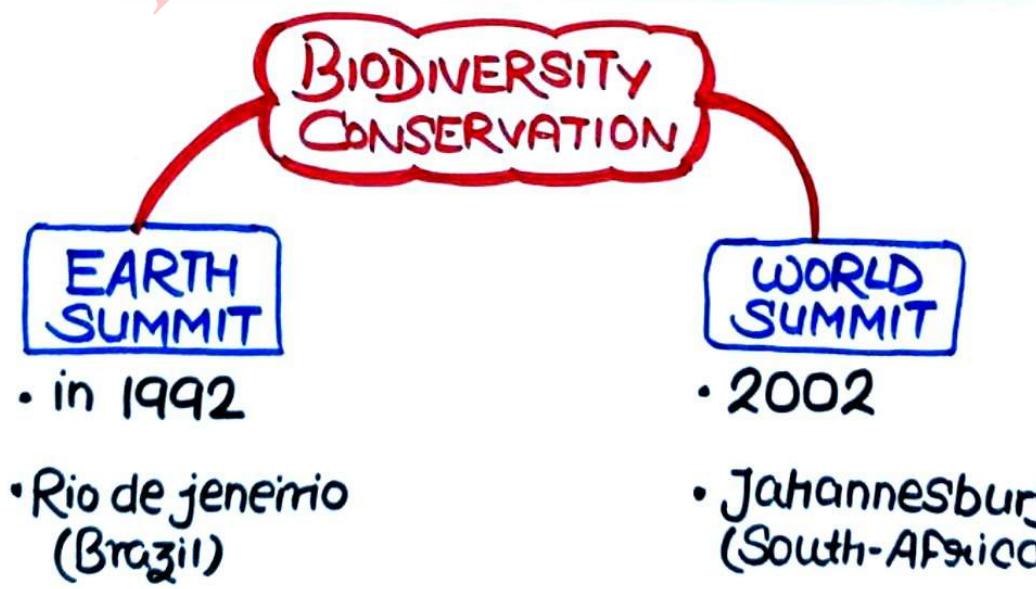
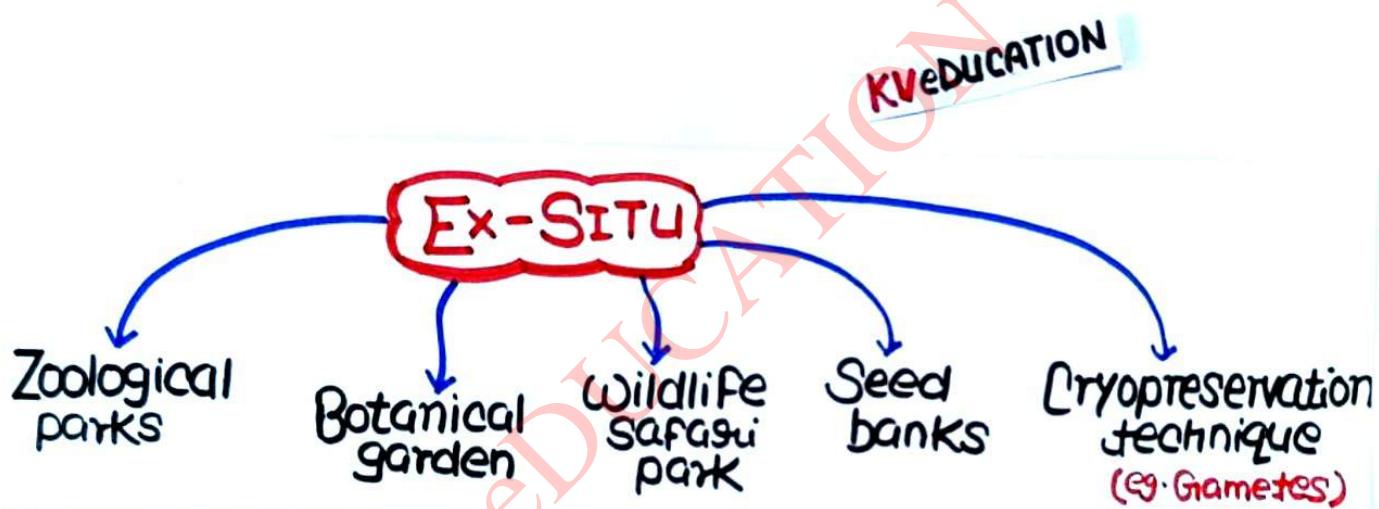
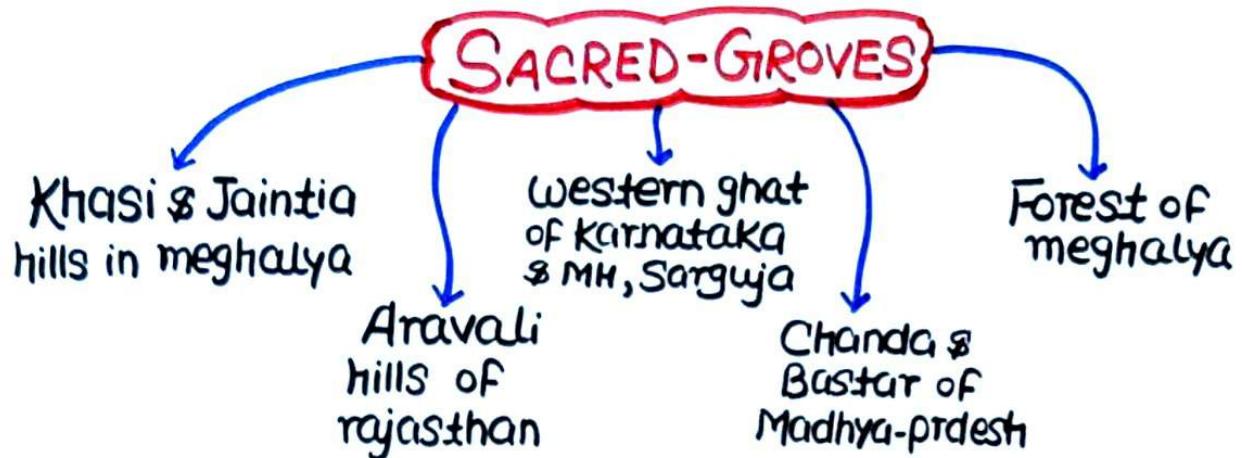
Area coverage only 2% of earth, but species ↑↑

Strict protection can reduce ongoing mass extinction by 30%.

• KAZIRANGA (Assam) — Rhinoceros

• JIM-CORBETT (Uttarakhand) — Tiger

• GIIR NATIONAL PARK (Guj.) — Lion



# ENVIRONMENTAL - ISSUES

- Environment act - 1986
- Air pollution act - 1981
- Water poll<sup>n</sup> act - 1974
- Sound poll<sup>n</sup> → Air poll<sup>n</sup> - 1987
- CNG buses (delhi) - 2002
- Chipko movement - 1974
- JFM - 1980
- National Forest policy - 1988
- Amritा devi bishnoi - 1731
- MONTREAL PROTOCOL { Signed - 1987  
Effective - 1989 }

## AIR-POLLUTION

- Type of Air pollutants
- Control of Air pollution
- Ozone
- Green house effect
- Smog
- Case study

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## AIR-POLLUTANTS

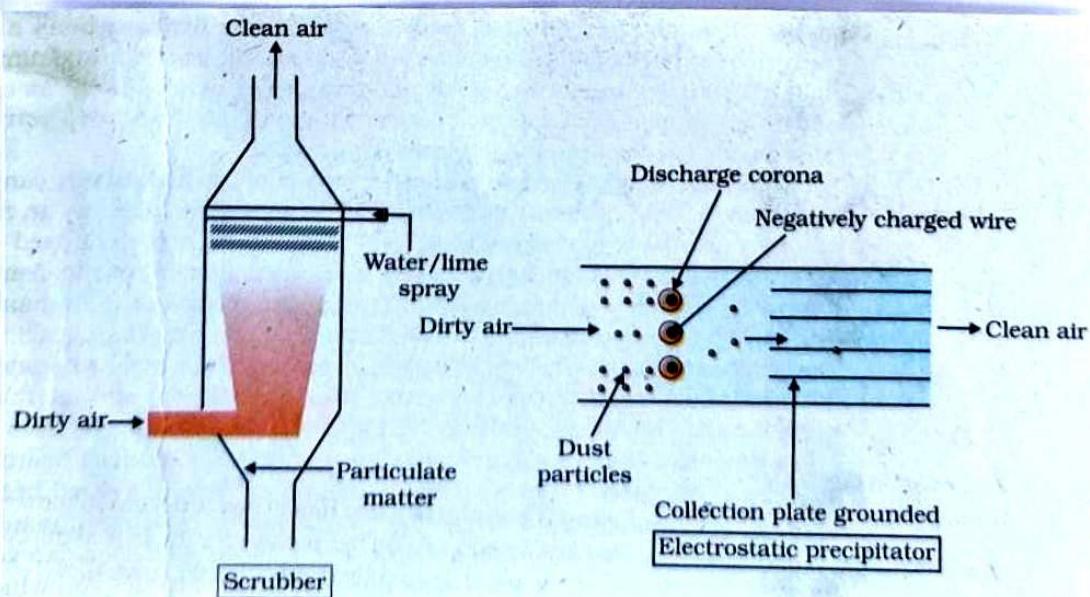
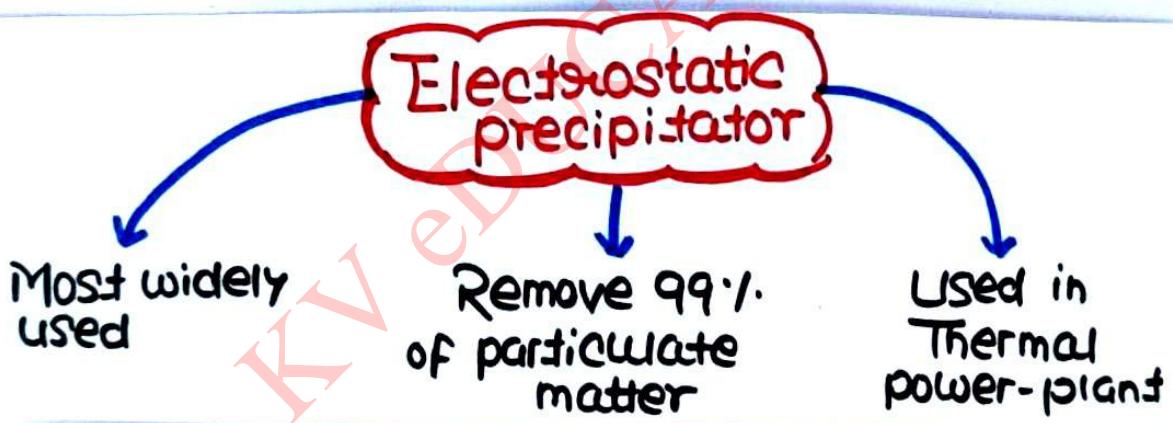
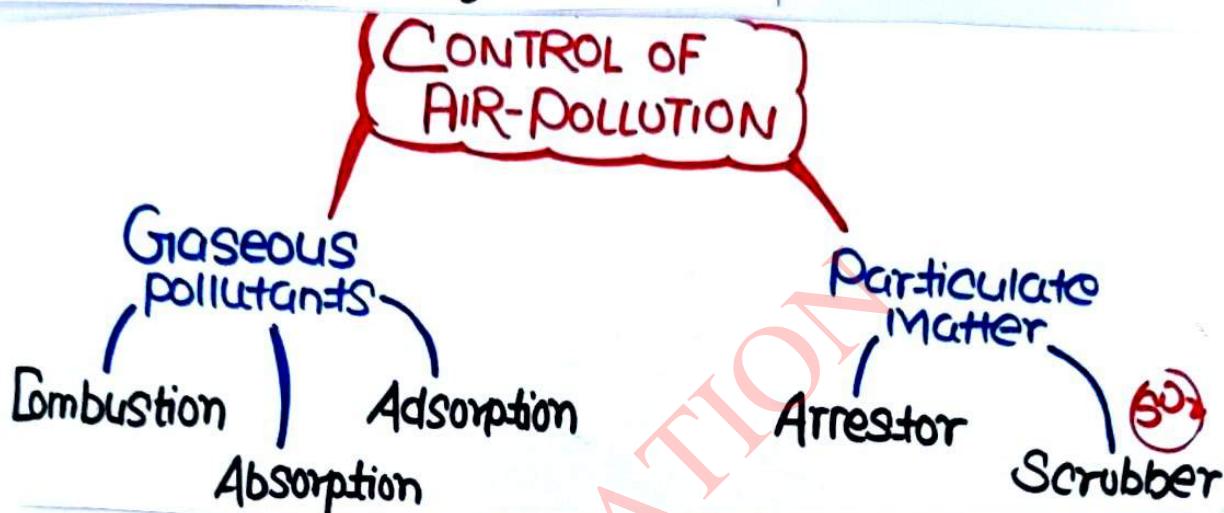
Gaseous  
• Gases

Particulates  
• Solid and Liquid  
particles

According to CPCB

Particulate  $\leq 2.5 \mu\text{m}$  is harmful  
(diameter)

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## OZONE

(Protection from  
UV-rays)

- present in STRATOSPHERE
- measured in DOBSON unit
- degraded by CFCs
- hole in ANTARTICA region
- DISEASE: Skin Cancer, Mutation, Cataract, Snow blindness

## Montreal Protocol (Montreal, CANADA)

Signed in → 1987 , Effective in → 1989

Control the emission of Ozone depleting substance  
(eg CFCs)



Kveducation

Green house gases →  $CO_2 > CH_4 > CFC > N_2O$   
(60%) (20%) (14%) (6%)

# SMOG (Smoke + Fog)

LOS-ANGELES  
OR  
PHOTOCHEMICAL

LONDON  
OR  
SULPHUR

PAN + O<sub>3</sub> + Nitrogen  
oxides

Vapours of H<sub>2</sub>SO<sub>4</sub>

(Smoke + Fog + Nitrogen  
oxides  
+ O<sub>2</sub> + UV-light + High-T)

(Smoke + Fog + Sulphur  
oxide  
+ Low T)

In 1990s → Delhi ranked 4<sup>th</sup> among  
41 most polluted cities  
of world

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In 2002 → All Buses of delhi  
(Diesel → CNG)

Euro III  
norms → Sulphur to  
be controlled [ 350 ppm in diesel  
150 ppm in petrol ]

Main-Target → 50 ppm in petrol and diesel

Old Vehicles X

Low sulphur ✓  
petrol & diesel

Unleaded  
petrol ✓

Catalytic  
converters ✓

Bharat Stage IV, April 2017

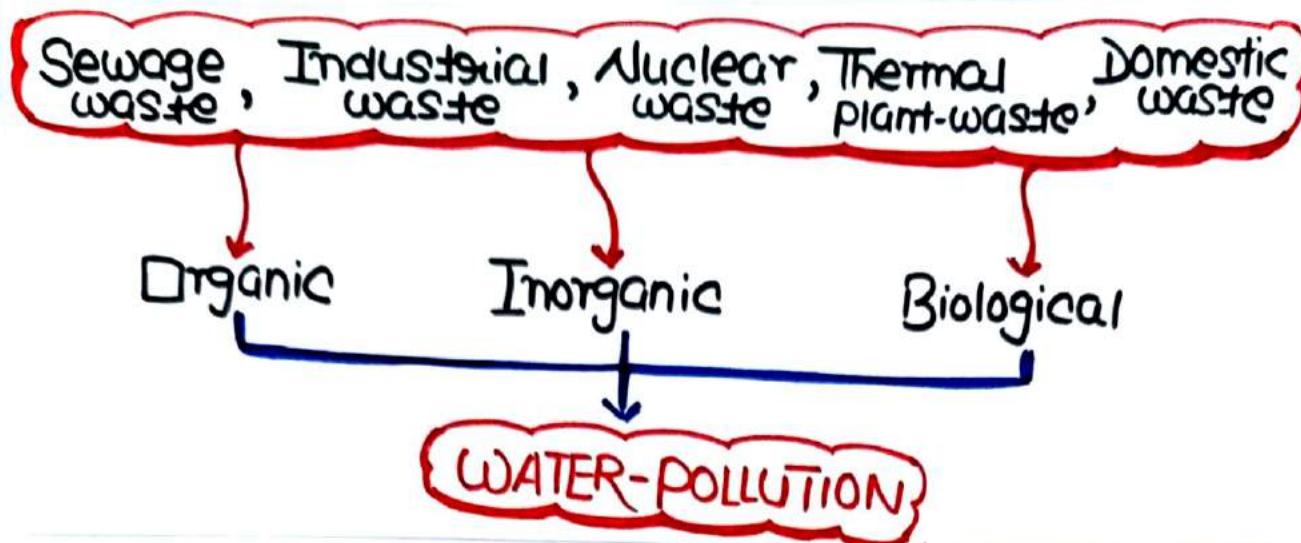
2,3,4 wheelers

### SOUND/NOISE POLLUTION

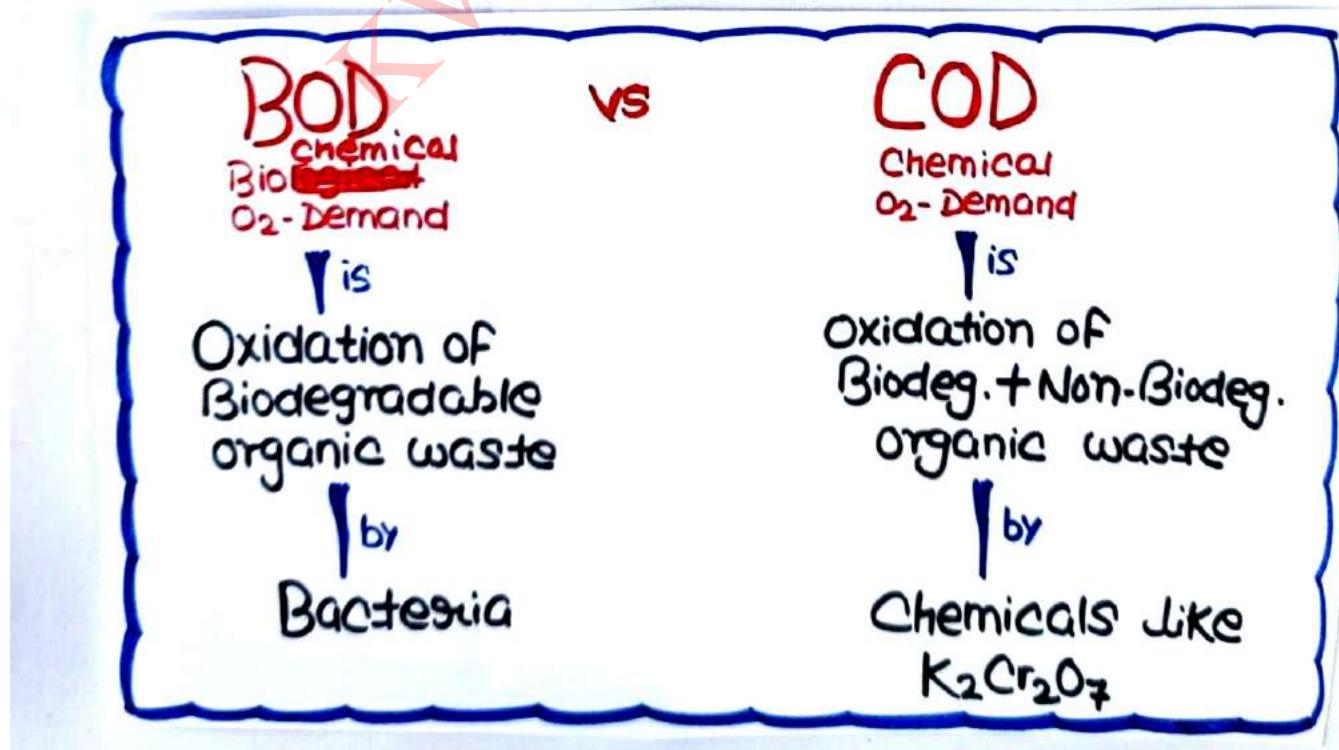
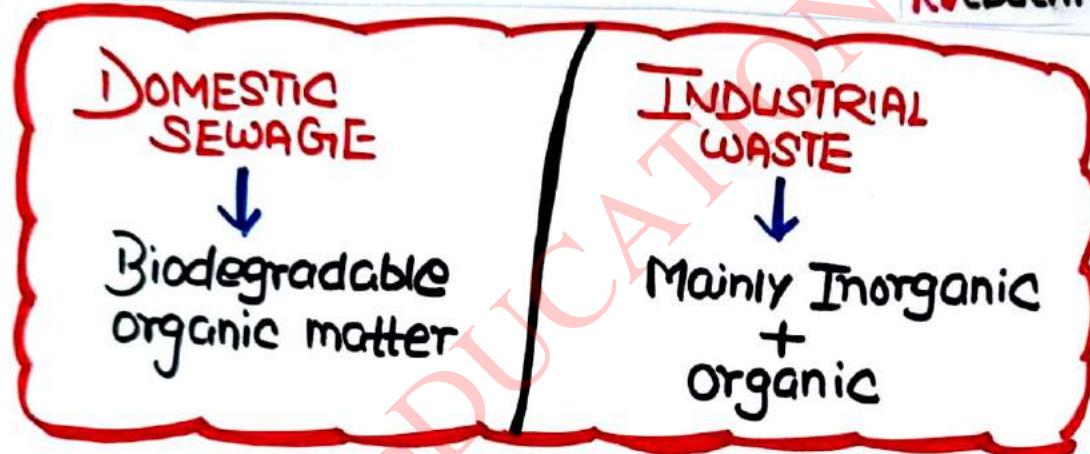
- Included in AIR-POLLUTION (1987)
- Unwanted sound
- Sound measured in decibel (dB)
- >80 dB is sound-pollution
- Neem, Ashoka etc absorb sound

### WATER-POLLUTION

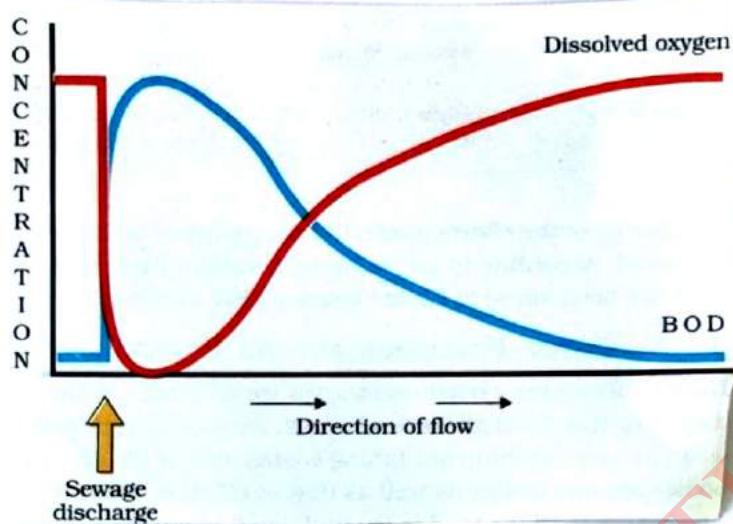
- Definition
- BOD & COD
- Biomagnification
- Eutrophication
- Sewage treatment



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**DISSOLVED OXYGEN** → Amount of oxygen dissolved in water

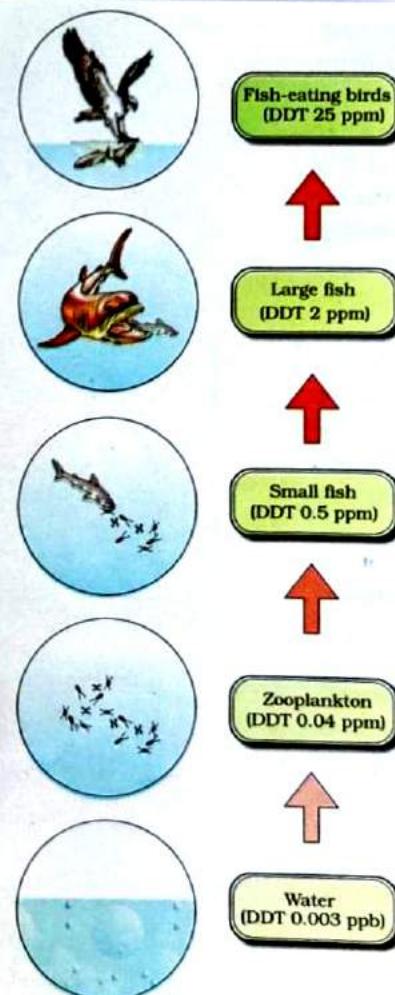


BOD & Organic waste

## BIOMAGNIFICATION

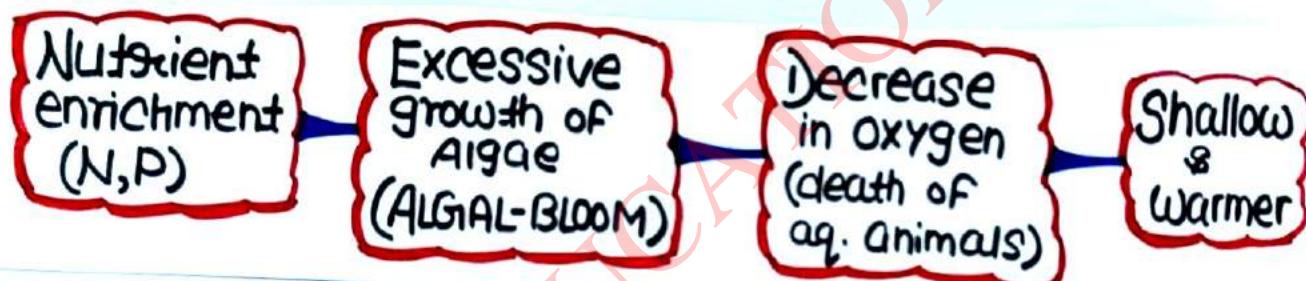
Accumulation of a particular substance in the body of the organisms at different trophic levels of a food chain

e.g. Accumulation of DDT which gets accumulated in zooplankton, Then further accumulated in successive animals



# EUTROPHICATION

FRESH LAKE  $\xrightarrow{\text{Natural ageing}}$  EUTROPHIC LAKE



IF Human-Activities (Industrial, Household) accelerates the ageing  $\rightarrow$  ACCELERATED EUTROPHICATION

Water-hyacinth  $\rightarrow$  Terror of Bengal (Eichhornia crassipes)

## Case-Studies

Organic-farming

Plastic-waste

Waste-water treatment

### ORGANIC-FARMING

Ramesh chander  
dagar [Sonipat]

Haryana Kisan  
welfare club  
(5000 farmers)

Waste products  
used as fertilizers  
(dung → Crop)

### WASTE WATER TREATMENT

• FOAM (Friends OF the Arcata Marsh) , ARCATA

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### PLASTIC-WASTE

Ahmed-khan  
(Banglore)

Polyblend  
(plastic-powder) +  
Bitumen

Used to lay  
Roads

### 2-STAGES

I

II

Sedimentation,  
Filtering,  
Chlorine treatment

- Series of Six connected marshes over 60 hectares
- plant, algae, fungi, bacteria were seeded which neutralise the pollutants

## RADIOACTIVE-WASTE

## NUCLEAR-ENERGY

2 problems

### Accidental leakage

- Three mile island
- Chernobyl incidents

### Safe-disposal of Radioactive waste (500m below earth)

## IMPROPER RESOURCE UTILISATION

Over-cultivation, Unrestricted grazing,  
Deforestation, poor irrigation

Irrigation without proper drainage

Waterlogging Conditions in the Soil

Draws salt to the surface of soil

Affects growth of crops & land

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## DEFORESTATION

Forested Area

Deforestation

Non-Forested Area

## FOREST [INDIA]

PAST

30%

PRESENT

21.54%

RECOMMENDED  
(acc. to NFP)

• Plains - 33%

• Hills - 67%

JHUM  
CULTIVATION

SLASH & BURN  
AGRICULTURE

→ NORTH-EASTERN STATES OF INDIA

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Farmers cut down the trees of forest  
and burn the plant remains

The ash is used as fertilizers and the  
land is used for farming or grazing

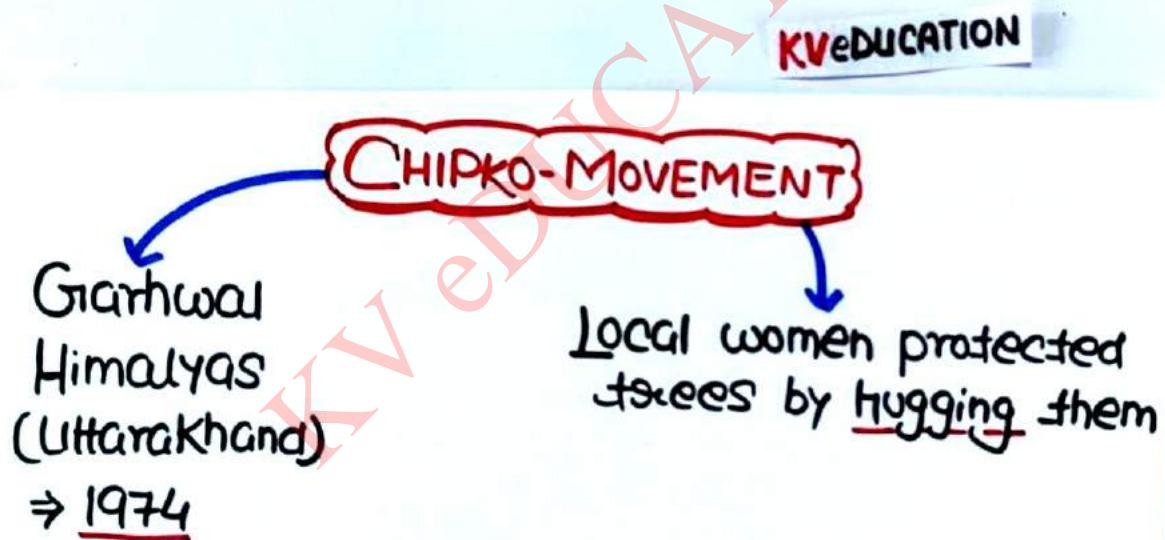
After cultivation, the area is left for  
recovery, Farmers moves to another forests  
and repeat this process

In earlier days, enough time was given so  
that land can recover after cultivation

But, due to increasing population the  
recovery time is reduced causes FOREST  
LOSS

## Case study FOREST-CONSERVATION

Amrita devi bishnoi  
Chipko-movement  
JFM



# BIOTECHNOLOGY & ITS APPLICATIONS

**GMO → Genetically Modified Organism**

## **GENETIC-MODIFICATIONS**

- Made crops more tolerant to abiotic stresses (cold, drought, salt, heat)
- Reduced reliance on chemical pesticides
- Help to reduce post harvest loss
- Increased efficiency of mineral usage
- Enhanced nutritional value of food eg. Golden rice (Vit-A enriched rice)

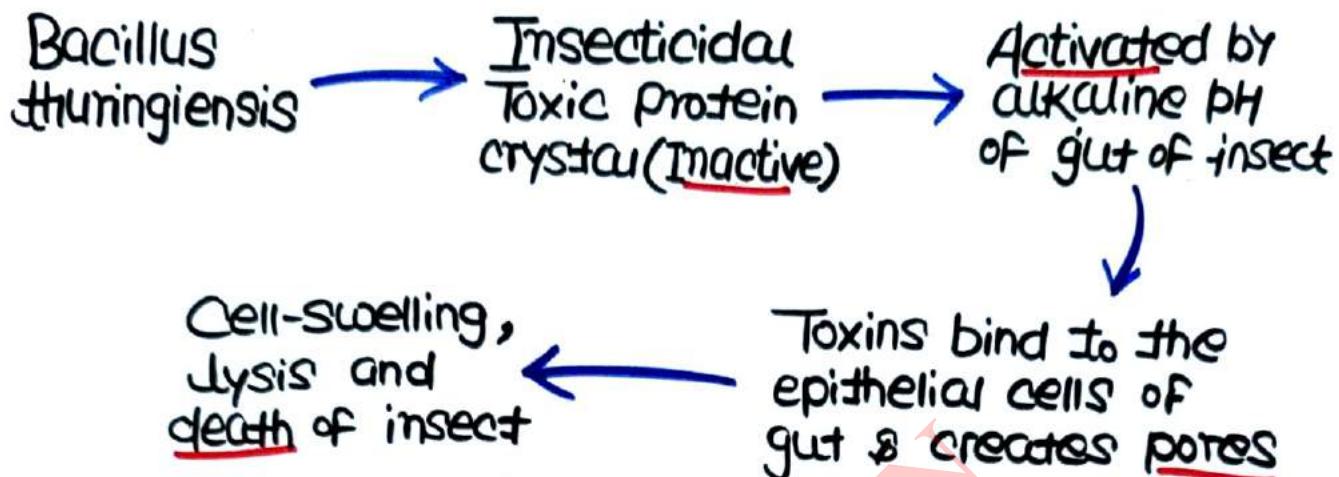
Some strains of *Bacillus thuringiensis*

produce INSECTICIDAL PROTEIN

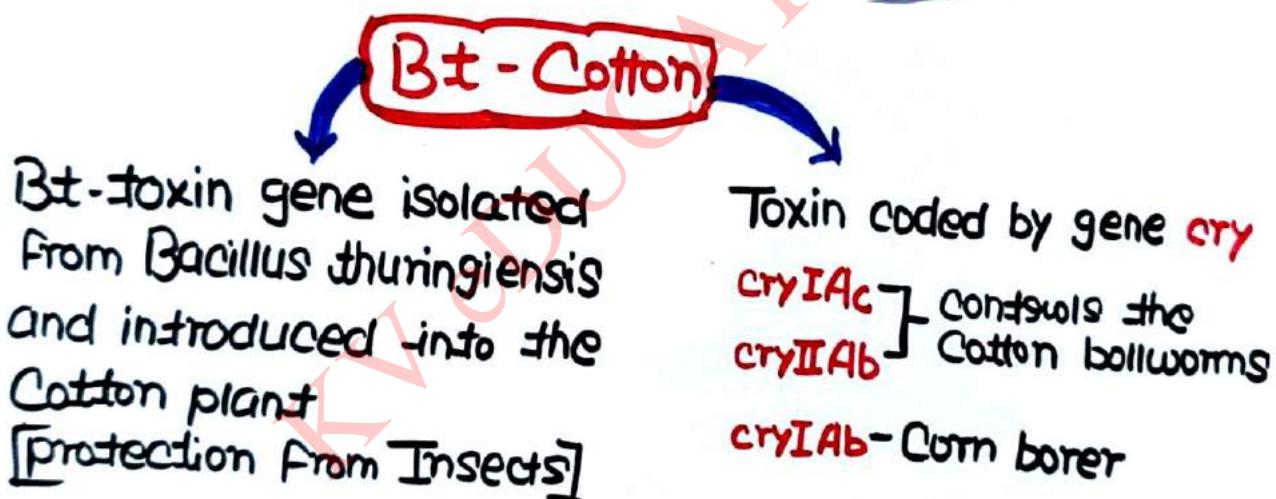
That kills insects like -

LEPIDOPTERANS [Tobacco budworm, army-worm]  
COLEOPTERANS [Beetles]  
DIPTERANS [flies, mosquito]

## How PROTEIN KILLS INSECTS but not Bacillus



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## RNA interference

- A nematode *Meloidogyne incognita* infects the roots of tobacco plants & cause great redn
- A strategy is adopted to prevent this which is based on the process RNA interference (all eukaryotic organism use this as cellular defence)

Using Agrobacterium vectors, nematode specific genes were introduced into host plant

The introduction of DNA was such that it produced both sense and anti-sense RNA in the host-cells

These two RNA's being complementary to each other formed a double stranded RNA that initiated RNAi and silenced the specific mRNA of the nematode

Diabetic patients across the world

Needs large amount of INSULIN

So, Insulin is extracted from pancreas of slaughtered pigs and cattle

But, Insulin from animals causes Allergy in some patients....

So, now we need insulin from other than Animals

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PRO-INSULIN

MATURE-INSULIN

- 3 polypeptide chains (A, B, C)
- Chains linked by disulphide bonds

- Only 2 polypeptide chains (A, B) C-chain absent
- Chains linked by disulphide bonds

C-peptide is absent in Mature Insulin

Now, main challenge is to getting Insulin in mature form using rDNA technology

In 1983, Eli Lilly an American company prepared 2 DNA sequences corresponds to A & B chain of Insulin to

Introduced them into plasmid of E.Coli to produce insulin chains

A & B chains produced separately, extracted and combined disulphide bond to form INSULIN

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**ADA** [Adenosine De-Aminase]

Enzyme crucial for IMMUNITY

Disease caused by gene deletion  
(Gene for making ADA)  
⇒ called ADA Deficiency

First Clinical gene therapy

given to

4-year old girl [1990]

with

ADA Deficiency

## How To TREAT ADA-DEFICIENCY

- In some children ADA deficiency can be cured by BONE MARROW TRANSPLANTATION
- In others, it can be treated by enzyme replacement therapy, in which functional ADA is given to the patient by injection
- But the problem with both of these that they are not completely curable

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### As a first step towards Gene-Therapy

Lymphocytes from the blood of the patient are grown in a culture outside the body

A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which subsequently returned to the patient

However, these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes

However, if the gene isolate from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be permanent cure

Conventional methods (Serum & Urine analysis) → Early detection is not possible 😕

TDNA technology, PCR, ELISA → Early detection 😊

We have to detect pathogens at very low concn (because high concn will cause severe disease)

So, low concentration of pathogen can be detected by using PCR (amplification)

**ELISA** → Enzyme Linked Immuno Sorbent Assay  
→ based on ANTIGEN-ANTIBODY inst<sup>n</sup> principle

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## TRANSGENIC- ANIMALS

TRANSGENIC MICE

Used to test the safety of

POLIO VACCINE

Human protein

α-1 Anti-trypsin

Used to treat

EMPHY-SEMA

First Transgenic Cow [Rosie, 1997]

Milk enriched with

Human alpha-lactalbumin [2.4 gm/Ltr]

→ Nutritionally more balanced milk

Animals that have their DNA manipulated to possess and express an extra (foreign) gene are known as **TRANSGENIC-ANIMALS**

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GEAC

[Genetically engineering approval committee]

Make decision regarding the validity of GM research

Safety of GM organisms for public

RICE

2,00,000 varieties (INDIA)

BASMATI (27 varieties)

In 1997, an American company got patent right on Basmati rice through US-patent & Trademark office

[Same things done with TURMERIC, NEEM]

**BIOPIRACY**

Use of Bio-resources by multinational companies and organisations without proper authorisations

# REPRODUCTION in ORGANISM

**LIFE SPAN**

Period from birth to death of  
(natural) an organism

**LIFE-SPAN**

- Elephant - 60-90 yrs
- Rose - 5-7 yrs
- Dog - 20-50 yrs
- Butter-fly - 1-2 wks
- Crow - 15 yrs
- Banana tree - 25 yrs
- Cow - 20-25 yrs
- Parrot - 140 yrs
- Crocodile - 60 yrs
- Horse - 60 yrs
- Fly - 30 days
- Rice plant - 3-4 months
- Tortoise - 100-150 yrs
- Banyan tree - 200 yrs

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When offspring is produced by

Single parent  
with or without  
gamete formation

**ASEXUAL-REP<sup>n</sup>**

Involvement of 2  
parents, fusion of  
male & female gametes

**SEXUAL-REP<sup>n</sup>**

# ASEXUAL-REPRODUCTION

## CLONE

Morphologically and Genetically Similar individuals

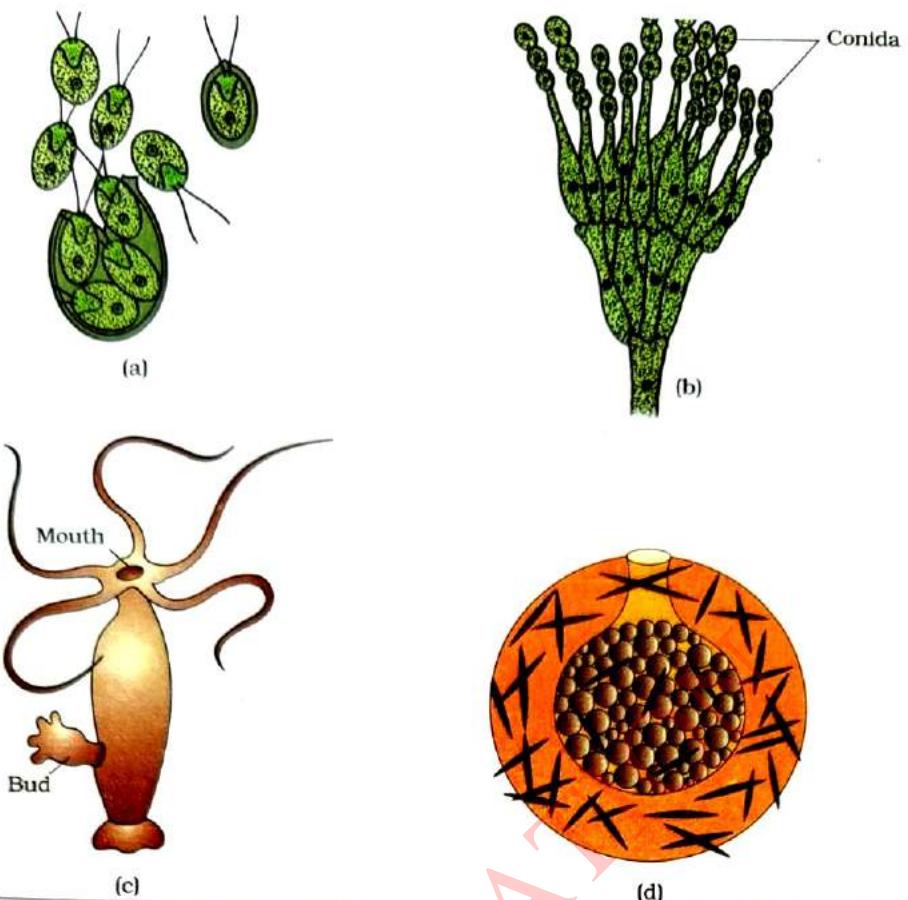
- \* Binary Fission - **Amoeba, Paramecium**
- \* Budding - **Hydra, Yeast**

- \* **Conidia - Fungi**
- \* **Gemmules - Sponges**

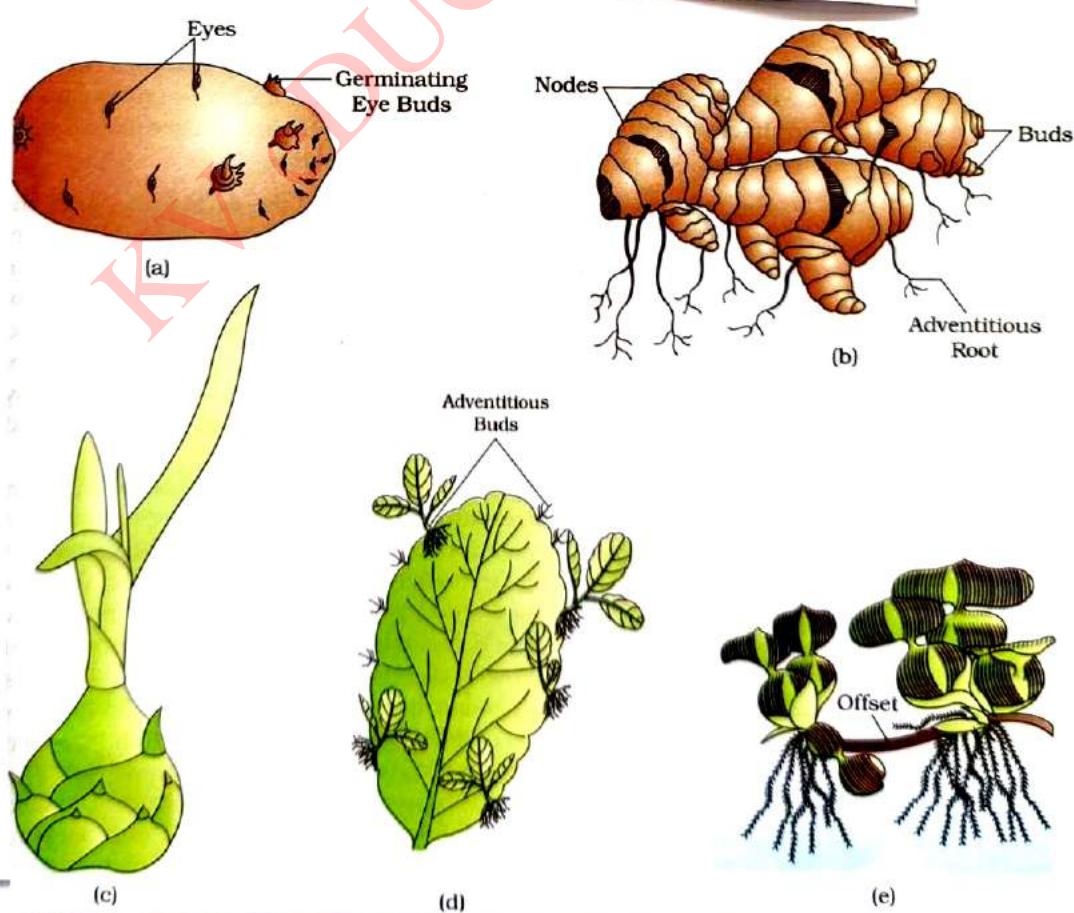
Asexual reproduction in plants is called as **VEGETATIVE - REPRODUCTION**

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Units of vegetative propagation are called **VEGETATIVE - PROPAGULES**  
(eg - Runner, Rhizome, Sucker, Tuber, Offset, Bulb)



**Figure 1.3** Asexual reproductive structures: (a) Zoospores of *Chlamydomonas*; (b) Conidia of *Penicillium*; (c) Buds in *Hydra*; (d) Gemmules in sponge



**Figure 1.4** Vegetative propagules in angiosperms: (a) Eyes of potato; (b) Rhizome of ginger; (c) Bulbil of *Agave*; (d) Leaf buds of *Bryophyllum*; (e) Offset of water hyacinth

# SEXUAL-REPRODUCTION

All organisms have to reach a certain stage of growth and maturity, before they can **REPRODUCE SEXUALLY**

↓ That period of growth is  
**JUVENILE-PHASE** (called **Vegetative phase in plants**)

\* **BAMBOO** Plant flowers once in life

\* **Strobilanthes** flowers once in 12 yrs  
Kunthiana  
(neelkushanji)

**OESTRUS CYCLE**: In non-primate mammals like cows, sheep, Rats, Deer, Dogs, Tiger

**MENSTRUAL CYCLE**: In primates like Monkey, Apes, Humans

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## EVENTS IN SEXUAL REPRODUCTION

### Pre-Fertilisation

- \* Gametogenesis
- \* Gamete transfer

### Fertilisation

- \* Fusion of gametes

### Post-Fertilisation

- \* Zygote formation
- \* Embryogenesis

## GAMETES

### Homo-Gametes

Male and female gametes are so similar in appearance  
eg. Some algae

### HETERO-Gametes

Male and female gamete are morphologically diff  
# Male gamete: Antherozoid/Sperm  
# Female gamete: Egg/Ovum  
eg. Majority of sexually rep. organism

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## BISEXUAL PLANTS

Male & female reproductive structures in same plant

## UNISEXUAL PLANTS

Male & female reproductive structures on different plants

## In several FUNGI & PLANTS

### HOMOTHALLIC & MONOECIOUS

used to denote

Bisexual condition

### HETEROTHALLIC & DIOECIOUS

used to denote

Unisexual condition

- **STAMINATE** - Unisexual MALE flower
- **PISTILLATE** - Unisexual FEMALE flower

## MALE & FEMALE Flowers

present on

Same plant  
called

MONOECIOUS

eg. Cucurbit  
Coconut

Different plant  
called

DIOECIOUS

eg. papaya  
Date palm

BISEXUAL  
ANIMALS  
(sponges,  
Tapeworm,  
Leech)

That possess  
both (M+F)  
Reproductive  
organs

HERMAPHRODITES

In diploid  
organisms

Specialised  
cell called,  
MEIOTYPE'S  
(gamete mother cell)

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Undergoes  
Meiosis

MEDIUM OF  
GAMETE  
TRANSFER

• Algae  
• Bryo  
• Pterido

• Gymno  
• Angio

Water  
Pollination  
(Pollen grains)

In majority  
of organisms

• Male gamete  
are motile  
• Female is  
stationary

Few  
Exceptions

Few FUNGI &  
ALGAE, in which  
both type of  
gamete are motile

Large number of male gametes

Fails to reach female gametes

To compensate loss, male gametes are produced in very large number

## FERTILISATION

Most vital event of sexual reproduction

Fusion of gametes (called SYNGAMY) result in the formation of diploid zygote

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### EXTERNAL FERTILISATION

Syngamy occurs in external medium (usually water)

### INTERNAL FERTILISATION

Syngamy occurs inside the body of the organism

Organisms with EXTERNAL-FERT<sup>n</sup>

↓  
Zygote is formed outside the body (usually water)

Organisms with INTERNAL-FERT<sup>n</sup>

↓  
Zygote is formed inside the body

## DEVELOPMENT OF ZYGOTE

Takes place

Outside the body of female parent (eg. in eggs)

Takes place

Inside the body of female parent

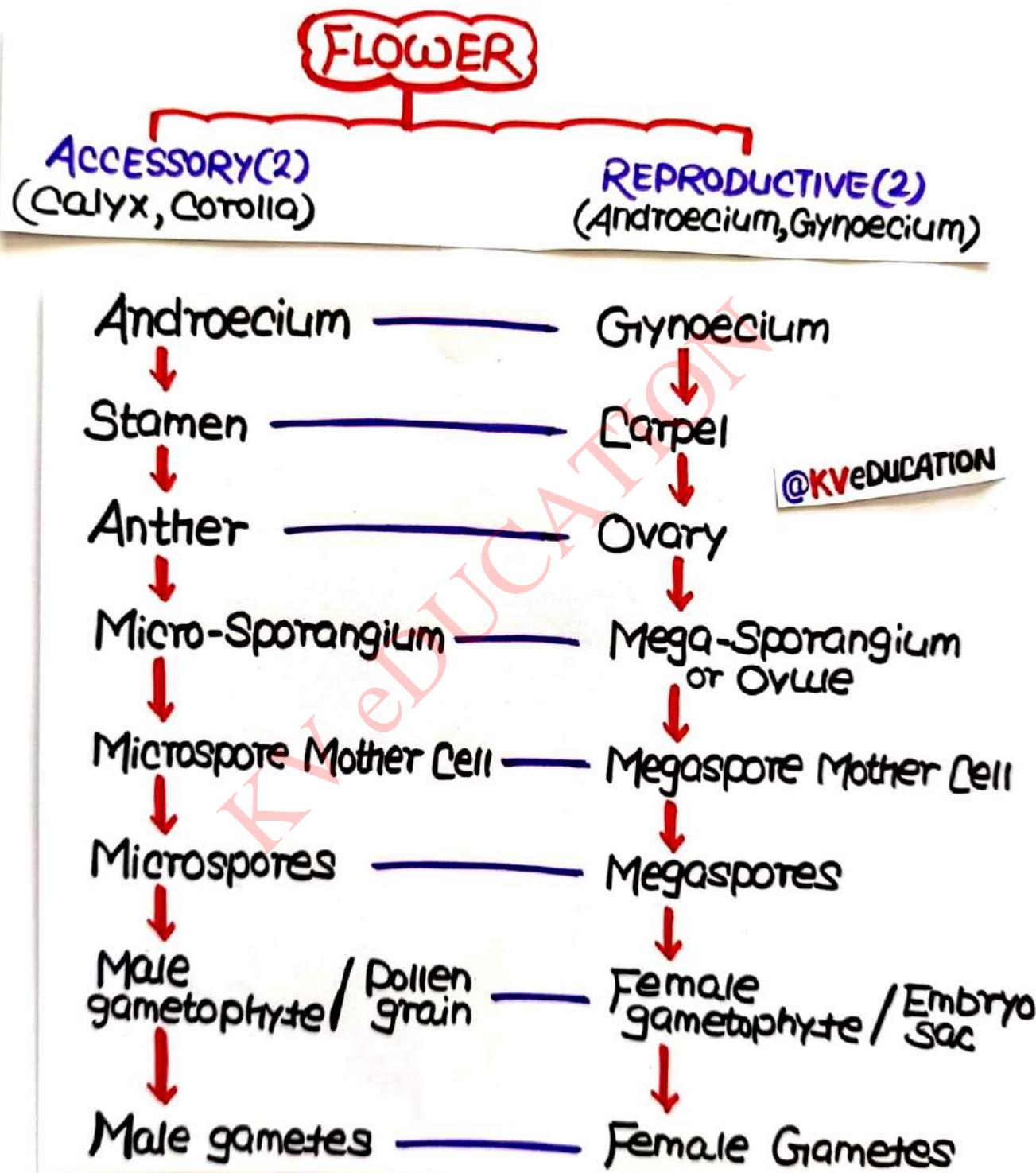
OVIPAROUS ANIMALS

VIVIPAROUS ANIMALS

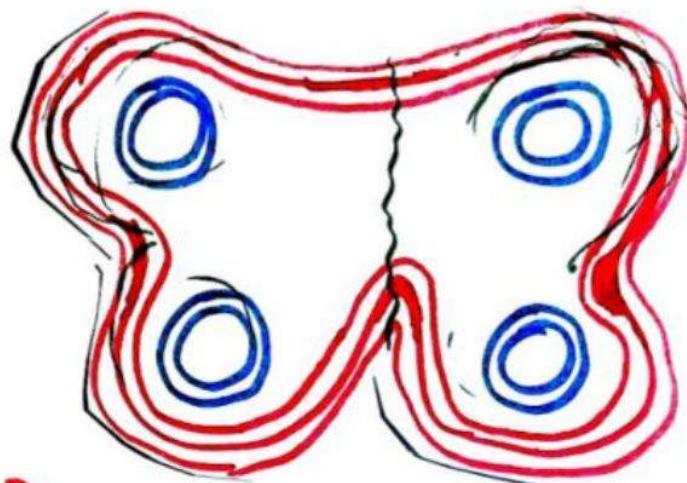
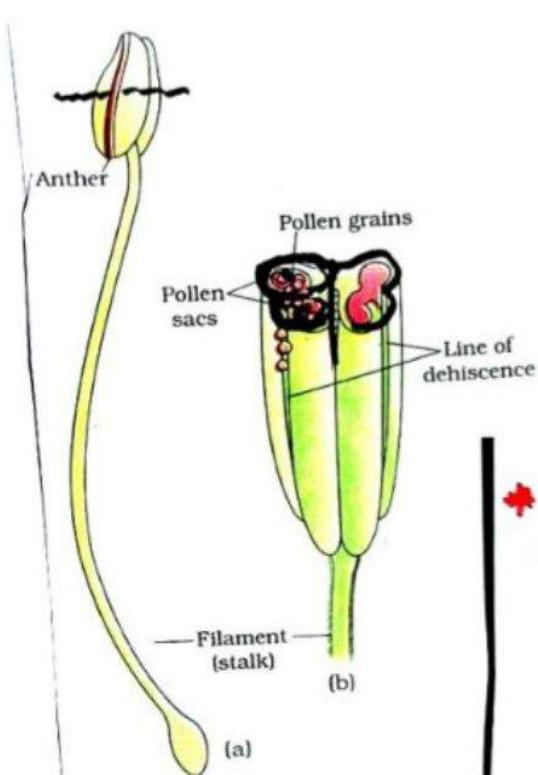
**Table 1.1: Chromosome Numbers in Meiocytes (diploid, 2n) and Gametes (haploid, n) of Some Organisms. Fill in the Blank Spaces.**

Name of organism	Chromosome number in meiocyte (2n)	Chromosome number in gamete (n)
Human beings	46	23
House fly	12	6
Rat	42	21
Dog	78	39
Cat	38	19
Fruit fly	8	4
<i>Ophioglossum (a fern)</i>	1260	630
Apple	34	17
Rice	24	12
Maize	20	10
Potato	48	24
Butterfly	380	190
Onion	16	8

# SEXUAL REPRODUCTION IN FL. PLANTS



**ANDROECIUM**  $\xrightarrow{\text{made of}}$  STAMENS  $\xrightarrow{\text{made of}}$  Anther + Filament



\* Bilobed  
 \* Dithecos  
 \* Tetrasporangiate

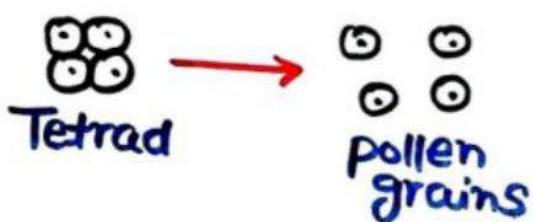
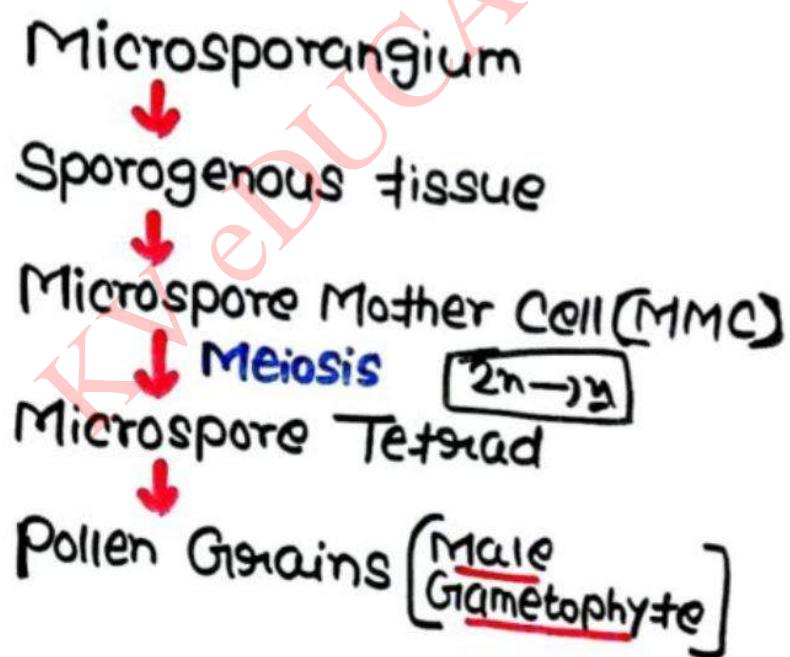
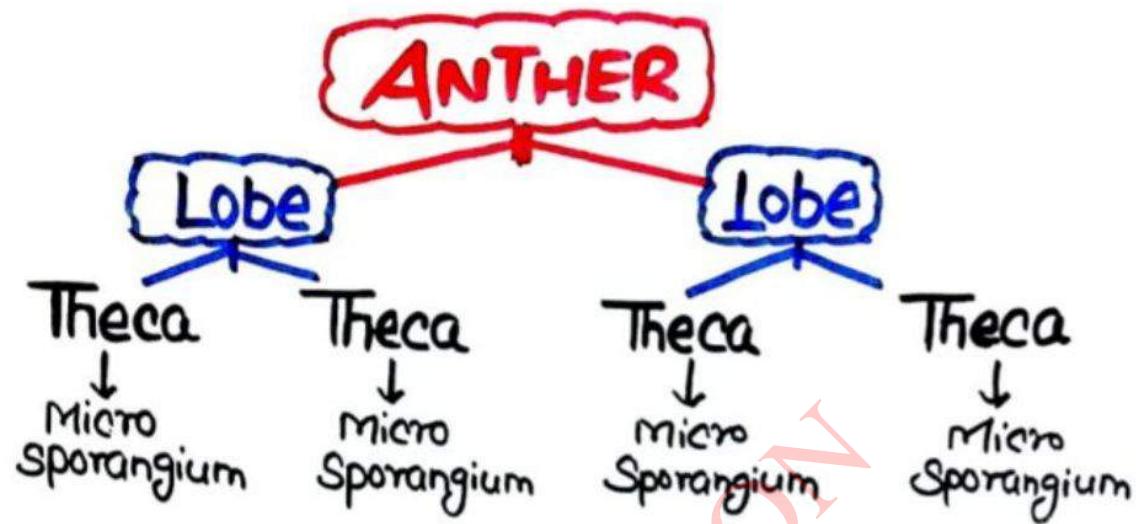
## 4 Layers of MICROSPOANGIUM

Epidermis  
 Endothecium  
 Middle layer

Protection

TAPETUM  
 → Nourishment of  
 developing P.grains

Cells of  
 TAPETUM → Dense Cytoplasm  
 \* +  
 \* > 1 Nucleus





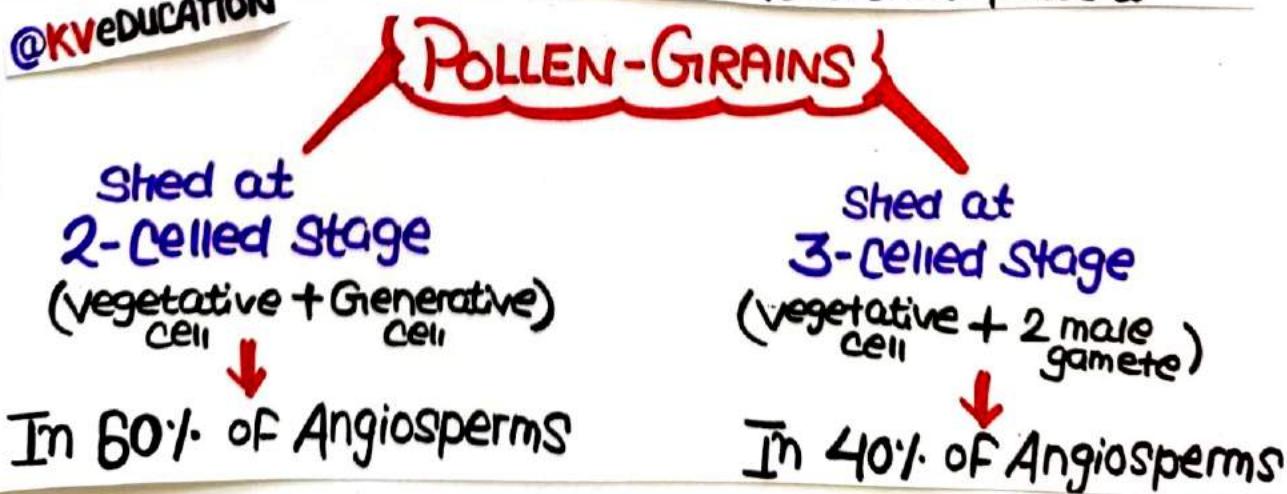
- \* Made up of SPOROPOLLENIN (one of the most resistant organic materials)
- ⇒ SPOROPOLLENIN can withstand high temp., strong acid & base
- ⇒ No enzyme that degrades Sporopollenin is so far known

Pollen grains are well preserved as fossils because of presence of SPOROPOLLENIN



- \* BIGGER in size
- \* Has food reserved
- \* Irregularly shaped  
large nucleus
- \* SMALLER in size
- \* Floats in the cytoplasm of the vegetative cell
- \* SHAPE :- Spindle  
CYTOPLASM :- Dense  
NUCLEUS :- present

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## POLLEN GRAIN VIABILITY

For

30 minutes

Months

\* Rice, Wheat

\* Rosaceae,  
Leguminosae,  
Solanaceae

Pollen grains of some species cause ALLERGY and BRONCHIAL-AFFLICTIONS

Pollen grains of PARTHENIUM cause allergy or carrot-grass

Rich in nutrients [used as food supplement]

Pollen consumption increase the performance of RACE-HORSES and ATHLETES

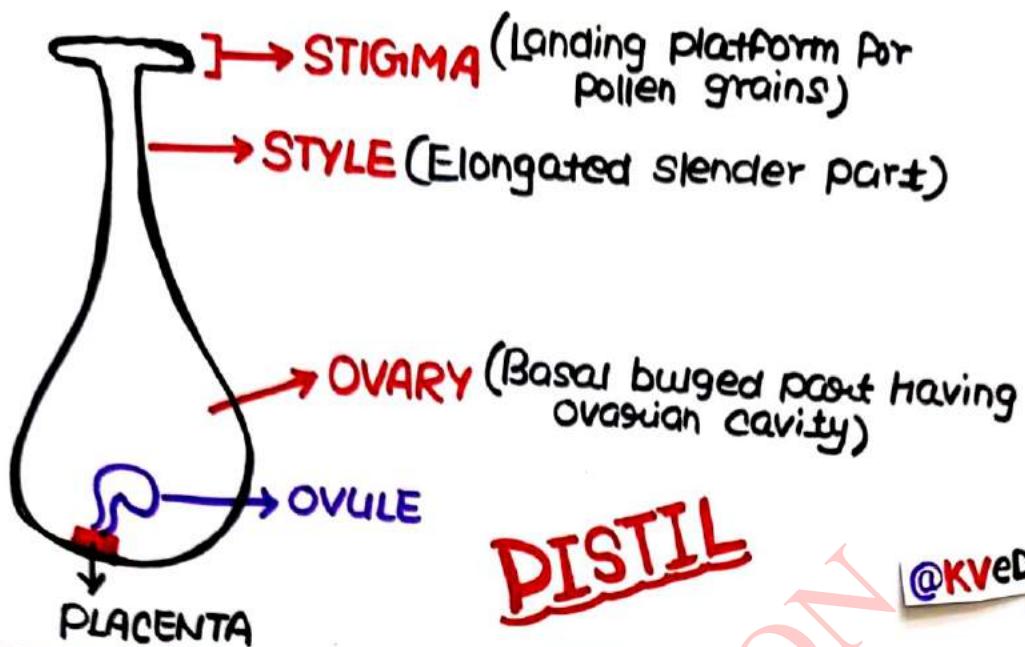
In western countries pollen products are used in the form of tablets & syrup

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Pollen-grains can be stored for years

↓  
LIQUID NITROGEN [-196°C]

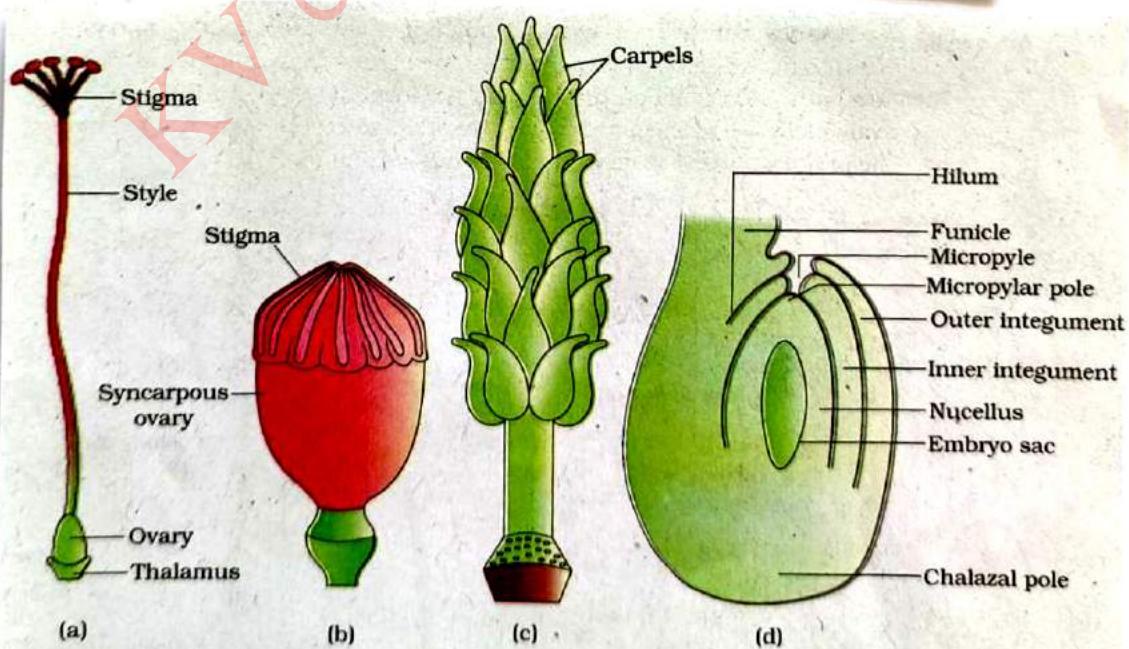
Such stored pollen can be used as pollen-bank similar to seed bank, in crop breeding programme



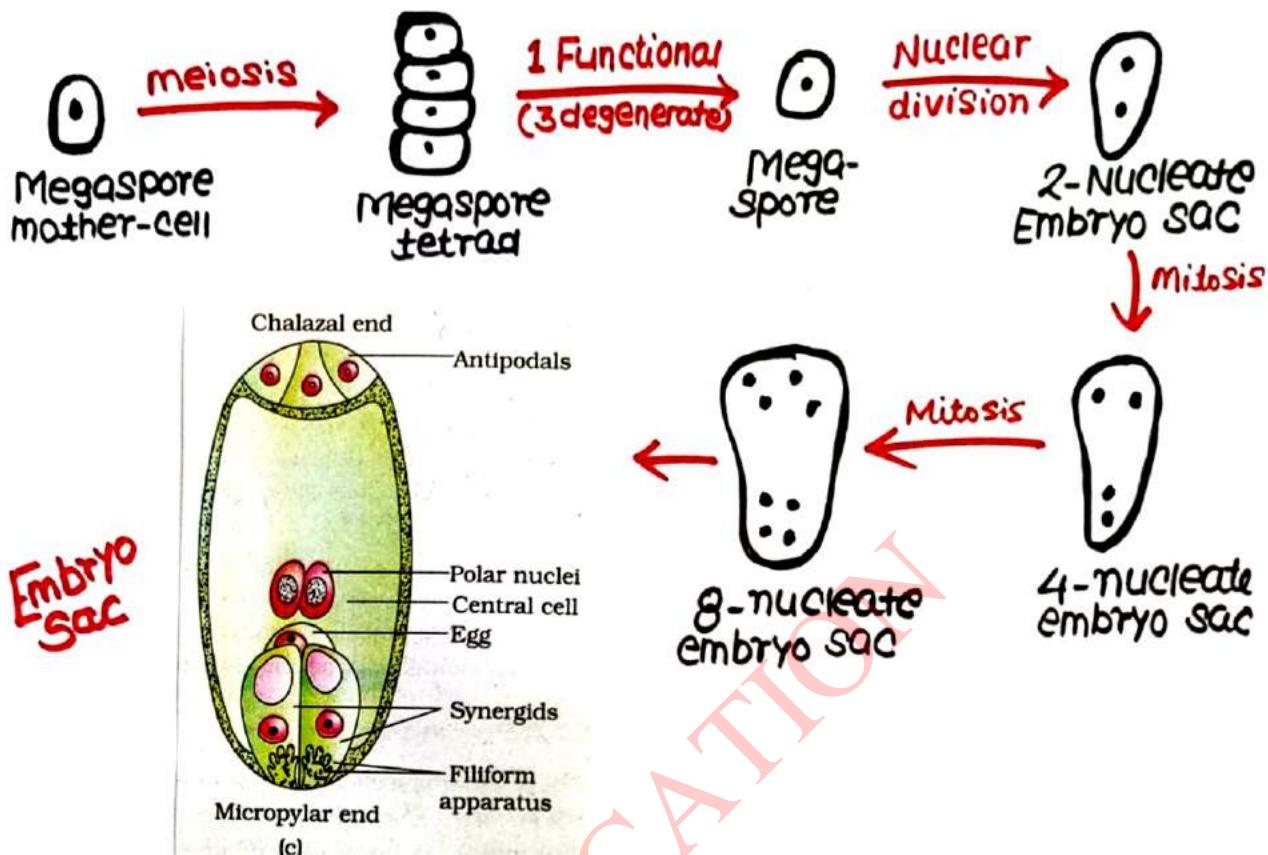
Number of OVULES in ovary may be

- One → Wheat, Paddy, Mango
- Many → Papaya, Water melon, Orchids

Ovule  $\xrightarrow{\text{form}}$  Seed      Ovary  $\xrightarrow{\text{form}}$  Fruit



**Figure 2.7** (a) A dissected flower of *Hibiscus* showing pistil (other floral parts have been removed); (b) Multicarpellary, syncarpous pistil of *Papaver*; (c) A multicarpellary, apocarpous gynoecium of *Michelia*; (d) A diagrammatic view of a typical anatropous ovule



7 Celled, 8 Nucleated

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## AGENTS OF POLLINATION

### BIOTIC

MORE Common

\* Zoophily  
(by animals)

### ABIOTIC

LESS Common

\* Anemophily  
(by wind)  
\* Hydrophily  
(by water)

## Zoophily

By animals like  
Bees (most common),  
butterflies, beetles,  
wasp, ants, moths, Birds

→ Even larger animals like  
lemurs, rodents, geckos  
lizard, garden lizard

### CRITERIA

- \* Colourful flowers
- \* Large flowers
- \* Nectar present
- \* Fragrance in flower

## ANEMOPHYLY

Pollination by wind

Pollen grains  
should be light  
in weight and  
more in number  
and non-sticky

Stigma should  
be STICKY'S  
FEATHERY  
AND  
STAMEN should  
be well exposed

Wind pollinated  
flowers often  
have a single  
ovule in each  
ovary

Quite  
common  
in grasses

## HYDROPHILY

- \* Pollination by WATER
- \* ONLY in 30 Genera (Monocots)

### EPI-HYDROPHILY

\* Polln on water surface  
eg. Vallisneria

### Hypo-HYDROPHILY

\* Polln below water surface  
eg. Zostera, Hydrilla  
(Sea-grass)

Aquatic plants but  
pollination not by water

- Water hyacinth
- Water lily

## OUT-BREEDING DEVICES

### NON-SYNCHRONISATION

\* pollen release & Stigma receptivity are not synchronised

### DIFFERENT POSITIONS

\* Anther & Stigma are placed at diff<sup>t</sup> positions

### SELF-IN COMPATIBILITY

\* Genetic mechanism which prevent self pollination

### UNISEXUAL FLOWERS

\* prevents self-polln

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## Pollen tube enters one of Synergid (having 2 male gamete)

One male gamete fuses with egg cell

Results in

formation of DIPLOID ZYGOTE

Another male gamete fuses with 2 polar nuclei located in the central cell

Results in

formation of PEN (primary endosperm nucleus)

called

## DOUBLE-FERTILISATION

after that

# Central cell becomes PEC (Primary Endosperm Cell) and develop into endosperm

# Zygote develops into the EMBRYO

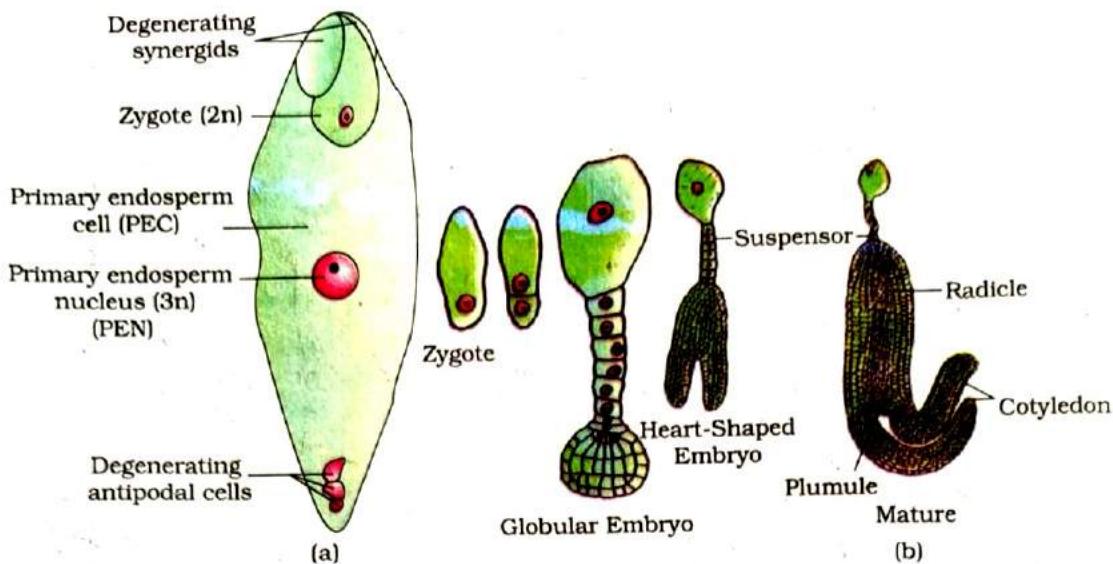
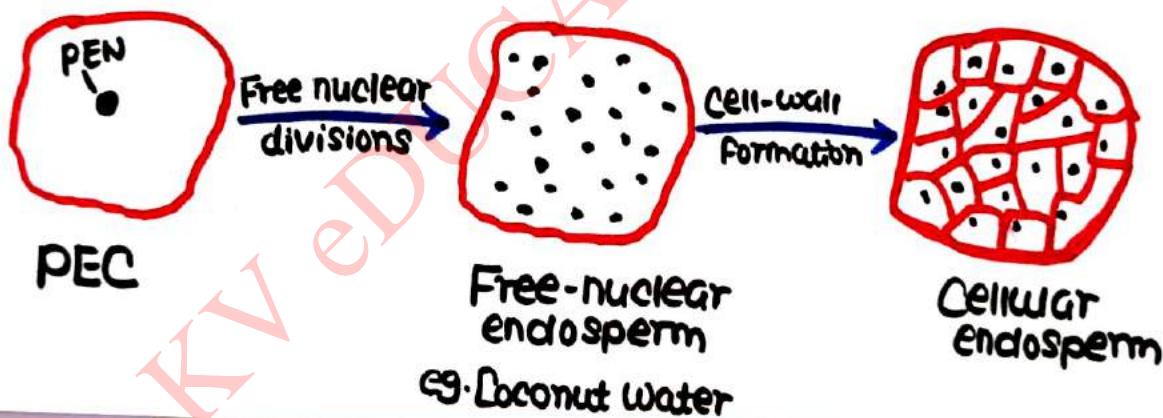


Figure 2.13 (a) Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN); (b) Stages in embryo development in a dicot [shown in reduced size as compared to (a)]

## Rough diagram to understand ENDOSPERM



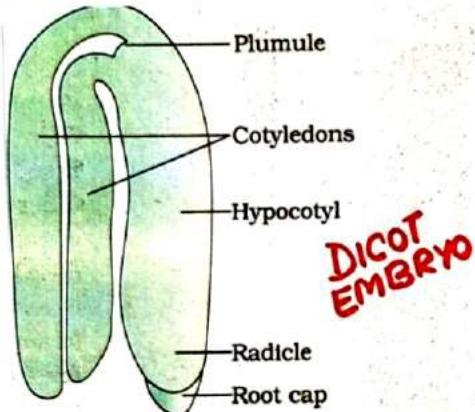
@KVeDUCATION

## DICOT-EMBRYO

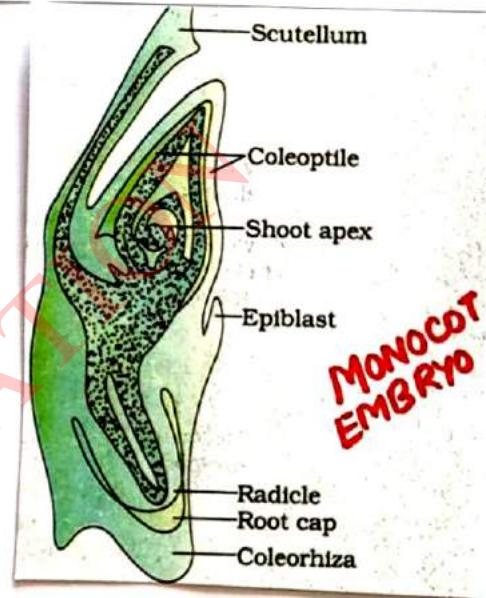
- # Consist of EMBRYONAL-AXIS and Two COTYLEDONS
- # Portion of embryonal axis above the level of cotyledons is the EPICOTYL (terminates as Plumule)
- # Cylindrical portion below the level of cotyledons is HYPOCOTYL (terminates as radicle)
- # Root tip is covered with a ROOT-CAP

# MONOCOT-EMBRYO

- # Posses only one cotyledon
- # In grass Family, Cotyledon is called SCUTELLUM
- # Radical and Root cap enclosed in COLEORRHIZA
- # Epicotyl enclosed in hollow structure, COLEOPTILE



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## ALBUMINOUS OR ENDOSPERMIC SEEDS

\* part of endosperm  
is retained

eg. Castor, Coconut,  
Wheat, Maize, Barley

## EX-ALBUMINOUS OR NON-ENDOSPERMIC SEEDS

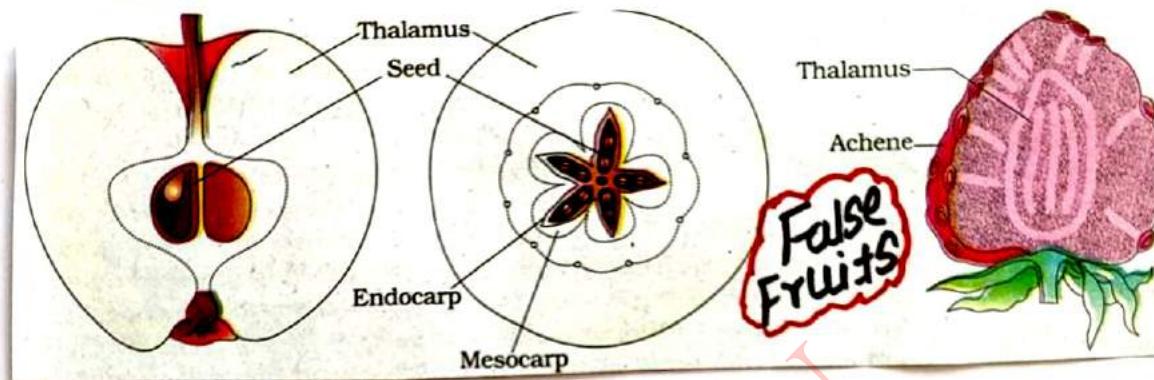
\* No residual  
endosperm

eg Pea, bean, ground  
nuts

In some seeds such as  
Black pepper, Beet  
remnants of nucellus  
are also persistent

This residual, persistent  
nucellus is the PERISPERM

**FALSE** . Fruit developed from other than ovary  
**FRUIT** • (eg. from THALAMUS) .... ex. Apple, Cashew, Strawberry



**POLYEMBRYONY** → >1 embryo in one seed  
eg. Citrus, Mango, fruits

Formation of --- without fertilisation

Organism

**PARTHENO-  
GENESIS**

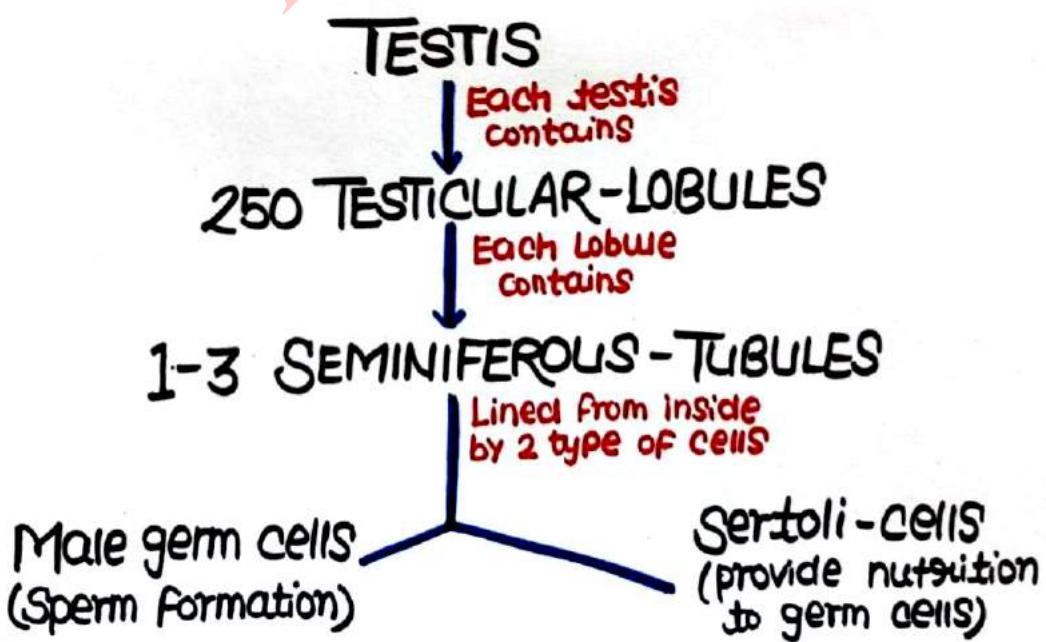
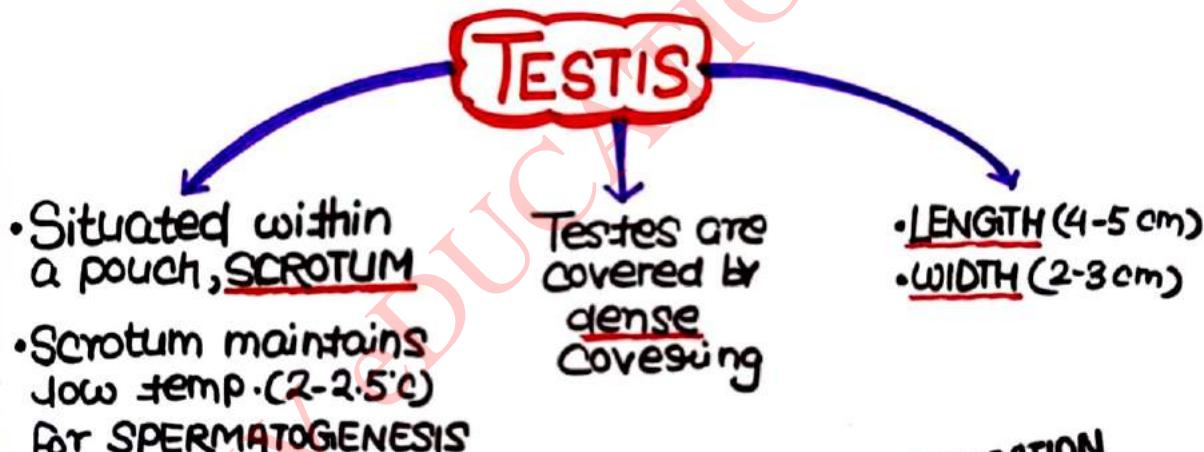
Fruit

**PARTHENO-  
CARPY**  
(eg. Banana)

Seed

**APOMIXIS**

# HUMAN-REPRODUCTION



Regions outside the seminiferous tubules

called

INTERSTITIAL-SPACES

contains

Small blood vessels and Interstitial cells or Leydig cells

Leydig cells synthesise and secrete testicular Hormone called ANDROGENS

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\* LH acts on LYEDIG-CELLS

\* FSH acts on SERTOLI-CELLS

MALE SEX  
ACCESSORY  
DUCTS

Rete-testis,  
Vasa efferentia,  
Epididymis,  
Vas deferens

PATHWAY OF SPERM

Seminiferous  
tubules

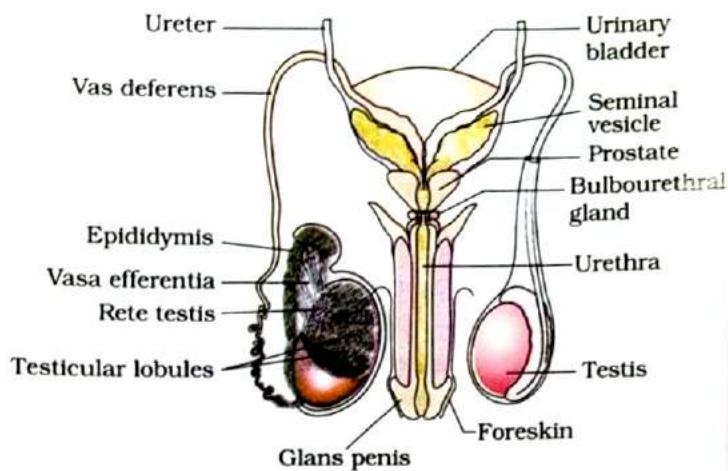
Rete  
testis

Vas  
efferens

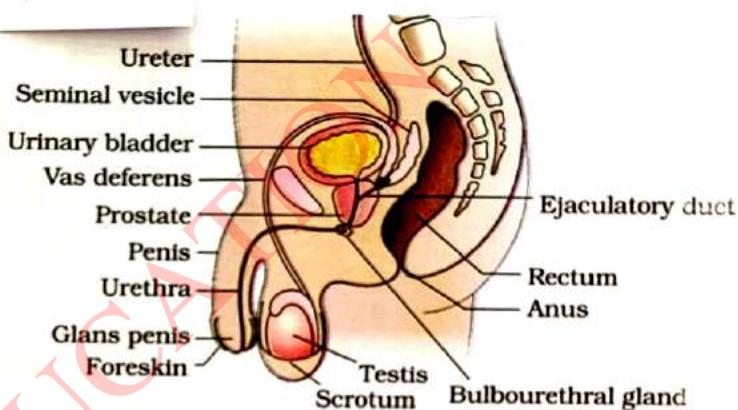
Urethra  
Ejaculatory  
duct

Vas  
deferens

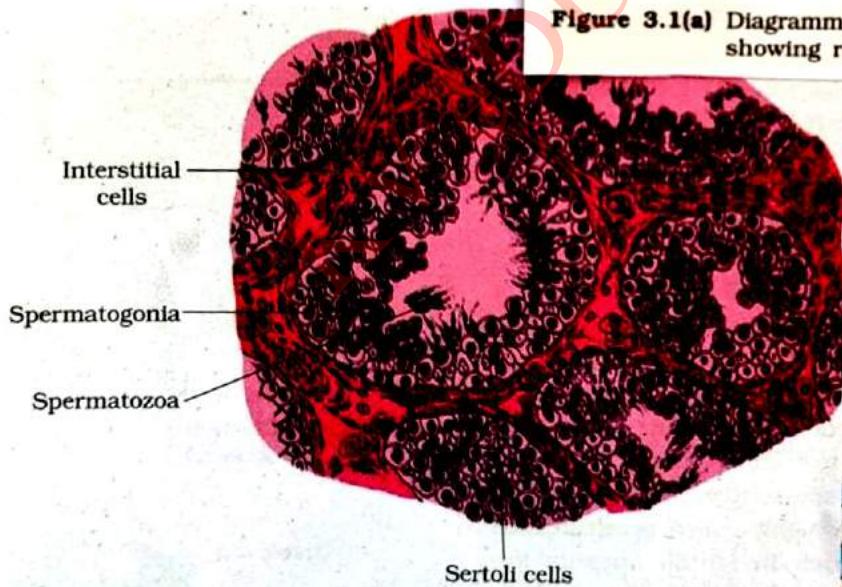
Epididymis



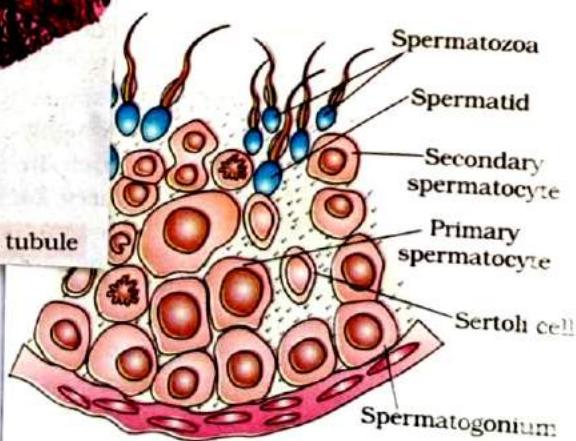
**Figure 3.1(b)** Diagrammatic view of male reproductive system (part of testis is open to show inner details)



**Figure 3.1(a)** Diagrammatic sectional view of male pelvis showing reproductive system



**Figure 3.2** Diagrammatic sectional view of seminiferous tubule



**Figure 3.5** Diagrammatic sectional view of a seminiferous tubule (enlarged)

## MALE ACCESSORY GLANDS

- Seminal vesicles (2)
- Prostate (1)
- Bulbourethral (2)

These secretions rich in Fructose, Calcium and other enzymes

Bulbourethral secretions helps in lubrication of penis

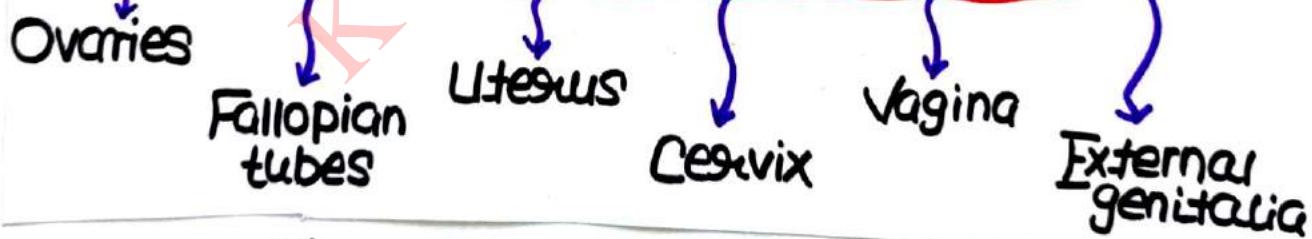
## MALE EXTERNAL GENITALIA (PENIS)

Made up of special tissue (ERECTILE)

Enlarged end of penis is, GLOWS-PENIS

GLOWS-PENIS is covered by loose fold of skin called, FORE-SKIN

## FEMALE REPRODUCTIVE SYSTEM



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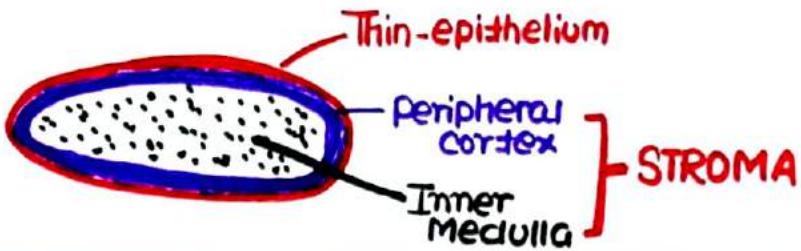
## OVARY

Primary sex organ that produce OVUM & OVARIAN-HORMONES

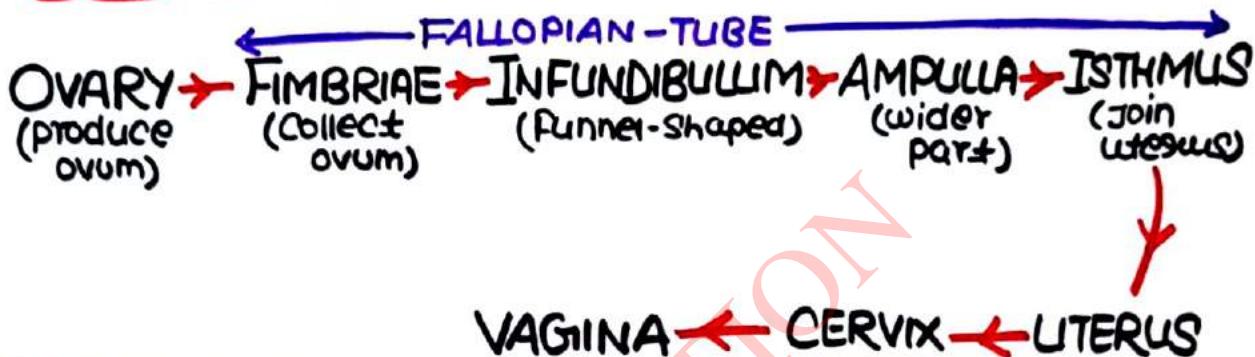
2-4 cm in length

Connected to pelvic wall & uterus by ligaments

Rough-diagram  
of ovary to  
understand  
NCERT



## FLOW OF FEMALE REPRODUCTIVE TRACT



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### UTERUS

- Shape (Inverted-pear)
- Also called as WOMB

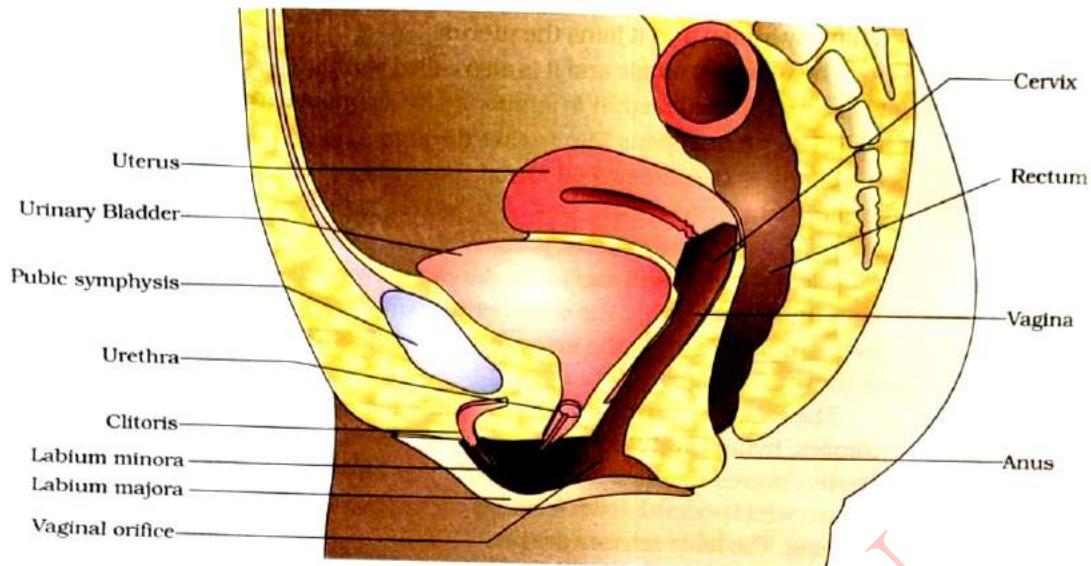
Attached to pelvic wall by LIGAMENTS

- 3 LAYERS OF UTERINE-WALL
- external - Perimetrium
  - middle - Myometrium
  - inner - Endometrium

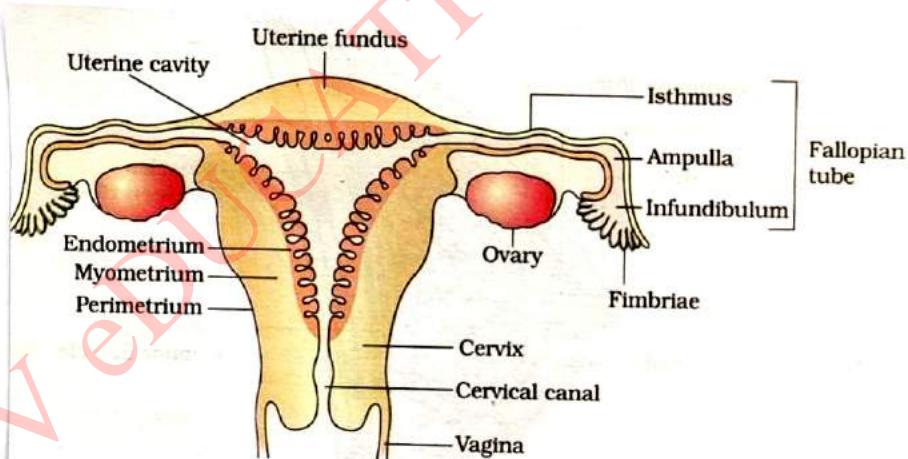
Layer which undergoes CYCLIC CHANGES during Menstrual-cycle → Endometrium

Layer which exhibits STRONG CONTRACTIONS during Child-birth → Myometrium

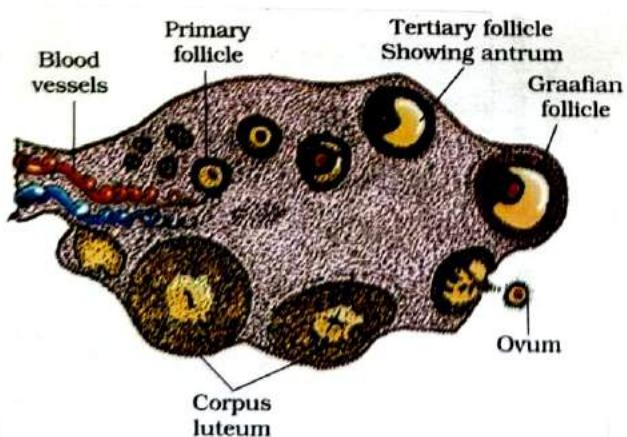




**Figure 3.3 (a)** Diagrammatic sectional view of female pelvis showing reproductive system



**Figure 3.3 (b)** Diagrammatic sectional view of the female reproductive system



**Figure 3.7** Diagrammatic Section view of ovary

\***MONS-PUBIS** :- cushion of fatty tissue covered by skin and pubic hairs

\***LABIA-MAJORA** :- Fleshy fold of tissue

\***LABIA-MINORA** :- paired fold of tissue under labia majora

\***HYMEN** :- partially covers the opening of vagina

\***CLITORIS** :- tiny finger like structure which lies at upper junction of 2 labia minora

Female Reproductive parts alongwith pair of Mammary glands

Integrated Structurally & Functionally

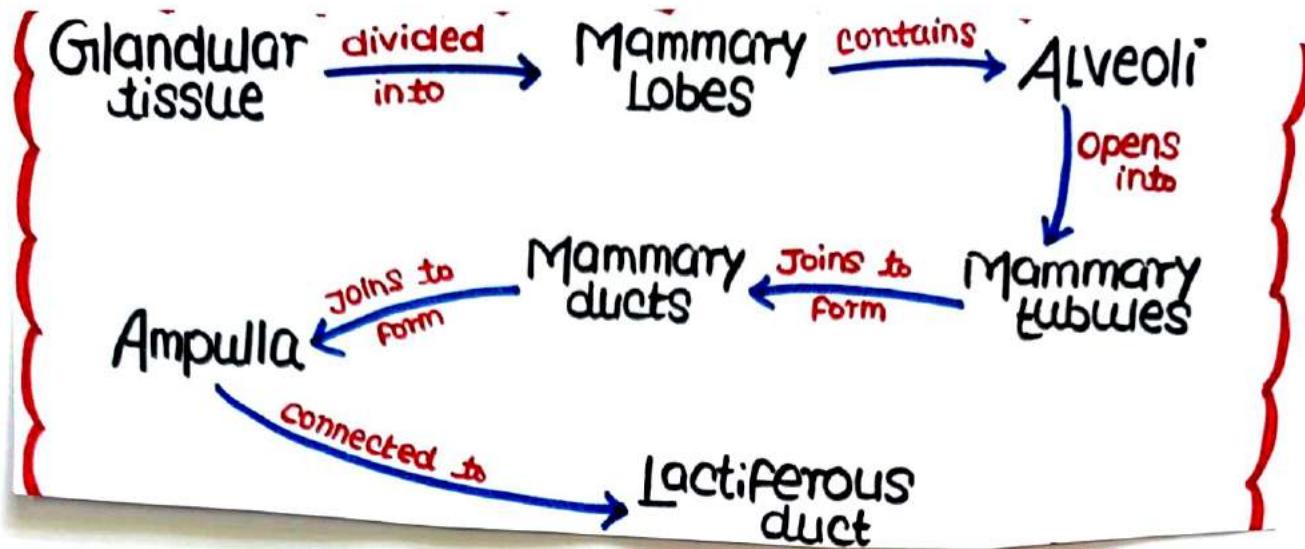
Ovulation, Fertilisation, Pregnancy, Birth, Child-care

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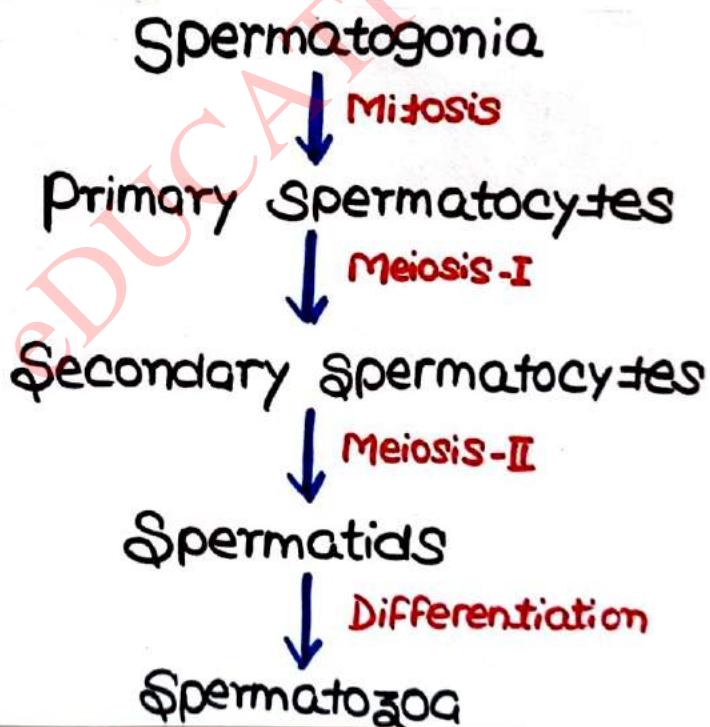
## MAMMARY-GLAND

GLANDULAR TISSUE  
(For milk formation)

VARIABLE AMOUNT OF FAT (for support)



## SPERMATOGENESIS

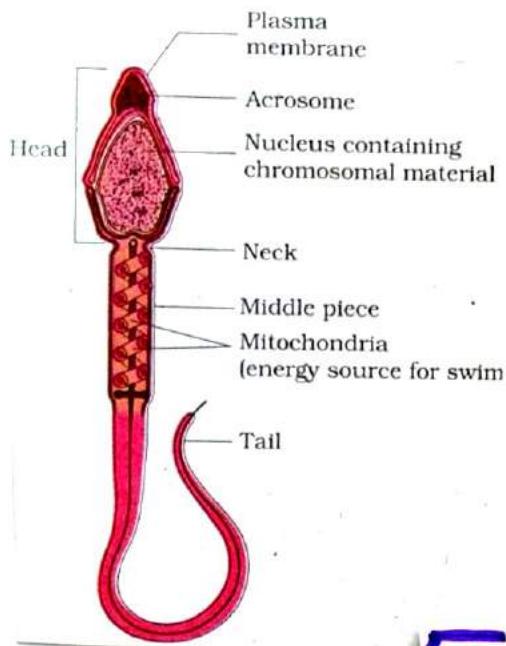


### SPERMOGENESIS

Spermatids are transferred into Spermatozoa (Sperm)

### SPERMATION

Release of the Sperm from the Seminiferous tube



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### ACROSOME

- Cap like structure which covers the anterior portion of sperm
- Filled with enzymes which help in fertilisation

### MIDDLE-PIECE

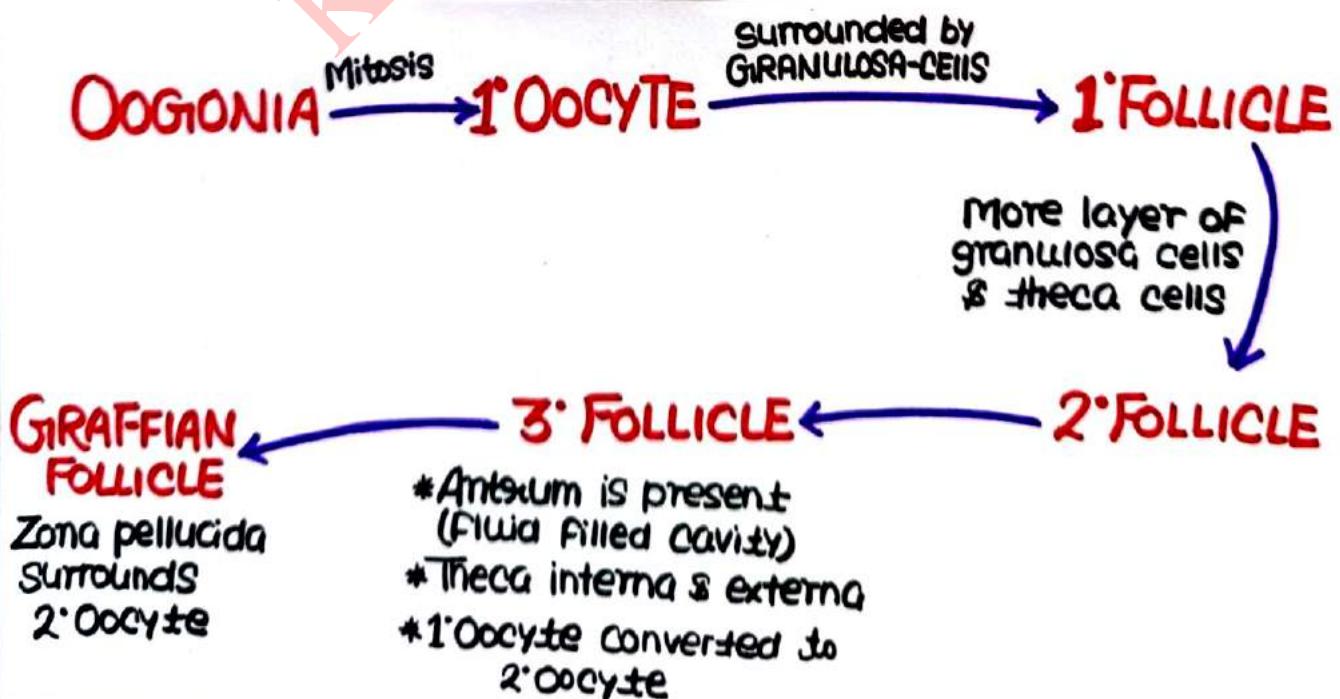
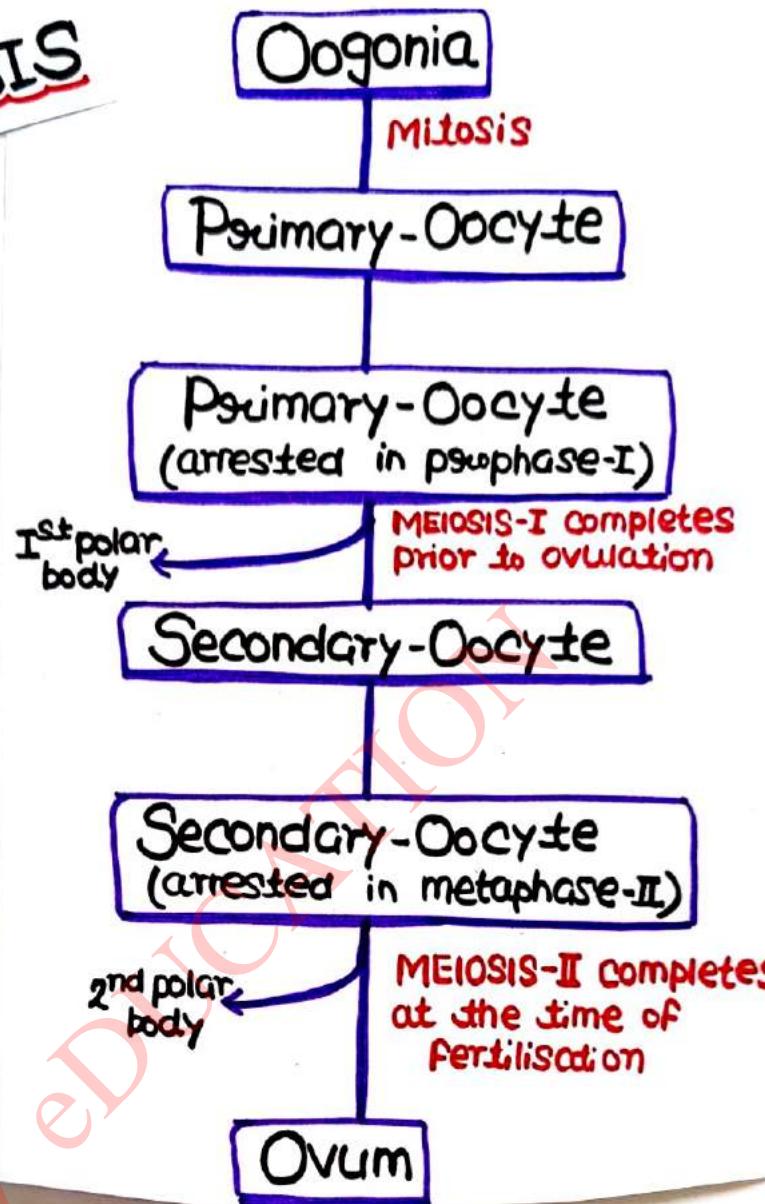
- Posses MITOCHONDRIA which produce energy needed for sperm motility

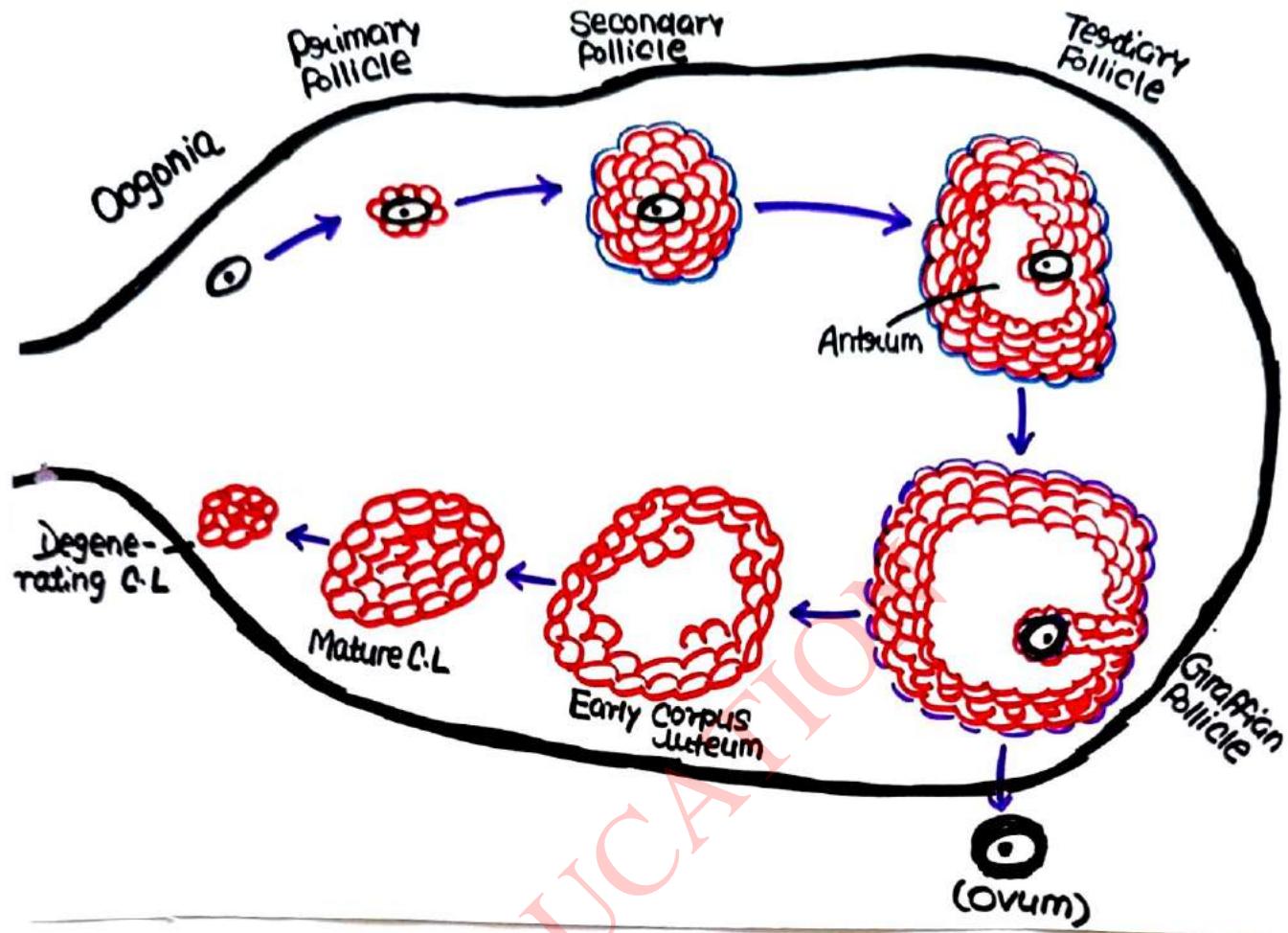
### TAIL

- cause Sperm motility

- Human Male ejaculates **200-300 million** sperm/coitus
- CRITERIA FOR **NORMAL FERTILITY**
  - at least **60%** must have normal shape & size
  - at least **40%** must show vigorous motility

# OOGENESIS



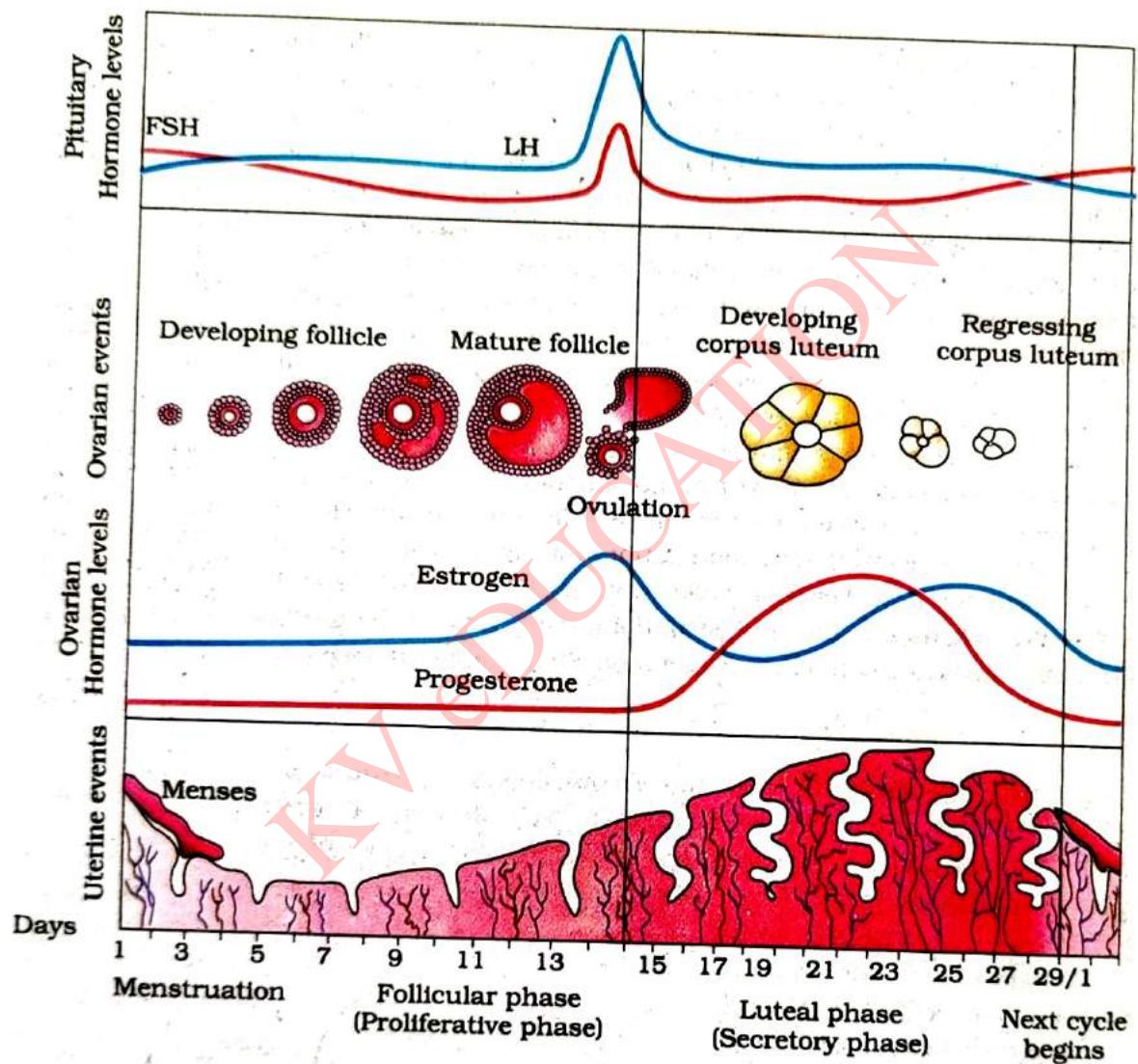


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## MENSTRUAL-CYCLE

### MENSTRUAL-PHASE

- \* Menstrual flow occurs & it last for 3-5 days
- \* Menstrual flow results due to breakdown of endometrial lining of the uterus and its blood vessels which forms liquid that comes out through vagina



**Figure 3.9** Diagrammatic presentation of various events during a menstrual cycle

## FOLLICULAR-PHASE

- \* Primary Follicle grows to become a fully mature Graffian Follicle and simultaneously the endometrium of uterus regenerates thru proliferation
- \* Level of FSH & LH increases gradually which stimulates the secretion of ESTROGENS
- \* Both LH and FSH attain a peak level in the middle of cycle (about 14<sup>th</sup> day)

## OVULATORY-PHASE

- \* Rapid secretion of LH at mid of the cycle, is called LH-SURGE
- \* LH SURGE induces rupture of Graffian Follicle and thereby release of OVUM (OVULATION)

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## LUTEAL-PHASE

- \* Remaining part of Graffian Follicle transforms as the CORPUS-LUTEUM
- \* Corpus Luteum releases large amount of progesterone which is essential for endometrium maintenance
- \* Such endometrium is necessary for implantation of the fertilised ovum and other events of pregnancy.

# **MENARCHE** - First menstruation begins at puberty

# **MENOPAUSE** - M. cycle ceases around 50 yr of age

# FERTILISATION

Semen released by penis in vagina (INSEMINATION)

↓  
Motile sperm swims rapidly and reaches AMPULLA of fallopian tube through cervix and uterus  
(Ovum released by ovary also transported to AMPULLA)

↓  
FERTILISATION takes place... only if both sperm and ovum simultaneously reached to Ampullary region  
(That is why all copulations will not lead to pregnancy)

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During FERTILISATION, a sperm comes in contact with the zona pellucida layer of ovum

↓  
This induce change in the membrane that block the entry of additional sperms

↓  
It ensure that only one sperm can fertilise ovum

↓  
The secretions of the acrosome help the sperm enter into the cytoplasm of ovum through the zona pellucida and plasma membrane

↓  
This induces completion of meiotic division of the 2<sup>o</sup> oocyte leads to formation of Second polar body and haploid ovum (Ootid)

**Sperm + Ovum**



**Zygote**

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↓ mitosis



**EMBRYO with  
2 blastomeres**

↓ Mitosis



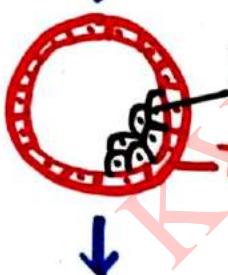
**EMBRYO with  
4 blastomeres**

↓ Mitosis



**Embryo with 8-16  
blastomeres (MORULA)**

↓ Mitosis



**Inner cell mass**

**Trophoblast**

→ **BLASTOCYST**

\***TROPHOBlast** - attached to endometrium

\***INNER CELL MASS** - get differentiated as embryo



**After attachment, uterine cell divide rapidly  
and covers the blastocyst**



**This is called IMPLANTATION  
& lead to pregnancy**

After implantation, finger like projections appear on the trophoblast called chorionic villi (which are surrounded by uterine tissue & maternal blood)

Chorionic villi and uterine tissue become interdigitated with each other and jointly form a

Structural & functional unit b/w developing embryo and maternal body called PLACENTA

## PLACENTA

Supplies oxygen and nutrients to the embryo

Remove  $\text{CO}_2$  and WASTE produced by embryo

Act as endocrine tissue & produce several hormones -  
hCG (human chorionic gonadotropin)  
hPL (human placental lactogen)  
estrogens, progesterogens

Hormones produced only during pregnancy

hCG  
hPL  
Relaxin

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In later phase of pregnancy, a hormone called Relaxin is also secreted by Ovary

During pregnancy...

ESTROGEN, PROGESTERONE, CORTISOL, PROLACTIN, THYROID HORMONE are also increased in maternal blood

Inner cell mass [Embryo] differentiates into

Ectoderm

Mesoderm

Endoderm

These 3 layers will give rise to all Tissues

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Inner cell mass have certain cells

STEM-CELLS

Potency to give rise to all the tissues and organs

## EMBRYONIC DEVELOPMENT DURING PREGNANCY

- Heart - After 1 Month
- Limbs & Digits - End of 2<sup>nd</sup> Month
- Major Organ System - End of 1<sup>st</sup> Trimester/12 weeks
- 1<sup>st</sup> Movement and Hairs on head - During 5<sup>th</sup> month
- Fine hairs on head, Eyelids separate, - End of 2<sup>nd</sup> Trimester/24 weeks  
Eyelashes formed

Fully developed FOETUS & PLACENTA



Mild Uterine Contractions



FOETAL EJECTION REFLEX



Release of OXYTOCIN from maternal pituitary



Stronger UTERINE-CONTRACTIONS



Expulsion of the baby out of the uterus through birth canal, is called PARTURITION



Soon, Placenta is also expelled out of uterus

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**LACTATION**

Mammary glands of the female undergo differentiation during preg. and starts producing milk towards end of pregnancy.

**COLOSTRUM**

Milk produced during the initial few days of lactation

# REPRODUCTIVE - HEALTH

Acc. to WHO (World Health Organisation)

REPRODUCTIVE - HEALTH

is

Total well being in all aspects of reproduction  
i.e. physical, Emotional, Behavioural, Social

Family Planning Programme → Initiated in India in 1951

**RCH** - Reproductive & Child Healthcare

**MMR** - Maternal Mortality Rate

**IMR** - Infant Mortality Rate

**CDRI** - Central Drug Research Institute

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**AMNIOCENTESIS**

Amniotic fluid of developing fetus is taken to analyse the fetal cells and dissolved substance

BANNED to prevent Female Foeticide

## CONTRACEPTIVE METHODS

### NATURAL METHODS

### ARTIFICIAL METHODS

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### NATURAL-METHODS

#### PERIODIC ABSTINENCE

\* Avoid coitus from 10-17d of M.cycle

#### WITHDRAWL OR

#### COITUS INREPTUS

\* penis withdrawal just before ejaculation

#### LACTATIONAL AMMENORHEA

\* Ovulation does not occurs during intense lactation (absence of menstruation)

### ARTIFICIAL-METHODS

#### Barrier methods

#### IUDs

#### Surgical

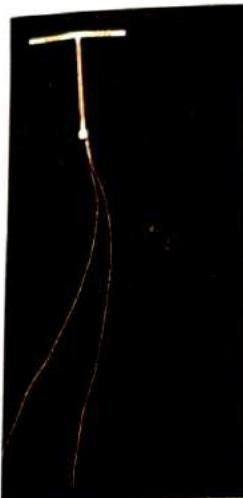
#### Chemical methods

#### Contraceptive pills

#### Injection & Implants

## BARRIER-METHODS

- **CONDOMS** - for both MALE & FEMALE
  - made of THIN RUBBER/LATEX SHEATH
  - disposable, self-inserted, provide privacy



4.2. Copper T (CuT)

## DIAPHRAGMS, CERVICAL-CAPS, VAULTS}

- Only for females
- Made up of Rubber
- They are reusable



Figure 4.1(a) Condom for male



Figure 4.1(b) Condom for female

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- Ideal contraceptive for females who want to delay pregnancy
- One of the most widely accepted method in india

## IUDs

### NON MEDICATED

- \* Increase the phagocytosis of sperm

eg. Lippes loop

### COPPER RELEASING

- \* Suppress the sperm motility

eg. CuT, Cu7, Multiload 375

### HORMONE RELEASING

- \* Make uterus unsuitable for implantation

eg. Progestasert, LNG-20

## ORAL-PILLS

Progestogens or  
Prog. + Estrogen  
combinations

Used in the  
form of the  
tablets &  
hence called Pills

Inhibit OVULATION  
& IMPLANTATION as  
well as alter the  
quality of cervical mucus  
to prevent/retard  
entry of sperms

**SAHELI** → Once a week pill  
→ Non-Steroidal  
→ Developed at CDR (Lucknow)

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## (SURGICAL METHODS)

### TUBECTOMY

\* Small part of  
fallopian tube  
removed/tied up

### VASECTOMY

\* Small part of  
vas-deference  
removed/tied up

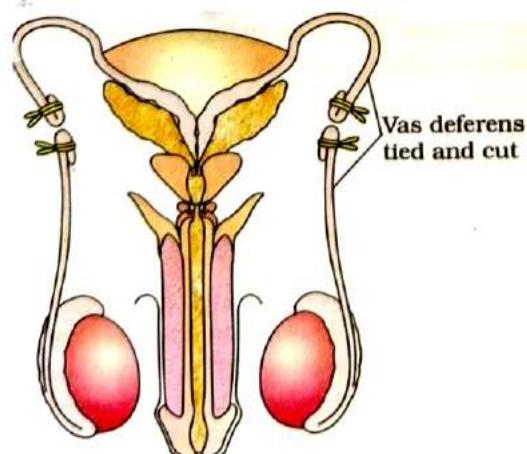


Figure 4.4 (a) Vasectomy

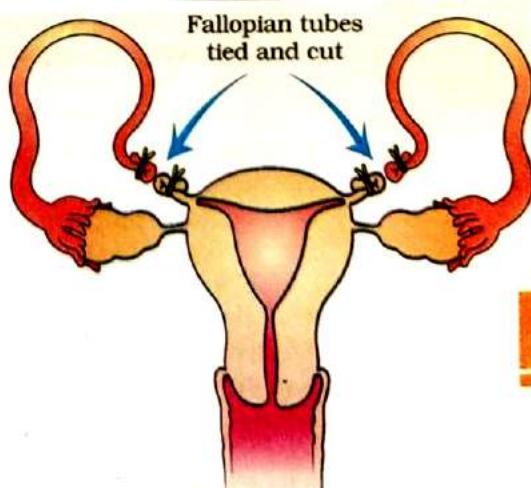


Figure 4.4 (b) Tubectomy

## IMPLANTS or INJECTIONS

- Progestogens alone or in combination with Estrogen
- Under the skin
- Mode of action similar to pills and their effective period are much longer

MTP

(Medical Termination of pregnancy)

Voluntary termination of pregnancy before full term

Legalised in India in 1971 under strict conditions

Safe during 1<sup>st</sup> Trimester

{ STD / RTI / VD }

Sexually Transmitted Disease

Reproductive Tract Infections

Veneral disease

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- Gonorrhoea, Syphilis, Genital herpes, HIV, Chlamydia, Genital warts, Trichomoniasis, Hep-B
- Among these HIV is most dangerous
- HIV, Hepatitis-B, Herpes  $\rightarrow$  NON-CURABLE
- Early symptoms are itching, swelling, Fluid discharge but if remains undetected & untreated then could lead to complications later like ABORTION, STILL-BIRTH, ECTOPIC, PID (Pelvic inflammatory disease)

# INFERTILITY

## ART

Assisted Reproductive Technique

**IN-VITRO**  
(Fertilisation outside body)

**A). ZIFT** (Zygote intra Fallopian transfer)

Zygote upto 8  $\xrightarrow{\text{transferred}}$  Fallopian tube  
blastomeres

**IN-VIVO**  
(Fertilisation inside body)

**A). GIFT** (Gamete Intra Fallopian Transfer)

OVUM  
from  $\xrightarrow{\text{transferred}}$  Fallopian tube  
donor of abnormal female

**B). IUT** (Intra Uterine Transfer)

Zygote more  
than 8  $\xrightarrow{\text{transferred}}$  Uterus  
blastomeres

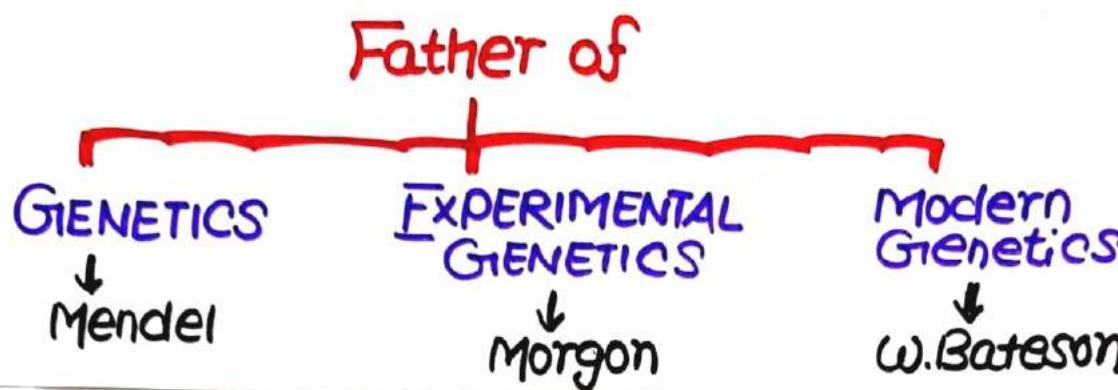
**B). AI** (Artificial Insemination)

Semen from  
husband or  
healthy donor  $\xrightarrow{\text{artificially introduced}}$  Vagina or  
uterus of the female

**C). ICSI** (Intra Cytoplasmic Sperm injection)

Sperm is directly injected  
into the ovum

# PRINCIPLE OF INHERITANCE & VARIATION



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## ALL-SCIENTISTS

- \* Father of genetics - Mendel
- \* Punnett square - R.C Punnett
- \* Chromosomal theory of Inheritance - Sutton & Boveri
- \* Re-discovery of Mendel's work - De Vries, Tschermak, Correns
- \* term 'LINKAGE' - T.H Morgan
- \* name 'X-Body' - Herting

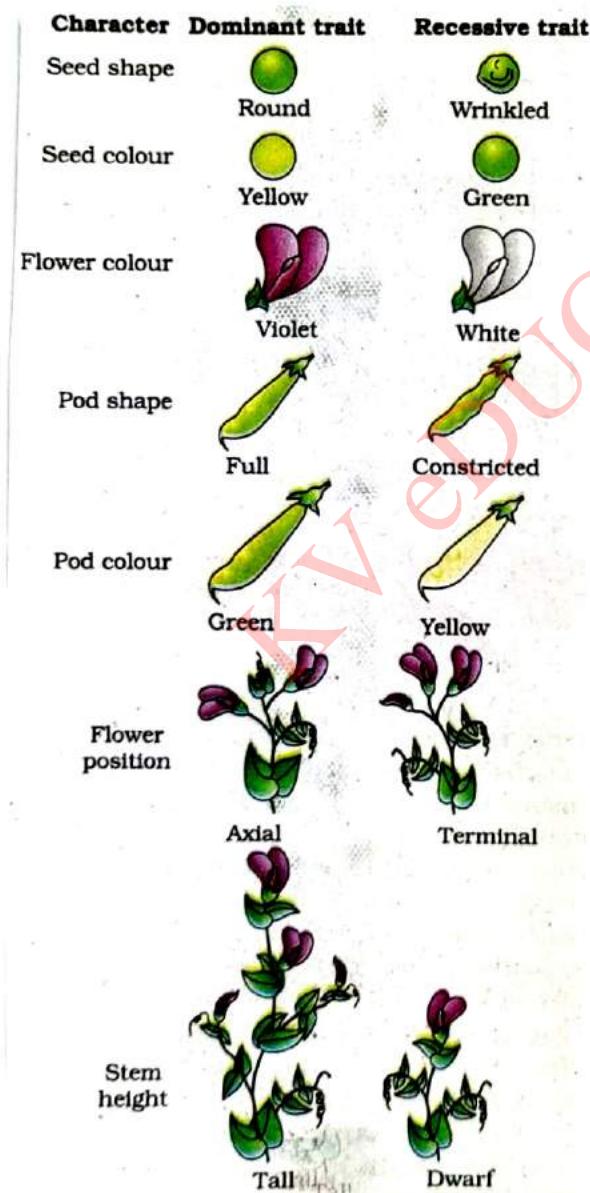
## ALLEL

Alternative form of gene, located on same position on the homologous Chromosome

- **PHENOTYPE** - External appearance of org<sup>m</sup>
- **GENOTYPE** - Genetic constitution of org<sup>m</sup>

**Heredity**: Transmission of characters across generations

**Variation**: Difference in individuals of same species



**MENDEL'S**  
working years

1856-1863

S.No.	Characters	Contrasting Traits
1.	Stem height	Tall/dwarf
2.	Flower colour	Violet/white
3.	Flower position	Axial/terminal
4.	Pod shape	Inflated/constricted
5.	Pod colour	Green/yellow
6.	Seed shape	Round/wrinkled
7.	Seed colour	Yellow/green

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Figure 5.1 Seven pairs of contrasting traits in pea plant studied by Mendel

## REASON FOR MENDEL-SUCCESS

1/2 characters  
at one time

Statistical  
record

Pea-plant  
selection

- Self poll'n
- Multiple traits
- Short life cycle

Mendel proposed 2 general rules to understand MONOHYBRID-CROSS

Law of  
DOMINANCE

Law of  
SEGREGATION

Monohybrid

$Aa$

Dihybrid

$AaBb$

Trihybrid

$AaBbCc$

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## LAW OF DOMINANCE

Characters are controlled by discrete unit called FACTORS

FACTORS occurs in pairs

In dissimilar pair of factors one member of the pair dominates (dominant) & the other (recessive)

Exceptions: Incomplete & Co-dominance

## { LAW OF SEGREGATION }

It states that, the alleles do not show any blending and that both the characters are recovered as such in  $F_2$  generation

⇒ There is no exception of this law

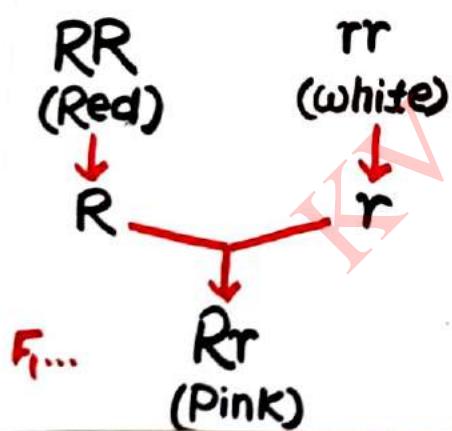
## { LAW OF INDEPENDENT-ASSORTMENT }

\* Explained by Dihybrid cross

\* It states that when two pairs of traits are combined in a hybrid, Segregation of one pair of characters is independent of other pair of characters

**EXCEPTION: Linkage**

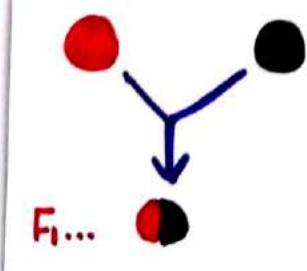
## { INCOMPLETE-DOMINANCE }



- $F_1$  generation is different from both the parents
  - Dominant factor is unable to express itself
- eg. *Mirabilis jalapa* (40'clock)  
*Antirrhinum majus* (Snapdragon)

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## { Co-DOMINANCE }



- Both the characters are expressed equally

eg. AB blood group ( $I^A I^B$ )  
Sickle cell anaemia  
Coat colour in Cattle

## {MULTIPLE-ALLEL}

- # More than 2 alternative forms of same gene are called MULTIPLE-ALLEL
- # They are located on same locus of chromosome
- # e.g. ABO blood group (3 alleles -  $I^A$ ,  $I^B$ ,  $i$ )

## {POLYGENIC-INHERITANCE}

- # When 1 character is controlled by  $>1$  genes
- # e.g. HUMAN (Skin colour, weight, Height, eye colour)

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## {PLEIOTROPIC-GENE}

- # Gene which controls  $>1$  characters
- # e.g. Phenylketonuria, Sickle cell anaemia

### TEST-CROSS

$F_1 \times$  Recessive parent

### BACK-CROSS

$F_1 \times$  Dominant parent

## {SEX-DETERMINATION}

$XX$  (female)

$XY$  (male)

e.g. Humans

$XX$  (female)

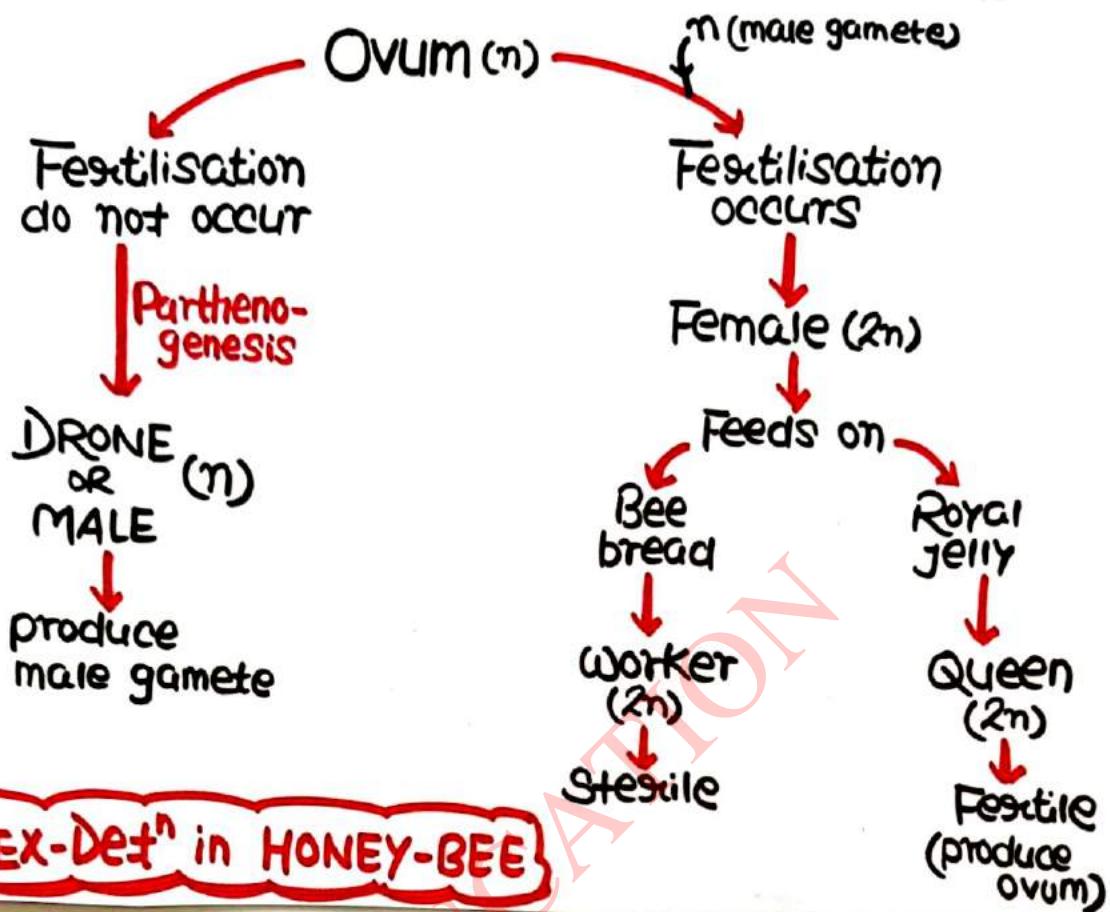
$XO$  (male)

e.g. Grasshopper

$ZZ$  (male)

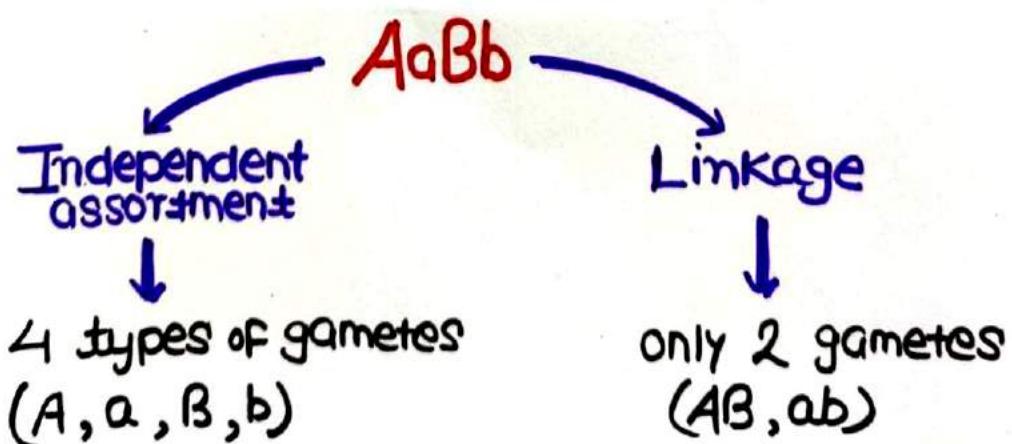
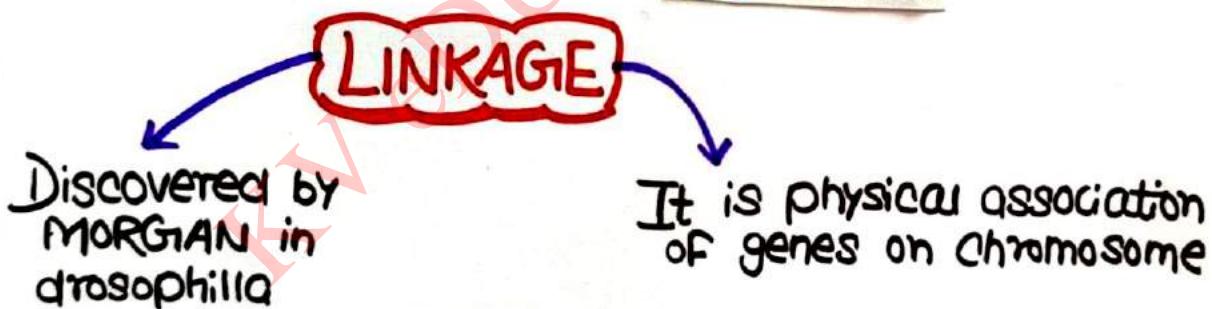
$ZW$  (female)

e.g. Birds



## SEX-Det<sup>n</sup> in HONEY-BEE

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$$\text{Linkage} \propto \frac{1}{\text{distance b/w genes}} \propto \frac{1}{\text{crossing over}}$$

Number of  
LINKAGE-GROUP

$n$  (haploid number of chromosomes)

e.g. pea,  $2n=14$ ,  $n=7$ ,  $\boxed{\text{Linkage group} = 7}$

### # Examples of X-LINKAGE (Sex Linkage)

- Haemophilia
- Colour blindness
- Eye colour in *Drosophila*

# Type of PHENOTYPE -  $2^n$

# Type of Genotype -  $3^n$

# Type of Gamete -  $2^n$

# possible genotypes -  $n(n+1)/2$   
(multiple allele)

# possible phenotype -  $2n+1$   
(polygenic inheritance)

$n$



Heterozygous pairs

e.g.  $AaBb$ ,  $n=2$

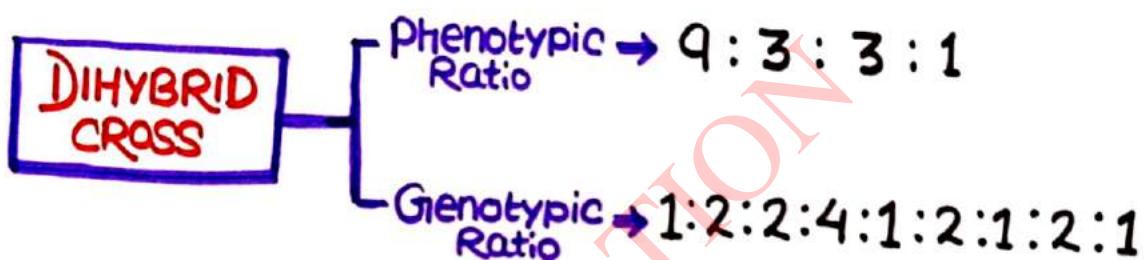
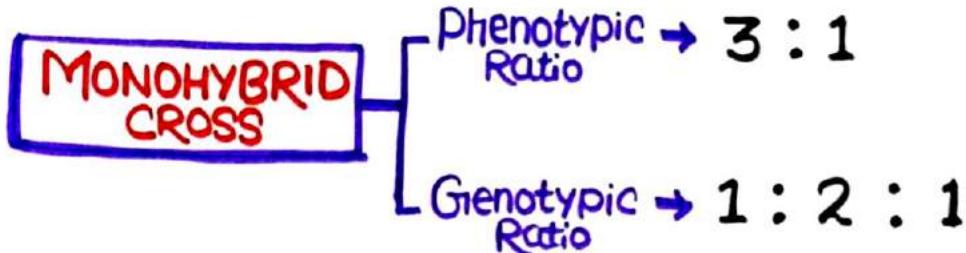
$AABB$ ,  $n=1$

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**ANEUPLOIDY** - Failure of segregation of chromatids during cell division cycle results in the gain or loss of chromosomes

**POLYPLOIDY** - Failure of cytokinesis after telophase stage of cell-division results in an increase of in a whole set of chromosome in an organism

# ALL-RATIOS



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Alteration of DNA sequence and consequently results in changes in the genotype & phenotype

## MUTATION

### POINT-MUTATION

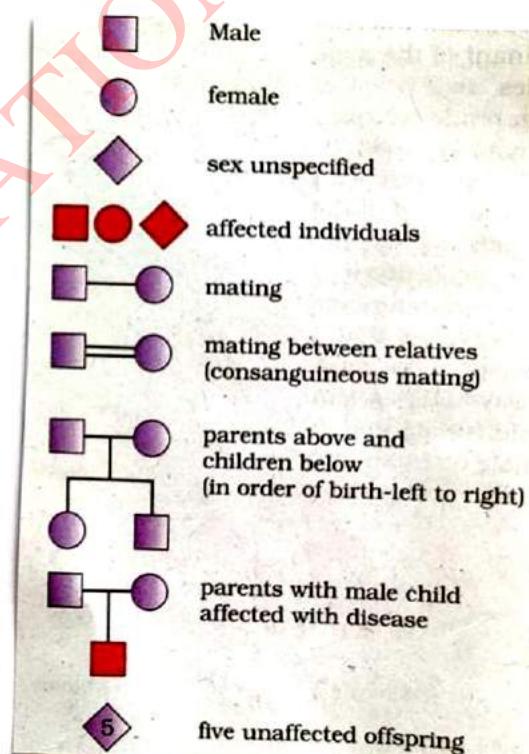
Due to change in single base pair  
e.g. Sickle cell anaemia

### FRAME-SHIFT MUTATION

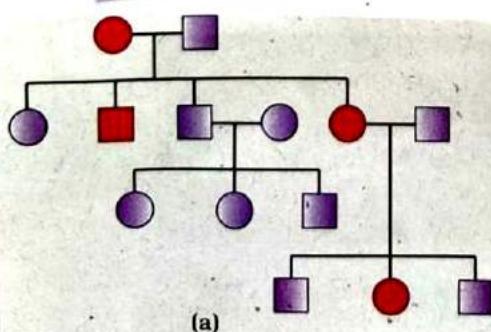
Deletion and insertions of base pairs of DNA

## PEDIGREE-ANALYSIS

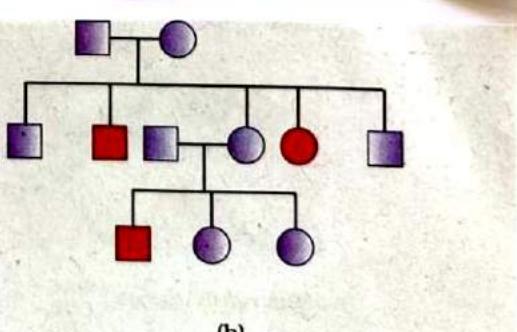
Study of an inherited trait in a group of related individuals to determine the pattern and characteristics of the trait, including its mode of inheritance and phenotypic variability



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(a)



(b)

Figure 5.14 Representative pedigree analysis of (a) Autosomal dominant trait (for example: Myotonic dystrophy) (b) Autosomal recessive trait (for example: Sickle-cell anaemia)

# GENETIC - DISORDERS

## MENDELIAN

- \* Colour blindness
- \* Haemophilia
- \* Sickle cell anaemia
- \* Phenylketonuria
- \* Thalassemia

## CHROMOSOMAL

- \* Down syndrome
- \* Klinefelter Syndrome
- \* Turner syndrome

# Colour blindness, Haemophilia ] Sex linked Recessive  
# Sickle cell, PKU, Thalassemia ] Autosomal linked Recessive

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## COLOUR-BLINDNESS

Defect in Red or Green cone of eye

Due to mutation in certain genes present in the X-chromosomes

Occurs in 8% of Males, 0.4% of Females

## HAEMOPHILIA

PROTEIN, which involved in blood clotting is affected

Single cut will result in non-stop bleeding

Family pedigree of Queen Victoria shows a number of haemophilic descendants as she was carrier of the disease

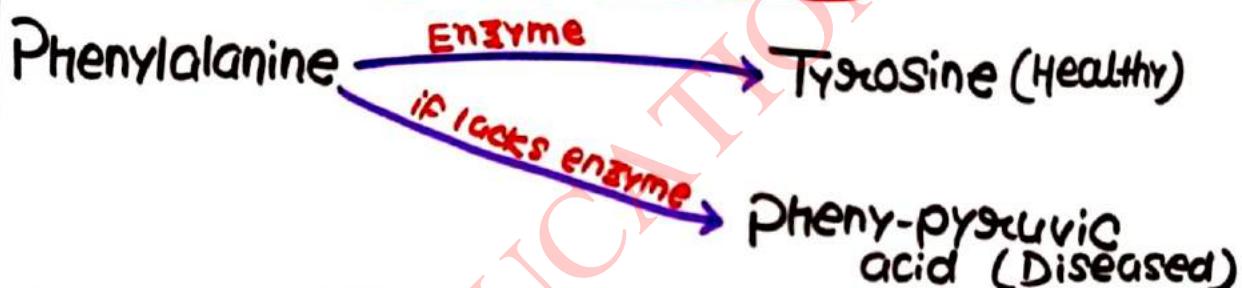
## SICKLE CELL ANAEMIA

Substitution of Glutamic acid by Valine at 6<sup>th</sup> position of beta globin chain of Hb

*cause*

Change in the shape of RBC from biconcave to elongated sickle like structure

## PHENYLKETONURIA



### Phenyl-pyruvic acid

Accumulation in brain cause MENTAL RETARDATION  
Also excreted in urine because of its poor absorption by kidney

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## THALASSEMIA

Reduced Rate of Synthesis of GLOBIN-CHAINS

### $\alpha$ -Thalassemia

\*  $\alpha$ -globin chain affected

### $\beta$ -Thalassemia

\*  $\beta$ -globin chain affected

- \* **Thalassemia** - Quantitative problem
- \* **Sickle cell Anaemia** - Qualitative problem

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### Down's Syndrome

Caused by presence of an additional copy of the chromosome number 21 [trisomy]

AFFECTED INDIVIDUAL IS  
Short statured, Round head, Furrowed tongue, partially open mouth, Broad palm  
⇒ physical, psychomotor, mental development is retarded

### Klinefelter's Syndrome

Caused due to presence of additional copy of X-chromosome resulting into karyotype of 47, XXY

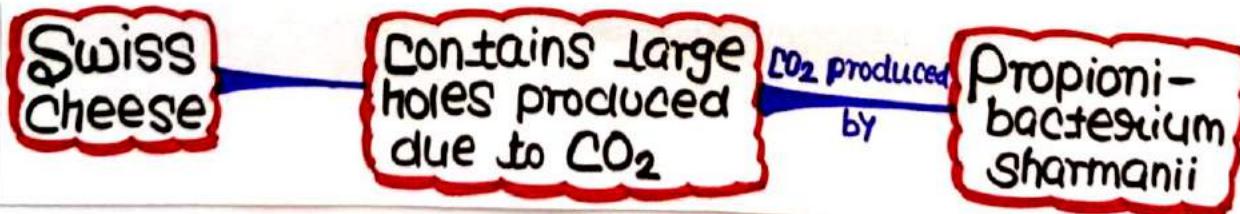
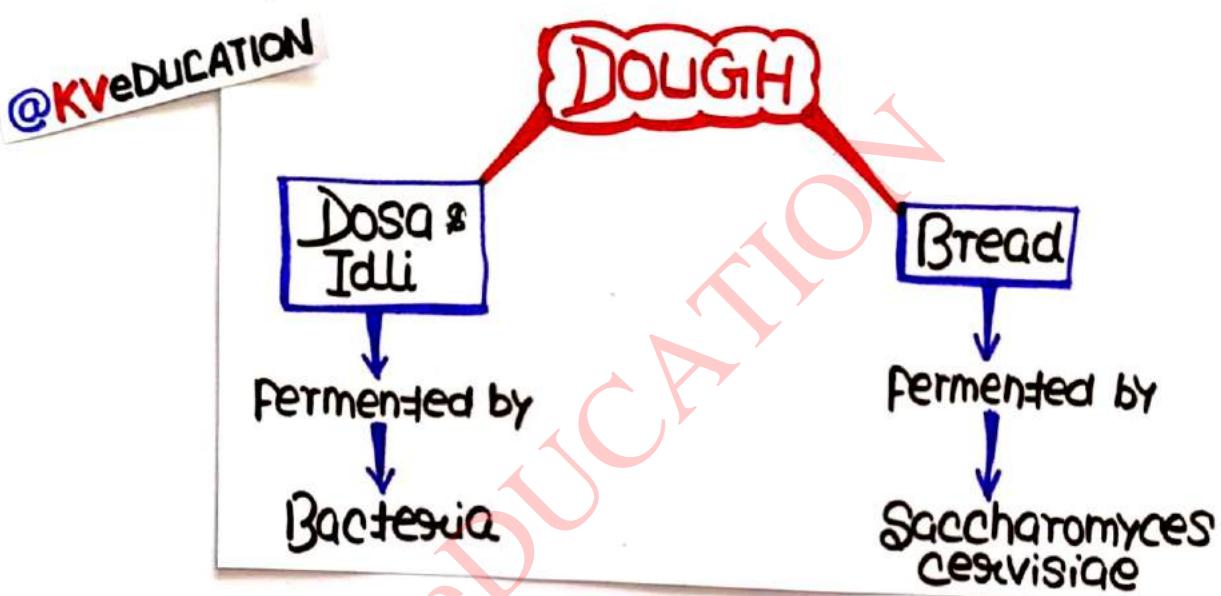
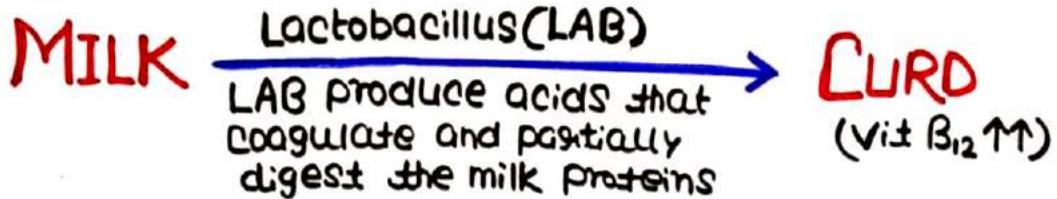
- Feminine development (Gynaecomastia)
- Such individuals are sterile

### Turner's Syndrome

Caused due to absence of one of the X-chromosome (45 with XO)

Such females are sterile as ovaries are rudimentary besides other features including lack of other secondary sexual characters

# MICROBES IN HUMAN WELFARE



## Saccharomyces Cervisiae (yeast)

Baker's yeast

↓ used to make

Bread

Brewer's yeast

↓ used to make

Beer, Wine, Rum, Whisky, Brandy

## ALCOHOLIC DRINKS

with DISTILLATION

Whisky, Rum, Brandy

without DISTILLATION

Wine, Beer

## ANTIBIOTICS

Chemical substance produced by some microbes to kill disease causing microbes

## PENICILLIN

discovered by Alexander flemming

full-potential explored by Ernest chain & Howard florey

was used to treat american soldiers during world war-II

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Antibiotics have greatly improved our capacity to treat deadly disease such as

Plague, Whooping cough, Diphtheria, ~~Leprosy~~ Leprosy  
(Kali-khansi) (Ghau-ghatu) (Kushit-rogi)

- \* **Saccharomyces cervisiae** - production of ETHANOL
- \* **Lipase** - Removes Oily stains
- \* **Protease & Pectinase** - Cleasing of Bottle juice
- \* **Streptokinase** - Clot-buster (Heart attack)
- \* **Cyclosporin-A** - Immunosuppressive agent (used in Organ Transplant)
- \* **STATINS** - Blood Cholesterol lowering agent

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- CITRIC ACID → *Aspergillus niger* (Fungi)
- ACETIC ACID → *Acetobacter aceti* (Bacteria)
- BUTYRIC ACID → *Clostridium butylicum* (Bacteria)
- LACTIC ACID → *Lactobacillus* (Bacteria)
- STREPTOKINASE → *Streptococcus* (Bacteria)
- CYCLOSPORIN-A → *Trichoderma polysporum* (Fungi)
- STATINS → *Monascus purpureus* (Fungi)

# BIOGAS

Mixture of gases (predominantly  $\text{CH}_4$ ) produced by microbial activity and which may be used as fuel

## METHANOGENES

(e.g. *Methanobacterium*)

are

Bacteria that grow anaerobically on cellulosic material

produce

Large amount of  $\text{CH}_4$  alongwith  $\text{CO}_2$  &  $\text{H}_2$   
(methane)

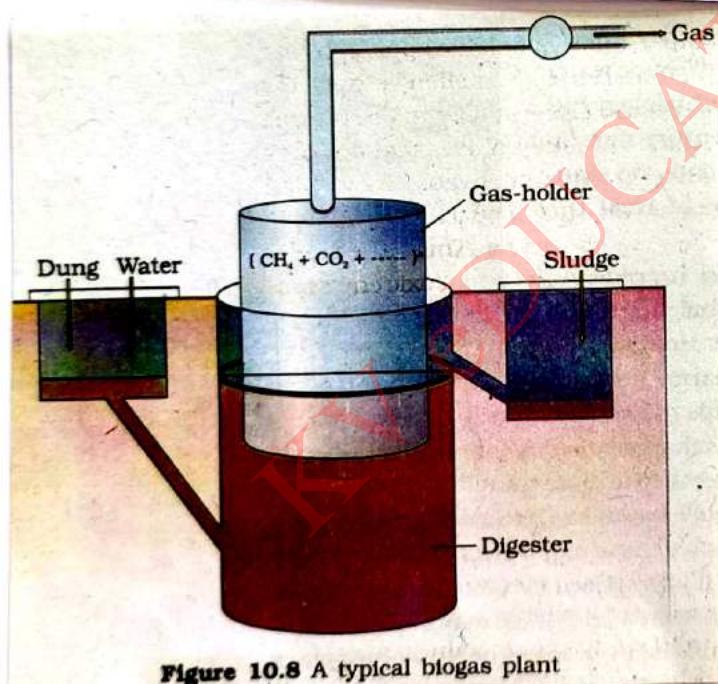


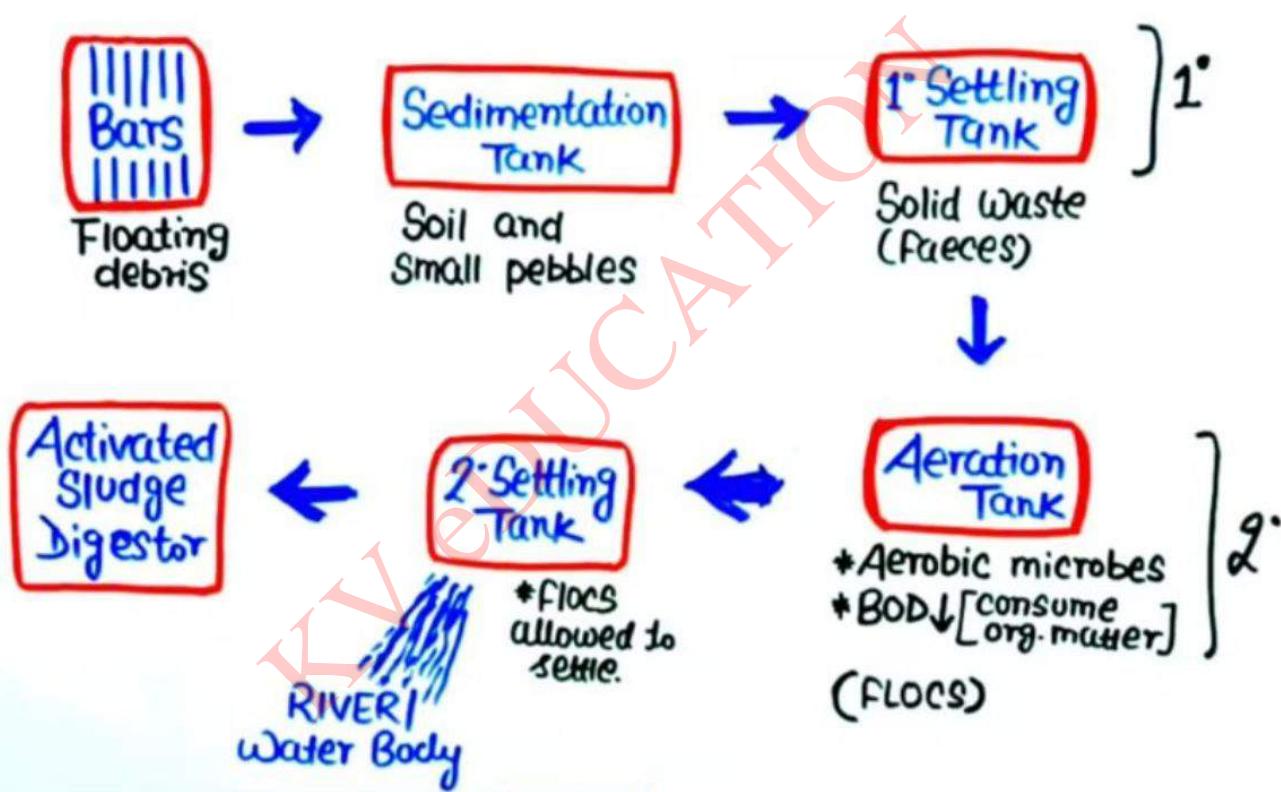
Figure 10.8 A typical biogas plant

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**METHANOBACTERIUM** - present in Rumen (part of stomach) of cattle  
help in breakdown of cellulose in cattle

**IARI**: Indian Agricultural Research Institute

**KVIC**: Khadi & Village Industries Commission



# ORGANIC-FARMING

Farming in which BIOFERTILIZERS are used

Main source of biofertilizers are Bacteria,  
Fungi and Cyanobacteria

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## MICROBES AS BIOCONTROL-AGENT

### INSECTS

Beetles with red & black markings, LADYBIRD and DRAGONFLIES

Controls → Aphids & Mosquito

### BACTERIA

*Bacillus thurengensis*

Controls → Butterfly caterpillars

### FUNGI

*Trichoderma*  
(free living in root ecosystem)

Controls → Several plant pathogens

### VIRUS

*Baculovirus*  
(Nucleopolyhedrovirus)

Control → Insects & some arthropods

## Features of BACULOVIRUSES (nucleopolyhedrovirus)

Species-specific, narrow spectrum insecticidal applications

No negative impact on plant, Birds, Mammals, fish

used in IPM (Integrated pest Management)  
OR  
when ecologically sensitive area is being threatened

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## MYCORRHIZA

Symbiotic association between FUNGI and a PLANT

FUNGI provides to PLANT

phosphorus, pathogen resistance,

Tolerance to salinity & drought

PLANT provides to FUNGI

shelter, carbon

## NITROGEN FIXING BACTERIA

### FREE-LIVING

- Azotobacter
- Beijerinckia
- Rhodospirillum

### SYMBIOTIC

- Frankia
- Rhizobium

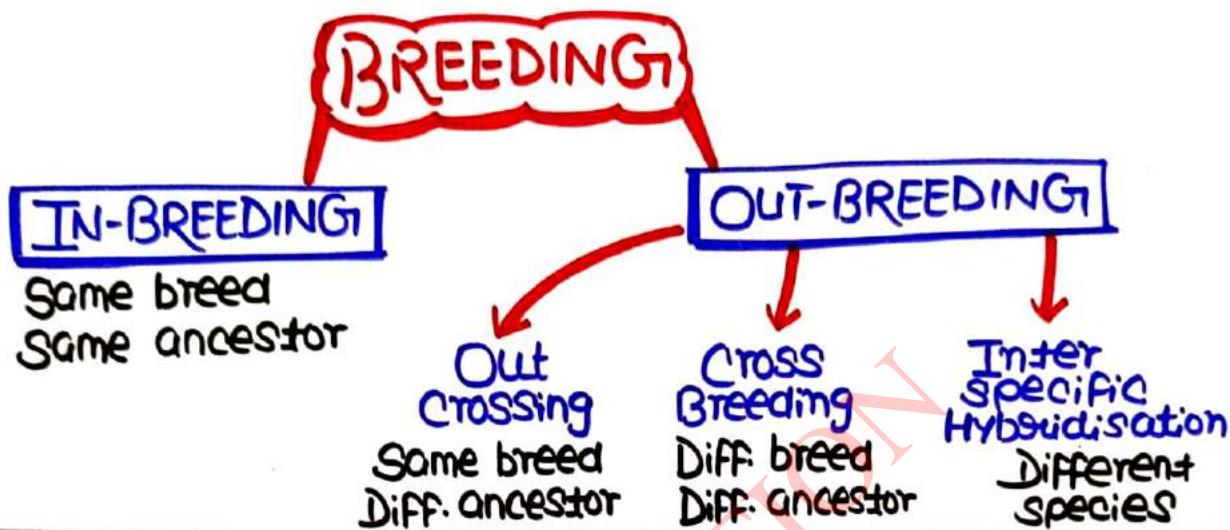
$N_2$ -FIXING  
cyanobacteria  
or  
Blue green algae

Anabaena

Nostoc

Oscillatoriella

# STRATEGIES FOR EN. IN FOOD PRODUCTION



**IN-BREEDING**

- Increase HOMOZYGOSITY
- Continued In-Breeding cause IN-BREEDING DEPRESSION (which reduce fertility & productivity)

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**Hisardale** Breed of sheep developed in Punjab  
By crossing Bikaneri & Mastino  
ewes rams

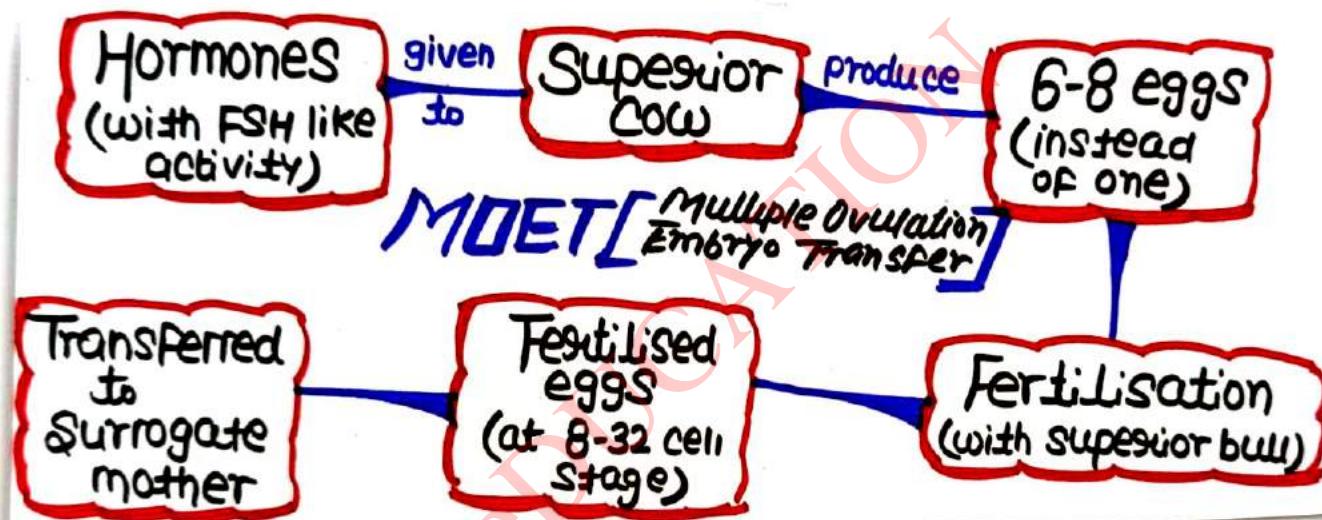
- # Best for purelines - In Breeding
- # Best for low productivity - Out Crossing
- # Best for desirable qualities - Cross Breeding

# CONTROL BREEDING EXPERIMENTS

Carried out by

## ARTIFICIAL-INSEMINATION

Semen from selected MALE is injected into reproductive tract of selected FEMALE



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Bee keeping is called as APICULTURE

Most common specie of H-bee is *Apis indica*

Bee-wax used in cosmetics, polishes

## AQUACULTURE vs PISCICULTURE

Aquatic Animals & Plants

Only FISHES

FRESH WATER : Catla, Common, Rohu, Carp

FISH FOR FOOD

MARINE WATER : Hilsa, Sardines, Pomfrets, Mackerels

In mid 1960s, several high yielding varieties of wheat and rice developed as a result of various plant breeding techniques

Drammatic food production in our country

GREEN-REVOLUTION

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WHEAT

# During 1960-2000, wheat production increases from 11 million tonnes to 75 million tonnes

# Norman E. Borlaug → International Centre for wheat & Maize Improvement [MEXICO] → Semi-dwarf variety of wheat

# INDIAN VARIETIES → introduced in 1963 → Sonalika & Kalyan-Sona

## RICE

# During 1960-2000, Rice production increased from 35 million tonnes to 89.5 million tonnes

# IRRI [Int'l Rice Research Inst.] , Phillipines

# IR-8 [IRRI] , Taichung Native-I [Taiwan]

# INDIAN-VARIETIES :- Jaya & Rathna

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*Saccharum barbesii* → grows in NORTH-INDIA → Bad quality

## SUGARCANE

*Saccharum officinarum* → grows in SOUTH-INDIA → Good quality

These 2 crossed to grow good quality in NORTH-INDIA

# IRON FORTIFIED RICE : 5 times more iron

# HYBRID MAIZE (2000') : 2 times more LYSINE, <sup>Trypsin-  
phosphatase</sup>

# ATLAS 66 (wheat) : High protein wheat

# Mung bean (Mutation) : Resistant to yellow Mosaic Virus, powdery mildew

## DISEASE

### BACTERIA

Black rot of crucifer

### FUNGI

- \* Brown rust of wheat
- \* Red spot of Sugarcane
- \* Late blight of potato

### VIRUS

- \* Tobacco mosaic
- \* Turnip mosaic

Crop	Variety	Resistance to diseases
Wheat	Himgiri	Leaf and stripe rust, hill bunt
Brassicà	Pusa swarnim (Karan rai)	White rust
Cauliflower	Pusa Shubhra, Pusa Snowball K-1	Black rot and Curl blight black rot
Cowpea	Pusa Komal	Bacterial blight
Chilli	Pusa Sadabahar	Chilly mosaic virus, Tobacco mosaic virus and Leaf curl

Crop	Variety	Insect Pests
Brassica (rapeseed mustard)	Pusa Gaurav	Aphids
Flat bean	Pusa Sem 2, Pusa Sem 3	Jassids, aphids and fruit borer
Okra (Bhindi)	Pusa Sawant Pusa A-4	Shoot and Fruit borer

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## BIOFORTIFICATION

Breeding crops with higher level of vitamins and minerals or higher protein and healthier fats – is the most practical means to improve public health.

## SCP (Single Cell Protein)

- protein derived from a culture of single-celled organisms, used especially as food supplement
- SPIRULINA - source of single cell protein
- Bacteria like *Methylophilus methylotrophus* can produce 25 tonnes of protein

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## TISSUE-CULTURE

- EXPLANTS - part of plant that can regenerate whole plant
- TOTIPOTENCY - capacity to regenerate whole plant from explant
- MICROPROPAGATION - production of thousands of plants through tissue culture
- SOMATIC HYB<sup>n</sup> - PROTOPLAST of 2 different plants fused (potato + Tomato = Pomato)

# HUMAN HEALTH & DISEASE

Discovery of blood circulation → **William Harvey**

**HEALTH**

State of complete **PHYSICAL, MENTAL** and **SOCIAL** well-being

**INFECTIOUS**

Transmitted from one to another person

**NON-INFECTIOUS**

Do not get transmitted from one person to another

**PATHOGEN**

Disease causing organism  
(Bacteria, Virus, Fungi, protozoan etc)

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**DISEASES**

**BACTERIAL**

Typhoid, plague, Diphteria, Dysentery, Pneumoniae

**VIRAL**

Common cold, AIDS

**PROTOZOAN**

Malaria, Amoebiasis

**HELMINTIC**

Ascariasis, Filariasis

## TYPHOID

pathogen enters the small intes. thru' food & water

High fever, weakness, Stomach-pain, Constipation, Headache, Loss of appetite (symptoms)

Intestinal perforation & death may occurs in severe cases

*Salmonella typhi\**

Confirmed by WIDAL-TEST

*Streptococcus pneumoniae*

## PNEUMONIA

Infects ALVEOLI

Alveoli get filled with fluid leading to problems in respn

SYMPTOMS

Fever, Chills, Cough, Headache

*Haemophilus influenzae*

In severe cases, Lips and nails may turn gray to bluish in colour

*Rhino-viruses\**

## COMMON-COLD

Infects the NOSE & RESPIRATORY PASSAGE (but not the lungs)

SYMPTOMS

Nasal discharge, Sore throat, cough, Headache, tiredness

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Usually last for 3-7 days

## AMOEBIASIS (Amoebic dysentery)

*Entamoeba\* histolytica*

Affects the LARGE-TESTINE of humans

SYMPTOMS INCLUDES

Constipation, Abdominal pain, Cramps, Stools with excess mucous and blood clots

## RINGWORMS

Caused by FUNGI belonging to genera

- MICROSPORUM
- TRICHOPHYTON
- EPIDERMOPHYTON

Dry, Scaly lesions on various part of body such as skin, nails, scalp

## ASCARIASIS

Caused by Ascaris, common round worm

SYMPOMS :- Fever, Anaemia, Internal, muscular, Intestinal bleeding, pain blockage

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## ELEPHENTIASIS/FILARIASIS

*Wuchereria (bancrofti, malayi)*

Inflammation of the organs, usually the lymphatic vessels of the lower limb

vector is FEMALE CWEX (mosquito)

## MALARIA

• Caused by PLASMODIUM (tiny protozoan)

• Female Anopheles (vector for malaria)

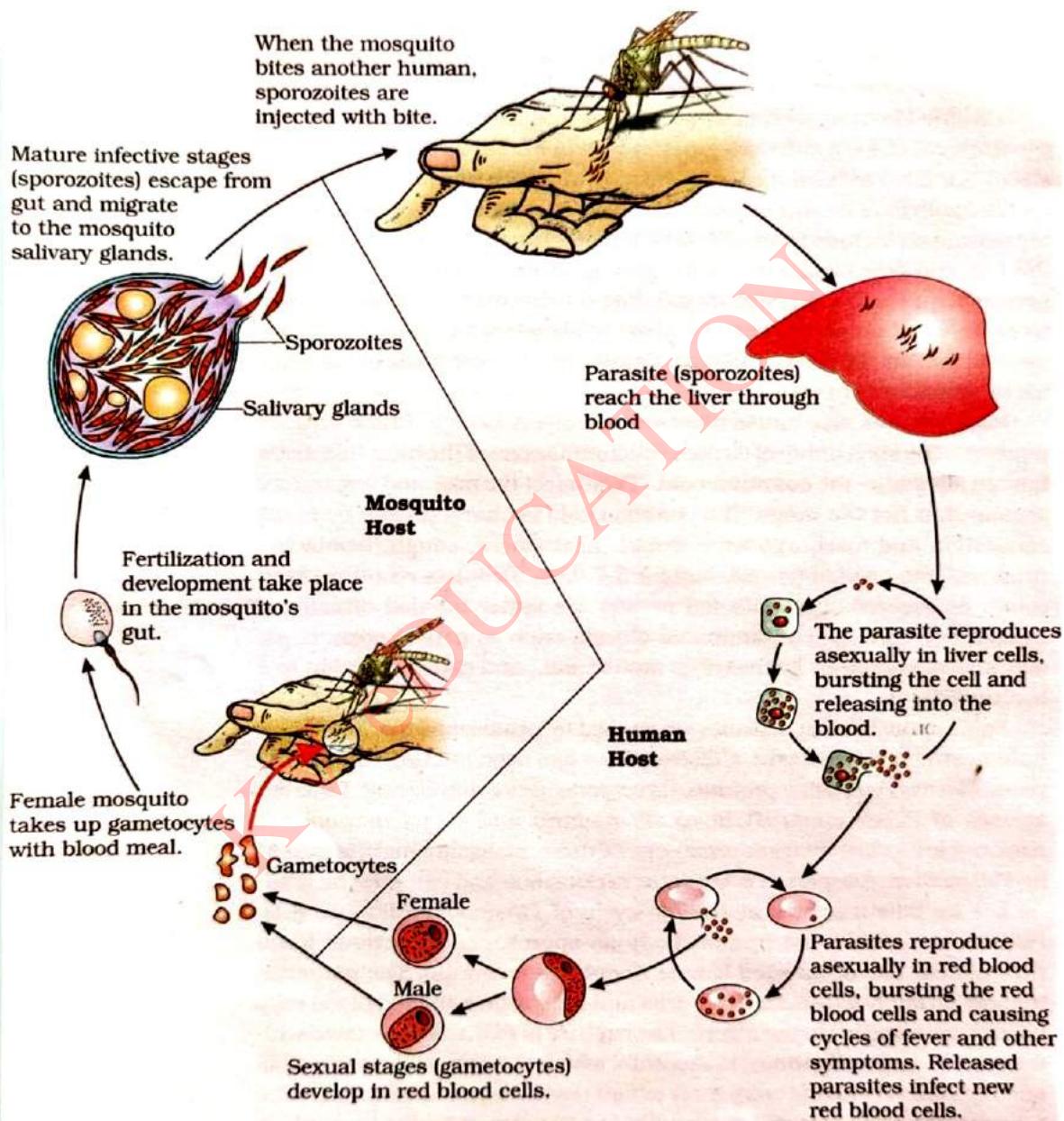
DIFFERENT SPECIES CAUSE DIFF. MALARIA

- Plasmodium vivax
- " malariq
- " falciparum (most serious)

Rupture  
of RBC

Release of  
toxic subs.  
HAEMOZOIN

Responsible  
for Chill And  
high fever



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Aedes  
mosquito

Vector  
for

Dengue

Ability of the host to fight the disease causing organisms

called

## IMMUNITY

### Innate

- Non-Specific
- present at time of birth

### Acquired

- pathogen-specific
- characterised by memory

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## INNATE-IMMUNITY

Consist of 4 type of barrier

### PHYSICAL

- Skin
- Mucus

### PHYSIOLOGICAL

- Acid in stomach
- Saliva in mouth
- Tears from eyes

### CELLULAR

- Monocytes
- Macrophages
- Neutrophil
- NK cells

### CYTOKINE

- Interferons

## ACQUIRED-IMMUNITY

### ACTIVE

Antibodies are produced in the host body

### PASSIVE

Antibodies are given directly [ready made]

#### Natural

Natural infection  
eg. Common cold

#### Artificial

Vaccination  
eg. Tetanus, Polio

#### Natural

by Mother  
eg IgA

#### Artificial

by Doctors  
eg. Anti-venom

## PRIMARY RESPONSE

When our body encounters a pathogen for the first time it produces a response called PRIMARY-RESPONSE

## SECONDARY RESPONSE

Subsequent encounter with the same pathogen elicits a highly intensified secondary or anamnestic response

## Primary & Secondary immune response

carried out by

B-Lymphocytes  
&  
T-Lymphocytes

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## HUMORAL IMMUNITY

- B-Lymphocytes (main cell involved)
- Involves production of ANTIBODIES
- pathogen killed by Antibodies
- pathogens are identified in blood

## CELL-MEDIATED IMMUNITY

- T-Lymphocytes (main cell involved)
- Does not involve production of ANTIBODIES
- pathogen killed by 'Killer T-cells'
- pathogens are identified via surface antigen of cell

# B-Lymphocytes produce antibody

# T-Lymphocytes do not secrete antibody (but help B-cells to produce them)

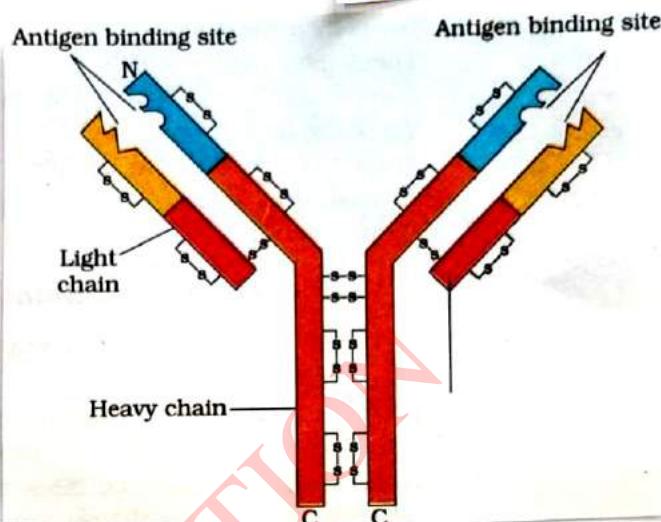
Each ANTIBODY molecule has 4 peptide chains

2 Light chains

2 Heavy chains

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ANTIBODY



Cross-placenta

Heaviest

produced in ALLERGY

IgG  $>$  IgA  $>$  IgM  $>$  IgD  $>$  IgE

(maximum)

(minimum)

present in colostrum

Activate B-Lymphocyte

Immunity responsible for GRAFT-REJECTION

Cell-Mediated Immunity

VACCINATION

Generate memory B-cells and T-cells that recognise the pathogen quickly on subsequent exposure and overwhelm the invaders with a massive production of antibodies

Any person allergic to dust, pollen, mites

Release of chemicals like HISTAMINE & SEROTONIN

**ALLERGY** [Sneezing, watery eyes, running nose, difficult breathing]

IgE Antibodies produced

(drugs like)  
• Anti-Histamine  
• Adrenaline  
• Steroids  
(reduce the symptoms)

## {AUTO-IMMUNITY}

Sometimes, due to GENETIC and Other unknown reasons

Body attacks self-cells  
eg. Rheumatoid arthritis

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## {HUMAN IMMUNE SYSTEM}

LYMPHOID ORGANS

LYMPH NODES

LYMPHOID TISSUE

# LYMPHOID-ORGANS

## PRIMARY

Differentiation &  
Maturation of  
lymphocytes  
occurs here

(B,T)

eg. • Bone marrow  
• Thymus

## SECONDARY

provides sites for  
interaction of  
lymphocytes with  
antigens

eg. Spleen, L-nodes, Tonsil,  
Peyer's patches

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## LYMPHOCYTES

B FORMATION: Bone marrow  
MATURATION: Bone marrow

T FORMATION: Bone marrow  
MATURATION: Thymus

## LYMPH-NODES

Small solid structures  
located at different  
points along the lymphatic  
system

Antigens traps in L-nodes  
↓ cause

Activation of immune  
response

Size of **THYMUS** reduces with age

## SPLEEN

mainly contains  
LYMPHOCYTES  
& PHAGOCYTES

Act as a filter  
of blood by trapping  
blood borne micro-  
organism

GRAVEYARD  
of RBC

# MALT

Mucosa Associated Lymphoid Tissue

Located within the lining of major tracts [RESPIRATORY, DIGESTIVE, UROGENITAL]

Constitute about 50% of the lymphoid tissue of the body

# AIDS

Acquired Immuno Deficiency Syndrome

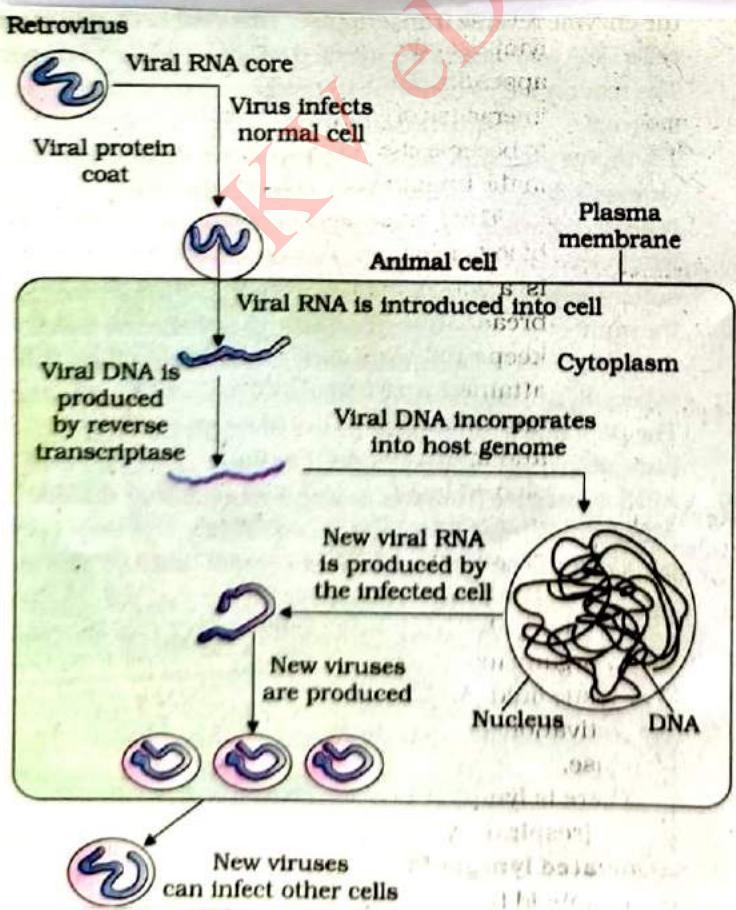
First reported in 1981

caused by HIV  
[Human immuno def. virus]  
↓  
member of RETROVIRUS

# DIAGNOSTIC TEST

# ELISA

(Enzyme Linked Immuno Sorbent Assay)



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HIV enters into Macrophages of the person

MACROPHAGES produce virus in large number  
(Hence, Macrophages are called HIV-FACTORY)

Simultaneously, HIV enters into  $T_H$ -cells, replicate and produce progeny viruses

Progeny viruses attacks other  $T_H$ -cells cause progressive decrease in  $T_H$ -cells

## CONTACT-INHIBITION

Normal cells show a property called CONTACT-INHIBITION by virtue of which contact with other cells inhibits their uncontrolled growth

## CANCEROUS-CELLS

Cells which have lost the property of CONTACT INHIBITION  
Cancerous cells just continue to divide giving rise to masses of cells called TUMORS

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## TUMORS

### BENIGN

- \* Remain confined to original location
- \* Don't spread to other parts of body
- \* Cause little damage

### MALIGNANT

- \* Grow very rapidly, invading and damaging the surrounding tissue
- \* Spread to other parts (called METASTASIS)
- \* More dangerous

# CARCINOGENS

Physical/Chemical/Biological agents that cause cancer

IONISING RADIATIONS : X-ray, Gamma-rays

## RADIATIONS

NON-IONISING RADIATIONS : UV-rays

CHEMICAL-CARCINOGENS → Tobacco (Lung cancer)

Cancer causing VIRUS → Oncogenic virus → have genes called Viral onco-genes

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## CELLULAR / PROTO ONCOGENES / ONCOGENES

Genes have been identified in normal cells → When activated under certain conditions → Could lead to oncoogenic transformation of the cells

Virus infected cells secrete proteins called INTERFERONS... which protect non-infected cells from further viral infection

# CANCER: Detection & Diagnosis

\* Based on BIOPSY & HISTOPATHOLOGICAL studies of Tissue and blood.

\* DETECT CANCER OF INTERNAL ORGANS :-

X-ray, CT [Computed Tomography], MRI (<sup>Magnetic Resonance</sup> Imaging)

## TREATMENT OF CANCER

Surgery, Radiation, Chemo-therapy

Chemotherapeutic drugs have side effects like hair loss, anaemia

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## OPIODS

RECEPTORS  
present in  
CNS & GIT

Papaver somniferum  
Latex of plant gives  
Morphine  
Acetylation gives  
Heroin (Smack)

## CANNABINOIDS

Receptors present in  
BRAIN

affect CVS

Obtained from inflorescences of the plant

Cannabis sativa

Flower tops, leaves & resin of plant used in various combinations to produce MARIJUANA, HASHISH, CHARAS, GANJA

# COCAINE / COKE / CRACK

Obtained from the coca plant Erythroxylum coca (South America)

Interfere with transport of DOPAMINE

potent stimulating action on CNS  
euphoria & ↑ sea energy

Excessive dose cause HELLUCINATIONS

Other plants with HELLUCINATING PROPERTIES

are

Atropa belladonna  
& Datura

Drugs like BARBITURATES, AMPHETAMINE, BENZODIAZEPINES & similar drugs

used as

Medicines to help patients cope with mental illness like depression & insomnia, are often abused

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Tobacco

contains

Nicotine

stimulates

Adrenal-gland to release ADR & nor-ADR

Increase HEART RATE & BLOOD-PRESSURE

causes

Released into blood circulation

Smoking increases CO in the blood

cause

Decreases Oxy-Hb (Oxygen deficiency)

# MOLECULAR BASIS OF INHERITANCE

**NUCLEIC-ACID** are **Polymer of NUCLEOTIDES** example **DNA & RNA**

**NUCLEOTIDE** = Nitrogen base + Pentose sugar + phosphate  
**NUCLEOSIDE**

## **NITROGEN-BASES**

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### **PURINES**

Adenine (A)

Guanine (G)

### **PYRIMIDINES**

Cytosine (C)

Uracil (U)

Thymine (T)

<b>DNA</b>	<b>RNA</b>
Sugar: Deoxyribose	Sugar: Ribose
N-Acid: A, T, G, C, U	N-Acid: A, T, G, C, U

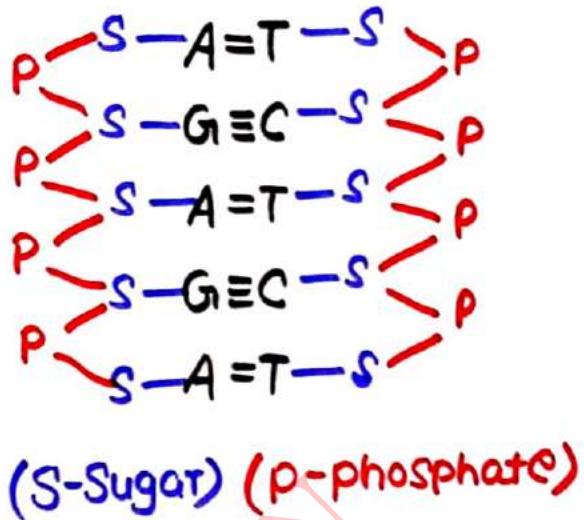
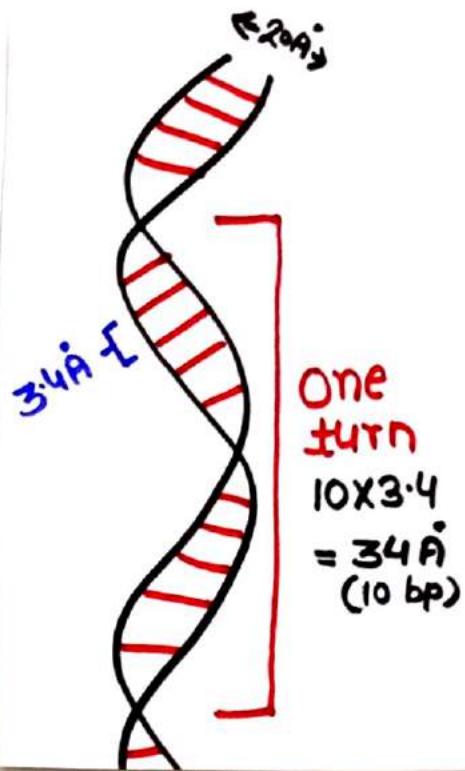
## **DNA**

DNA first identified by (as NUCLEIN) **Friedrich meischer (1869)**

Double Helix Model of DNA **Watson & Crick**

Studied DNA with X-RAY **Wilkins & Franklin**

DNA is **ACIDIC** in nature



$\text{A} = \text{T}$  → Hydrogen-bonds  
 $\text{G} \equiv \text{C}$

CHARGAFF'S RULE In DNA → Purines = Pyrimidine  
 $(\text{A} + \text{G})$   $(\text{T} + \text{C})$

DENATURATION OF DNA → If DNA placed at high T, double strand will separates

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# HISTONE - Positively Charged  
# DNA - Negatively Charged

**HISTONES** →  $H_1, H_2A, H_2B, H_3, H_4$   
(Linker)

**HISTONE OCTAMER** →  $2 \times (H_2A, H_2B, H_3, H_4)$

**NUCLEOSOME** →  $H_1$   
(Linker histone) + Histone octamer + 200 bp DNA

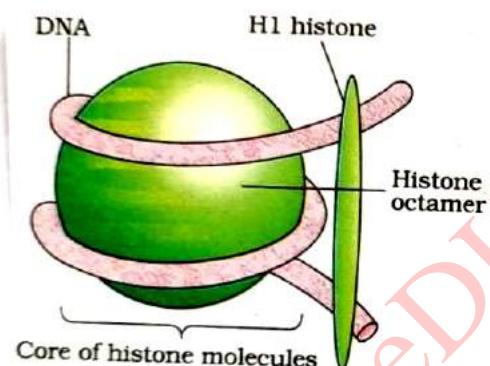
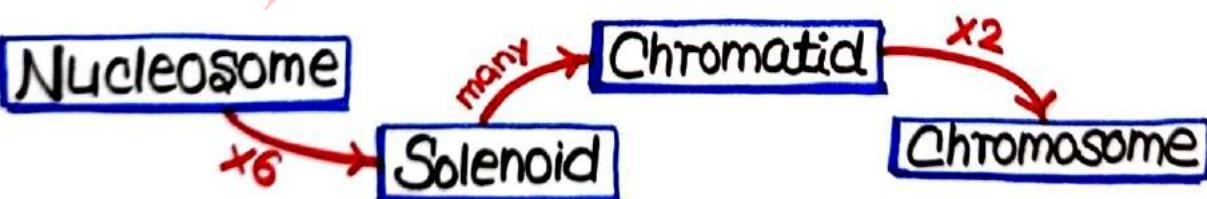


Figure 6.4a Nucleosome

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# Loosely packed chromatin - **EUCHROMATIN**  
# Densely packed chromatin - **HETEROCHROMATIN**

## TRANSFORMING-PRINCIPLE

F. GRIFFITH

*Streptococcus pneumoniae*

### Smooth Colonies

- Capsulated
- Mucous coat(✓)
- Virulent

Mice die

### Rough Colonies

- Non capsulated
- Mucous coat(x)
- Non virulent

Mice Live

Mice live  
[Heat killed  
S-strain]

## Biochemical characterisation of Transforming principle

AVERY, Macleod, McCarty

Transforming substance is DNA

Digestive-Enzymes

protease

Transformation occurs

RNases

Transformation occurs

DNase

Transformation\* does not occur

Hershey & Chase

Bacteriophage infects E.Coli

Radioactive S & P were used

Unequivocal proof that DNA is G-mater-  
ial

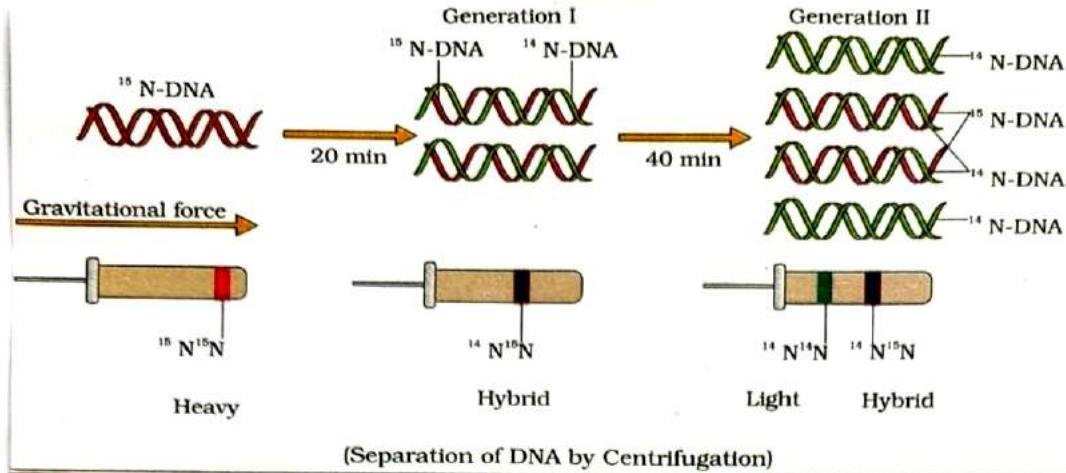
DNA have P  
Protein have S

Infection  
Blending  
Centrifugation

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## SEMICONSERVATIVE DNA-REPLICATION

- First proposed by WATSON & CRICK
- Experimentally proved by MESELSON & STAHL (1958) in E.coli and TAYLOR in Vicia faba - in 1958
- Meselson and Stahl used heavy isotope of (N<sup>15</sup>)
  - ↳ grew E.coli in <sup>15</sup>NH<sub>4</sub>Cl
  - ↳ centrifugation in CsCl



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## DNA-REPLICATION

Separation of 2 chains, UNZIPPING

- starts at specific point called ORIGIN of Replication
- unzipping occurs with the help of HELICASE

Formation of RNA-Primer by RNA-Polymerase

Formation of new chains catalysed by DNA polymerase

New chains always formed in 5'-3' direction

One chain is formed continuously,  
**LEADING-STRAND**

Another chain is discontinuous,  
**LAGGING-STRAND**  
made up of small fragments, OKAZAKI  
(Joined by ligase enzyme)

RNA →

Ribosomal, Messenger, Transfer  
(rRNA) (mRNA) (tRNA)  
maximum + minimum +  
most stable least stable

### RIBOSOMAL-RNA (rRNA)

PROKARYOTIC  
RIBOSOME  
(70s)

50s  
23s 5s

30s  
16s

EUKARYOTIC  
RIBOSOME  
(80s)

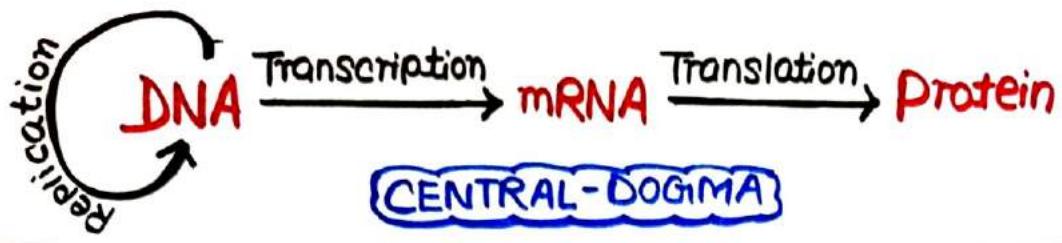
60s  
28s 5.8s 5s

40s  
18s

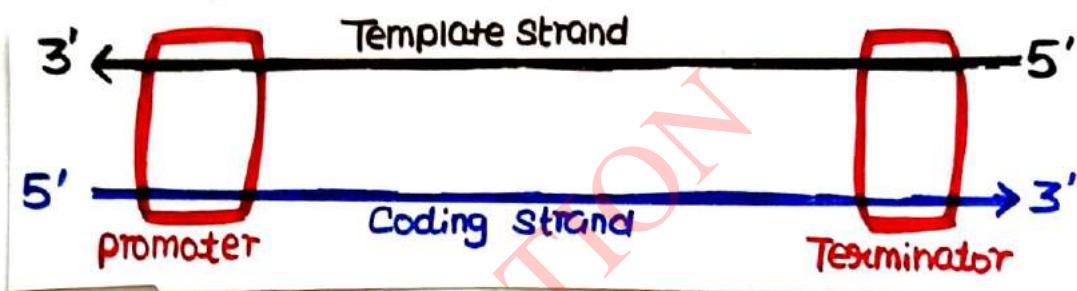
@KVeducation

### GENETIC-MATERIAL PROPERTIES

- \* Should be able to generate its replica [Replication]  
(Both DNA & RNA are able to replicate)
- \* Should be stable chemically and structurally  
(DNA is more stable than RNA) presence of Thymine
- \* Should show scope for slow changes (MUTATION) that are required for evolution  
(RNA shows more mutation than DNA)
- \* It should be able to express itself in the form of 'MENDELIAN-CHARACTERS'  
(RNA can easily express itself, but DNA being more stable is preferred for storage of genetic information)



**TRANSCRIPTION UNIT** promoter + Structural + Terminator gene



**# TEMPLATE/ANTISENSE STRAND**

\* has polarity in the  $3' \rightarrow 5'$  direction

**# CODING-STRAND**

\* has polarity in the  $5' \rightarrow 3'$  direction

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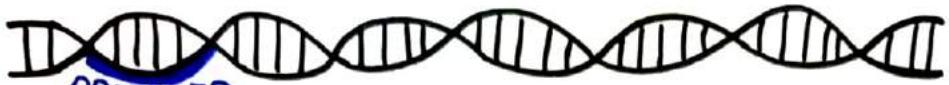
**RNA-POLYMERASE**

**PROKARYOTES**  
(only 1 type)

\* 1 type of RNA polymerase will form all types of RNAs (tRNA, mRNA, rRNA)

**EUKARYOTES**  
(3 types)

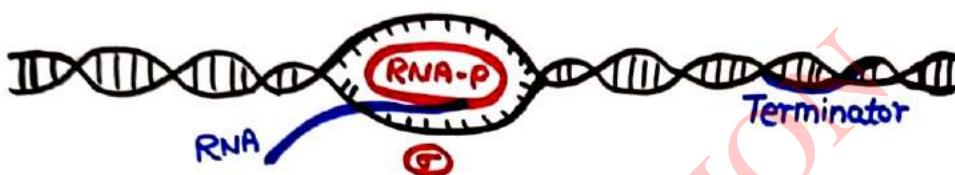
- \* I: will form rRNA (28S, 18S, 5.8S)
- \* II: will form hnRNA
- \* III: will form tRNA, snRNA, 5srRNA



① Sigma factor recognise promoter region



With the help of Sigma(σ) factor, RNA polymerase attached to PROMOTOR SITE



• opening of the helix and continues elongation

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• Rho factor recognises Terminator region

• Results in TERMINATION of transcription

(P) - RNA-P  
Rho-factor

## TRANSCRIPTION IN PROKARYOTES

In bacteria, since the mRNA does not require any processing to become active

Transcription and translation takes place in same compartment [no separation of cytosol & nucleus]

Many times the translation can begin much before the mRNA is fully transcribed

hnRNA



↓ **SPlicing** (Non-functional introns are removed)

mRNA



↓ **CAPPING** [ $^m\text{G}_{\text{PPP}}$  added to 5' end]  
**TAILING** [poly A tail at 3' end]

mRNA



## TRANSCRIPTION IN EUKARYOTES

presence of introns and process of **SPlicing** represents the dominance of RNA-WORLD

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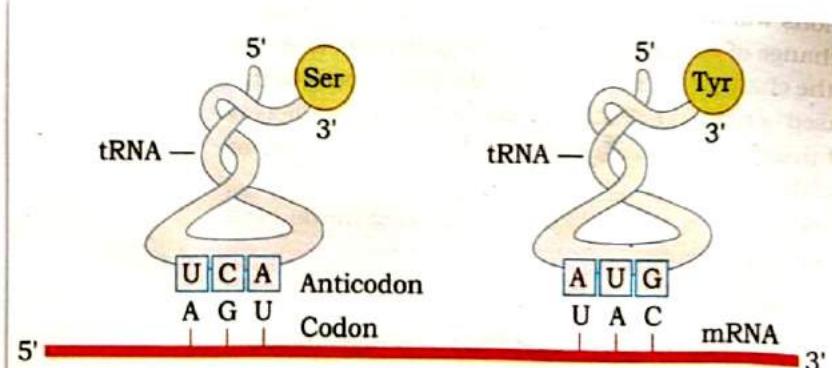


Figure 6.12 tRNA - the adapter molecule

## tRNA - The Adaptor Molecule

- tRNA has an ANTICODON-LOOP that has bases complementary to the code
- It also has an AMINO-ACID ACCEPTOR END to which it binds to amino acids
- tRNA are specific for each amino acids
- For Initiation, There is another specific tRNA that is referred to as INITIATOR tRNA
- There are no tRNA for Stop codons
- Secondary structure of tRNA looks like CLOVER LEAF
- In actual structure, the tRNA is a compact molecule which looks like inverted L

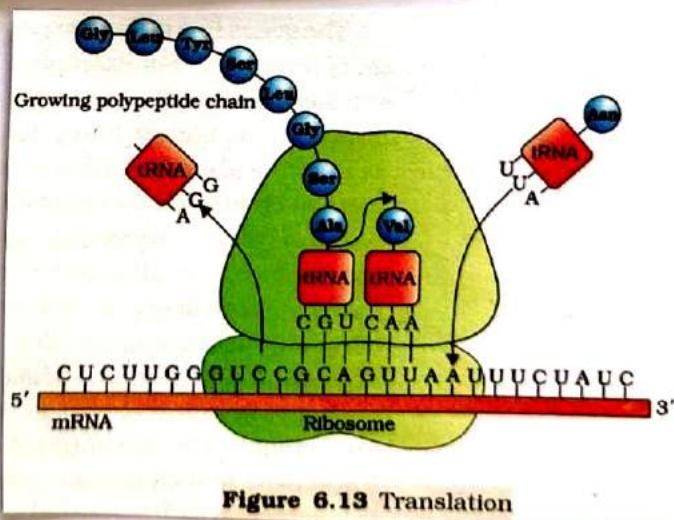


Figure 6.13 Translation

## GENETIC-CODE

#SCIENTISTS - George, Har-Gobind, Marshall  
Gamow, Khorana, Nirenberg

Codon is TRIPLET

STOP → UAA  
Codons → UGA  
→ UAG

Total Codons - 64

Coding codons - 61

Stop codons - 3

Codon is read in mRNA in contiguous fashion  
(there is no punctuation)

Code is nearly UNIVERSAL

EXCEPTIONS are -

Mitochondria & some protocodon

Some amino acids are coded by more than one codon, hence the code is, DEGENERATE

AUG has dual functions

act as initiator codon  
codes for methionine

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Polycistronic structural gene is regulated by a common promoter & regulatory genes

I referred  
to as  
**OPERON**  
examples

lac operon, trp operon, ara operon, his, val operon

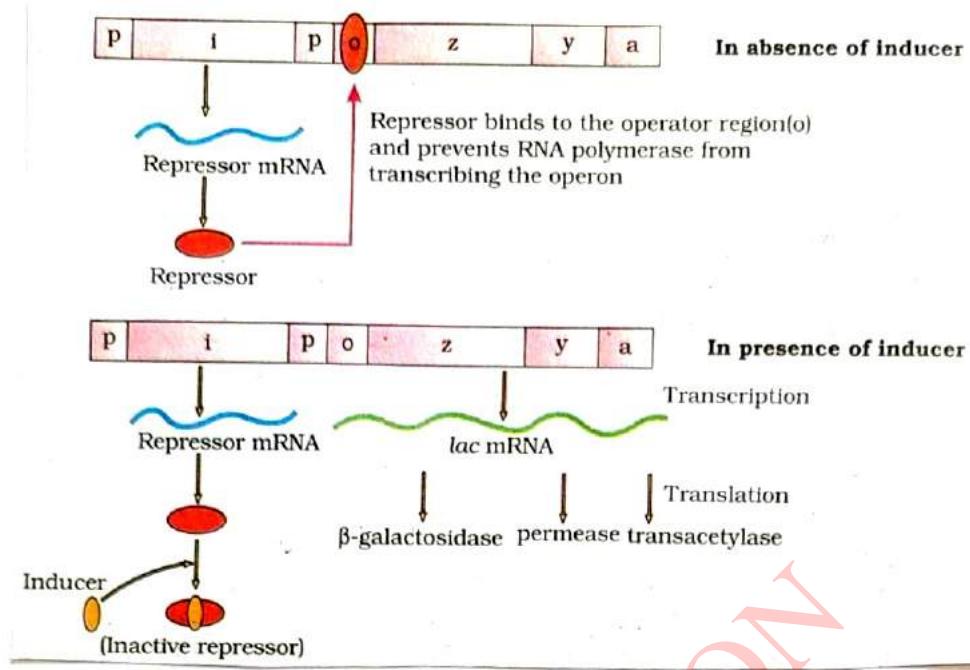
Lac-operon

NEGATIVE type of regulation

Gene products are required for metabolism of LACTOSE

Scientists related to 'Lac-operon'

Francis Jacob  
&  
Jacques monod

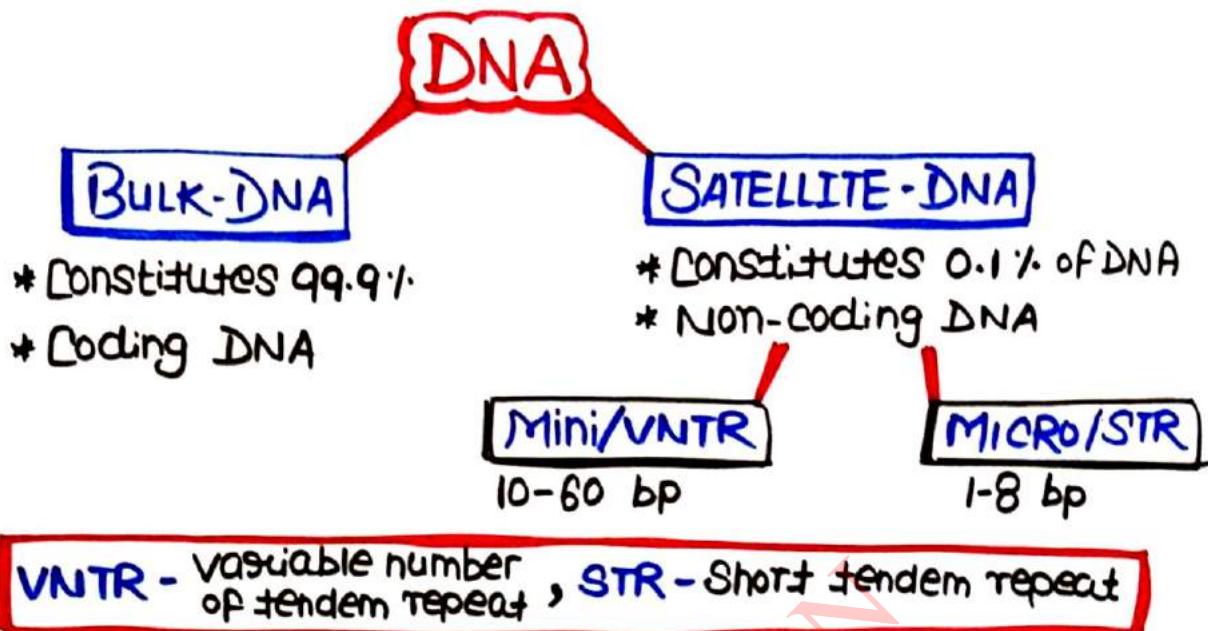


## -DNA-FINGERPRINTING-

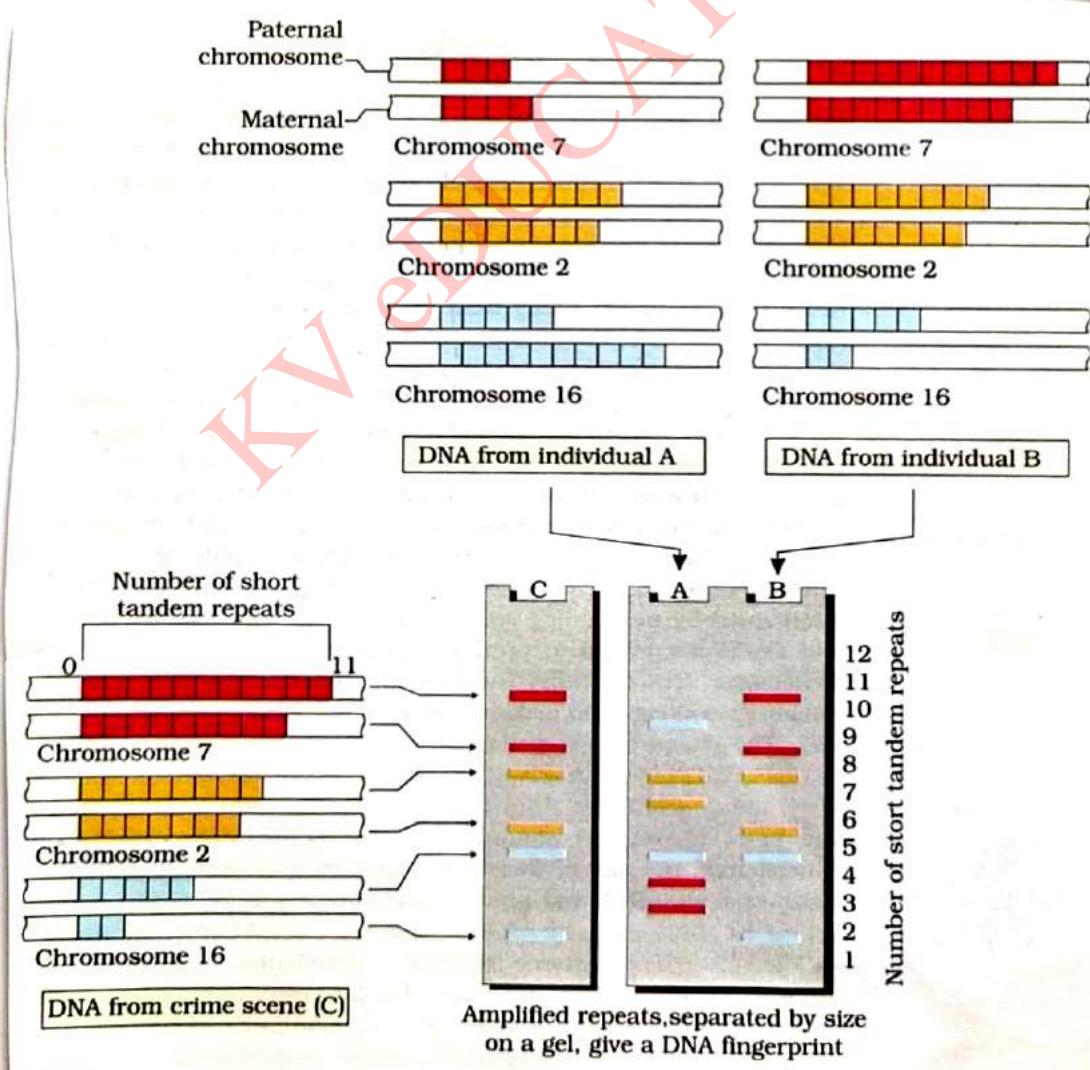
Who developed DNA fingerprint technique  $\rightarrow$  Alec Jeffreys

Alec Jeffrey used **SATELLITE-DNA** that shows high degree of polymorphism....

**DNA polymorphism** involves one of two or more variants of a particular DNA sequence



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## Human Genome Project

\* For sequencing Human genome

Launched [1990]

\* 13 year project

↳ U.S dept. of Energy  
↳ National inst of health  
↳ Wellcome trust (UK)  
↳ Japan, China, Germany, France & others

\* HUMAN GENOME (approx.  $3 \times 10^9$  bp)

\* US \$ 3 per bp

## METHODOLOGIES

Expressed sequence Tags

Sequence Annotation

HOST - Bacteria | HOST - Yeast  
vector - BAC | vector - YAC

- \* Human Genome: 3164.7 million nucleotide bases
- \* Average Gene: 3000 bases
- \* Largest Human Gene [dystrophin]: 2.4 million bases
- \* Total number of genes = 30,000
- \* 99.9% nucleotides are same in all people
- \* >50% Genes : function unknown
- \* <2% of genome code for proteins
- \* Chromosome 1 has most genes [2968]
- \* Chromosome Y has fewest genes [231]
- \* 1.4 Million location [SNPs found]

# EVOLUTION

- \* Universe age - 20 billion yrs
- \* Earth age - 4.5 billion yrs
- \* Non cellular form of life - 3 billion yrs
- \* 1<sup>st</sup> cellular form of life - 2000 mya
- \* Invertebrates formed - 500 mya
- \* Jawless fish - 350 mya
- \* Sea-weeds - 320 mya
- \* Fish like skeptiles - 200 mya
- \* Dinosaurs suddenly disappeared - 65 mya
- \* Dryopithecus & Ramapithecus - 15 mya

- \* Modern th' of evolution - Oparin & Haldane
- \* Hot dilute soup - Haldane
- \* Germ theory - Pasteur
- \* Biogenetic law - Ernst Haeckel
- \* Mutation theory - Hugo de Vries
- \* Pr' on population - Thomas Malthus
- \* Pr' on Geology - Charles Lyell
- \* Natural Selection th. - Darwin
- \* Acquired Chr. Inheritance - Lamarck

## { MILLER-EXPERIMENT }

He created electric discharge in a closed flask containing  $\text{CH}_4, \text{H}_2, \text{NH}_3$  &  $\text{H}_2\text{O}$  vapours (at  $800^\circ\text{C}$ )

He observed formation of AMINO-ACIDS

# Alfred Wallace  $\xrightarrow{\text{worked on}}$  Malay archipelago

# Darwin  $\xrightarrow{\text{worked on}}$  Galapagos island

{ Embryological support for evolution }

proposed by ERNST HECKEL

Dissapproved by Karl Ernst von Baer

## { HOMOLOGOUS-ORGANS }

- Fore limb bones in mammals
- Thorns & Tendrils of Bougainvillea & Cucurbita
- Heart/Brains of vertebrates

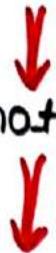
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## { ANALOGOUS-ORGANS }

- Wings of butterfly & birds
- Eye of OCTOPUS & MAMMALS
- Flippers of PENGUINS & DOLPHINS

## Example of NATURAL-SELECTION [from england]

1850s (white moth > dark moth)



1920s (Dark moth > White moth)

## ADAPTIVE-RADIATIONS

Process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of habitats  
eg. Australian marsupials, placental mammals.

More than one ADAPTIVE-RADIATION in an isolated geographical area

## CONVERGENT-EVOLUTION

eg. Australian marsupials, placental mammals

## CONVERGENT OF AUSTRALIAN MARSUPIALS & PLACENTAL MAMMALS

# Mole - Marsupial mole

# Anteater - Numbat

# Mouse - Marsupial mouse

# Lemur - Spotted cuscus

# Flying squirrel - Flying phalanger

# Bobcat - Tasmanian tiger cat

# Wolf - Tasmanian wolf

LAMARCK

Inheritance of  
acquired characters

BRANCHING-DESCENT  
and  
NATURAL-SELECTION

Two key concepts  
of Darwinian  
Theory of Evolution

## DARWIN vs HUGO de VRIES

- |  |   |
|--|---|
| <ul style="list-style-type: none"><li>* Minor variations cause evolution</li><li>* Darwinian variations are small &amp; directional</li><li>* Slow changes</li></ul> | <ul style="list-style-type: none"><li>* Evolution caused by Mutation</li><li>* Mutations are Random &amp; directionless</li><li>* Single step, Large mutation (SALTATION)</li></ul> |
|--|---|

## { HARDY-WEINBERG PRINCIPLE }

- It says that allele frequencies in a population are stable and is constant from generation to gen.
- The gene pool remains constant [Genetic-Equilibrium]
- Sum total of all the allelic frequencies is 1

$$\bullet \quad p^2 + 2pq + q^2 = 1$$

$\begin{matrix} \text{Homozygous} \\ \text{dominant} \end{matrix}$        $\downarrow$        $\begin{matrix} \text{Heterozygous} \\ \downarrow \end{matrix}$        $\begin{matrix} \text{Homozygous} \\ \text{recessive} \end{matrix}$

## Factors Affecting HARDY-WEINBERG EQ<sup>m</sup>

Gene migration

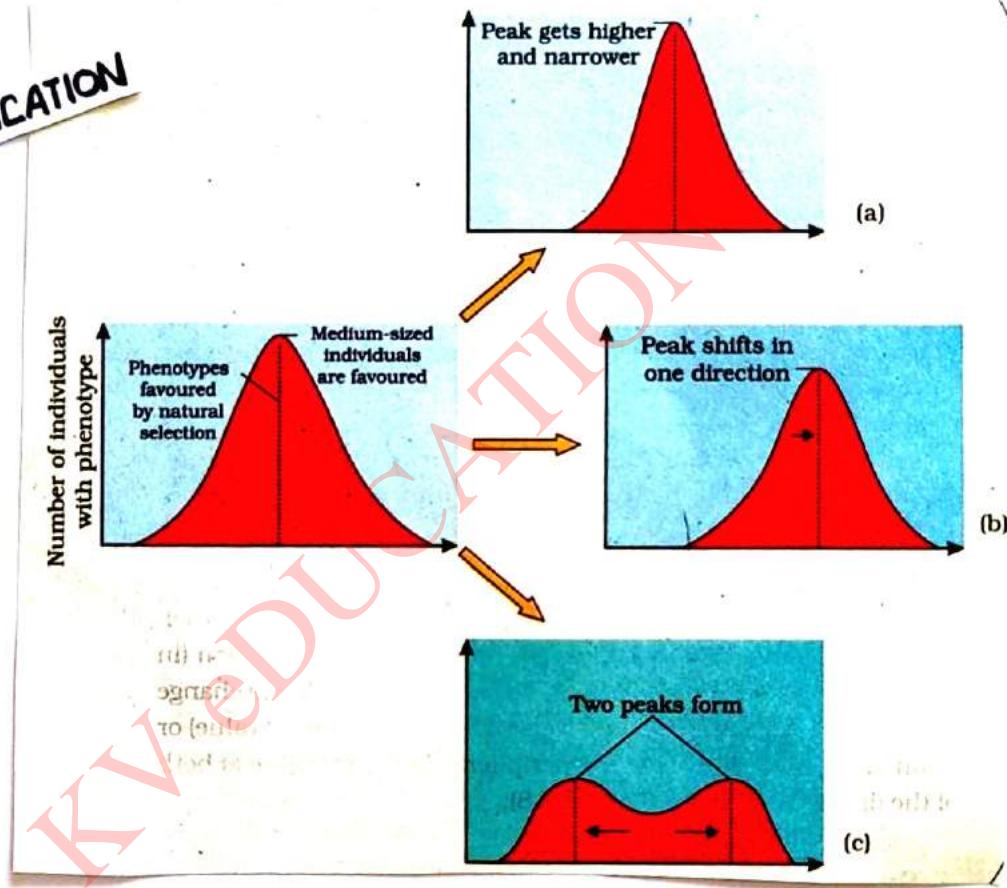
Genetic drift

Mutation

Natural selection

Genetic recombination

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Sometimes the change in allele frequency is so different in the new sample of population that they become a different species.

The original drifted population becomes founders

The effect is called **FOUNDER-EFFECT**

## ERA

**COENOZOIC**

Quaternary  
Tertiary ) **Age**  
Angio.

**MESOZOIC**

Cretaceous  
Jurassic  
Triassic ) **Or.**-Angio.  
Age-B/PIG

**PALAEZOIC**

permian  
Carboniferous  
Devonian  
Silurian ) **Origin**  
Bryo.  
Pterido.  
Gymno.

## ERA

**COENOZOIC**

Quaternary  
Tertiary

**MESOZOIC**

Cretaceous  
Jurassic  
Triassic - Birds  
- Mammals

**PALAEZOIC**

permian - x  
Carboniferous - Reptiles  
Devonian - Amphibia  
Silurian - Fishes

Coelocanth → South Africa (1938)

Biggest Dinosaurs → Tyrannosaurus → 20 feet in height

First Mammals → Were shrew like

South American overridden by → North American animals

pouched mammals survived due to → Continental drift  
(Australia)

## {EVOLUTION OF MAN}

# DRYOPITHECUS → Walk like GORILLA and CHIMPANZEE

# RAMAPITHECUS

# AUSTRALOPITHECUS (600 cc)

# HOMO-HABILIS (650-800 cc)

# HOMO-ERECTUS - java man (900 cc)

- peking man (1050 cc)

- Heidelberg (

# HOMO-SAPIENS - Neanderthal (1400 cc)

- Cromagnon (1650 cc)

- Modern man (1450 cc)

• Ramapithecus was more man-like

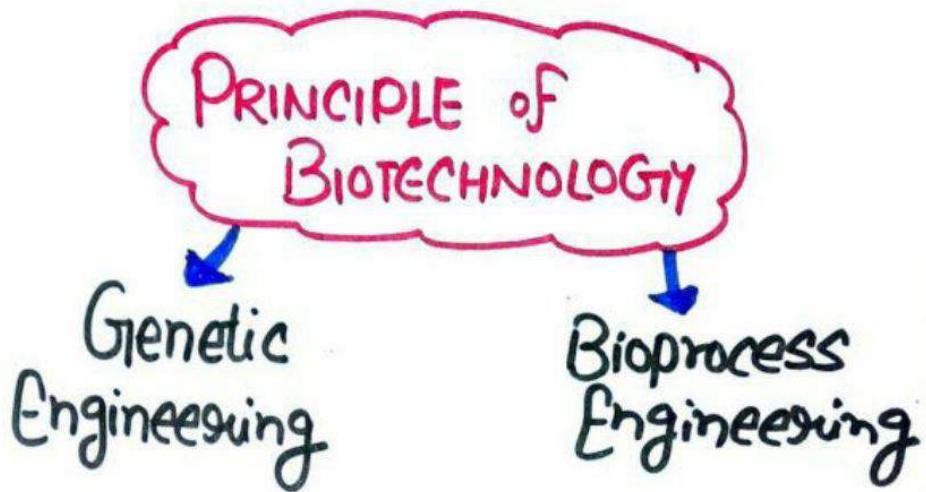
• Dryopithecus was more ape-like

• Hunted with stone weapons → Australopithecus

• First human like being → Homo habilis

• Buried their dead → Neanderthal

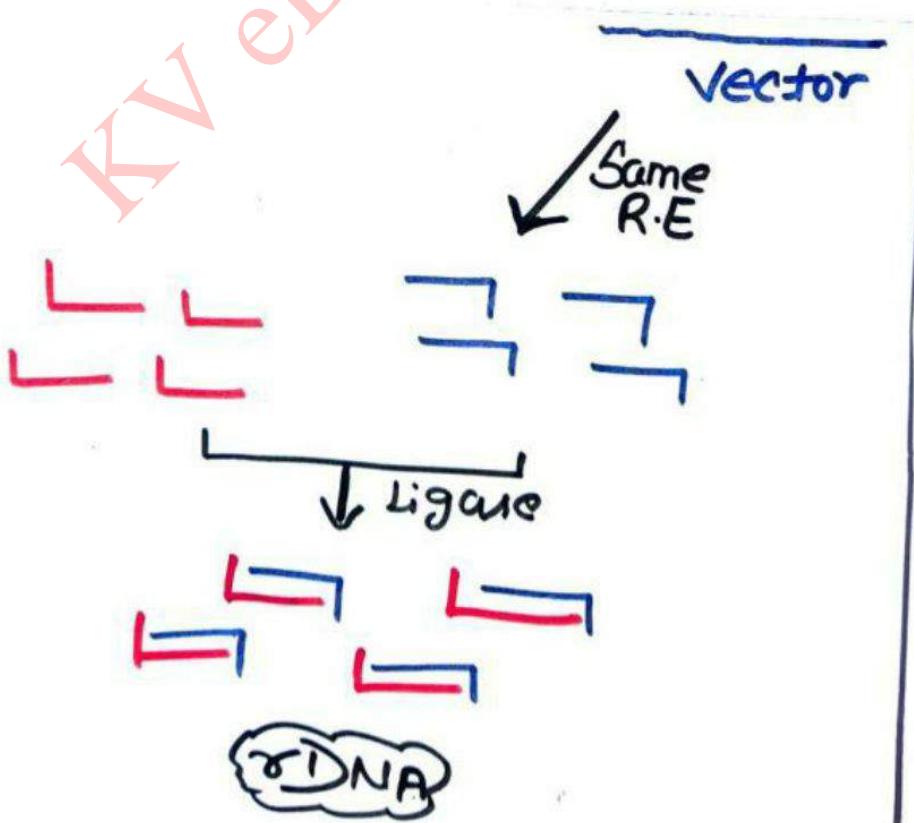
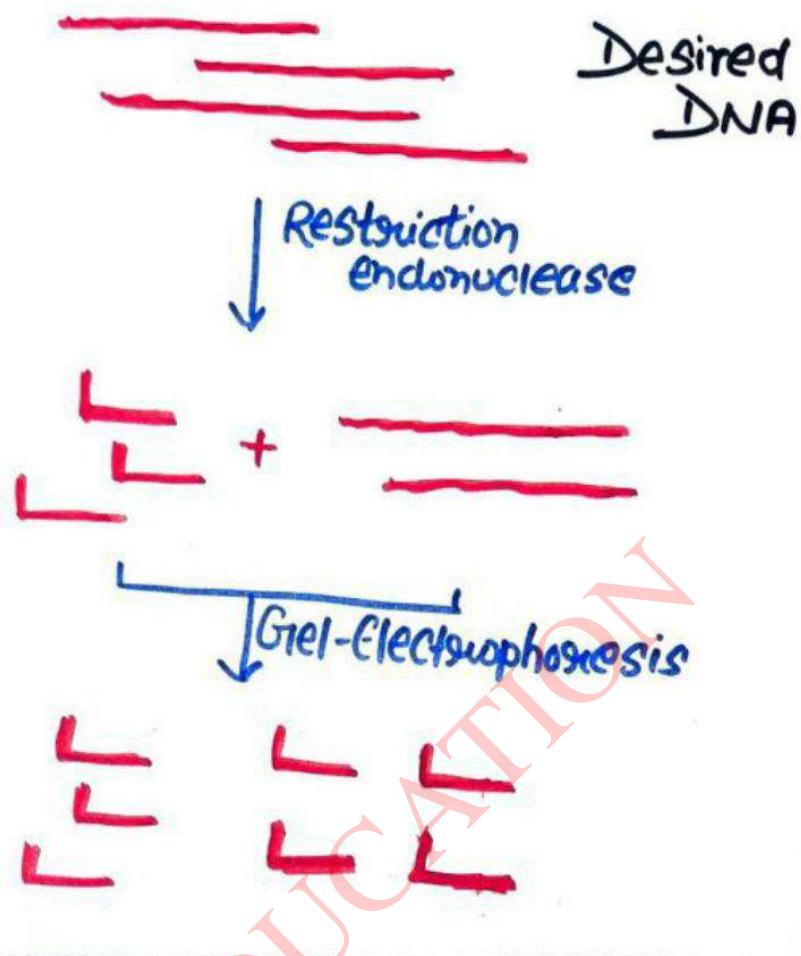
@Kveducation

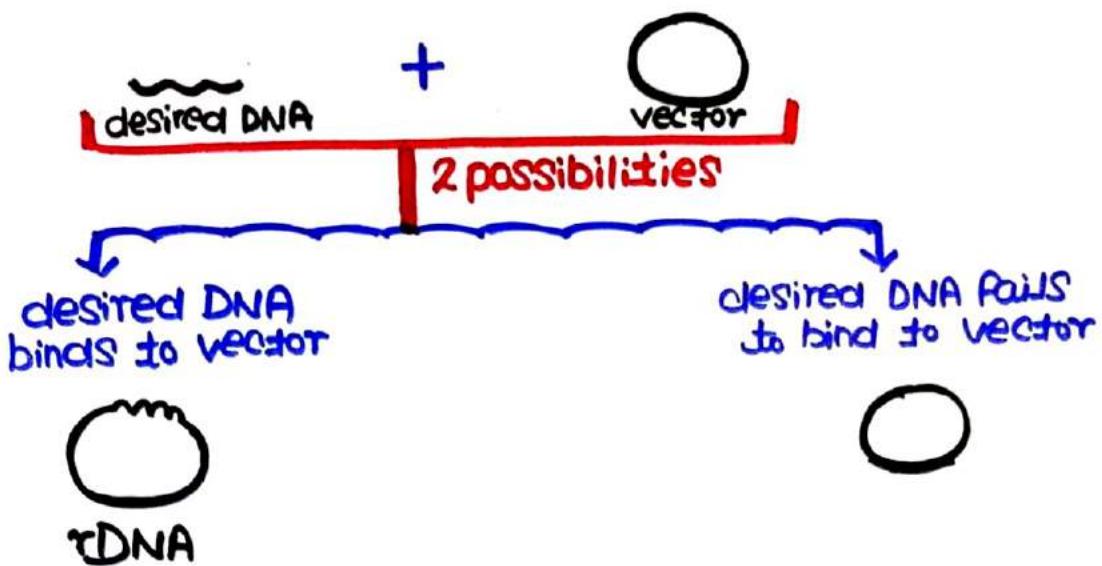


### First rDNA

- \* By: Stanley Cohen & Herbert Boyer
- \* Vector: Plasmid of *Salmonella typhimurium*
- \* Host: *E.Coli*







TRANSFORMATION  
(introduce into host cell)

3 possibilities



Transformant  
(with rDNA)



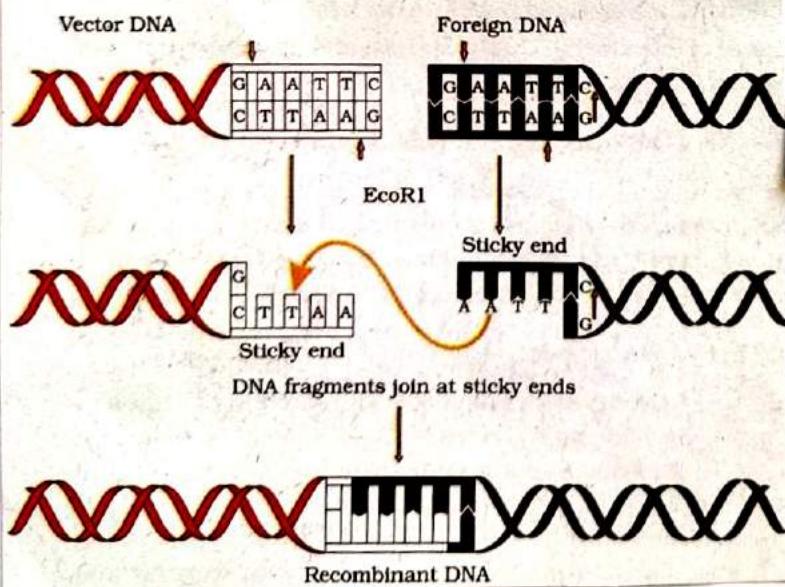
Transformant  
(Non-rDNA)



Non-Transformant

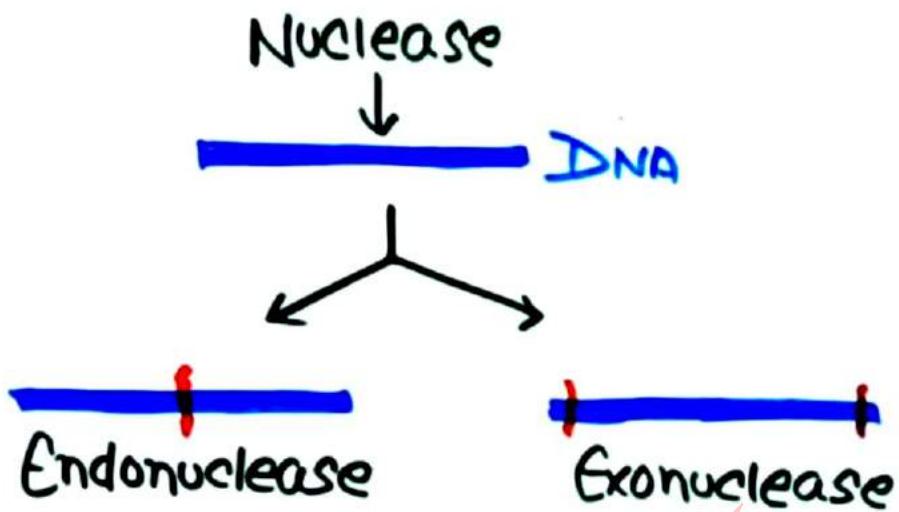
The enzyme cuts both DNA strands at the same site

EcoRI cuts the DNA between bases G and A only when the sequence GAATTTC is present in the DNA



Pallindromic Sequence  
(for EcoRI)

GAATTTC  
CTTAAG



**RESTRICTION ENZYME**

2 Enzyme responsible for restructuring the growth of **BACTERIOPHAGE** in **E.COLI** (1963)

(i) Add methyl group to DNA  
 (ii) Cut the DNA (Restriction Endonuclease)

First: <b>Hind II</b>	<b>&gt;900 R.E</b> from <b>&gt;230 strains</b> of <b>Bacteria</b>	<b>Eco RI</b> ↓ Escherichia coli RY 13 * R = Strain → Roman <sub>no.</sub> = Order of discovery
-----------------------	--	--

# FEATURES OF CLONING-VECTORS

## # ORIGIN OF REPLICATION (OR) →

- Sequence from where replication starts
- Any piece of DNA when linked to this sequence can be made to replicate within host cells

## # SELECTABLE-MARKERS →

- Helps in identifying TRANSFORMANT, NON TRANSFORMANT
- Gene encoding resistance to antibiotics such as ampicillin, chloramphenicol, tetracycline are useful SELECTABLE-MARKERS

## # CLONING-SITES →

- In order to link the alien DNA, the vector needs to have very few, preferably single, RECOGNITION-SITES for the commonly used restriction enzyme

## • INSERTIONAL-INACTIVATION

rDNA → Insertion of DNA cause → Inactivation of  $\beta$ -galactosidase → Do not produce any colour

Non-rDNA →  $\beta$ -galactosidase do not get inactivated → produce colour

## # VECTORS FOR CLONING GENES IN PLANTS & ANIMALS →

- For plants - *Agrobacterium tumifaciens*
- For Animals - Retroviruses

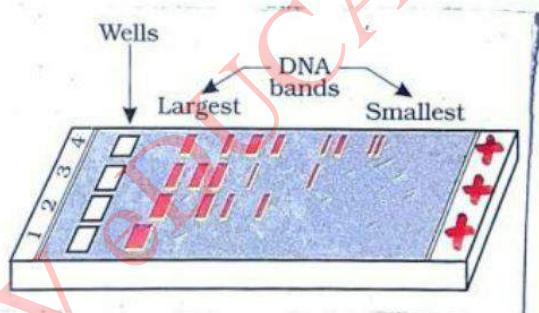
# Gel Electrophoresis For DNA (-ve)

Agarose  
[natural polymer  
from sea weeds]

Movement under  
electric field

↓  
DNA

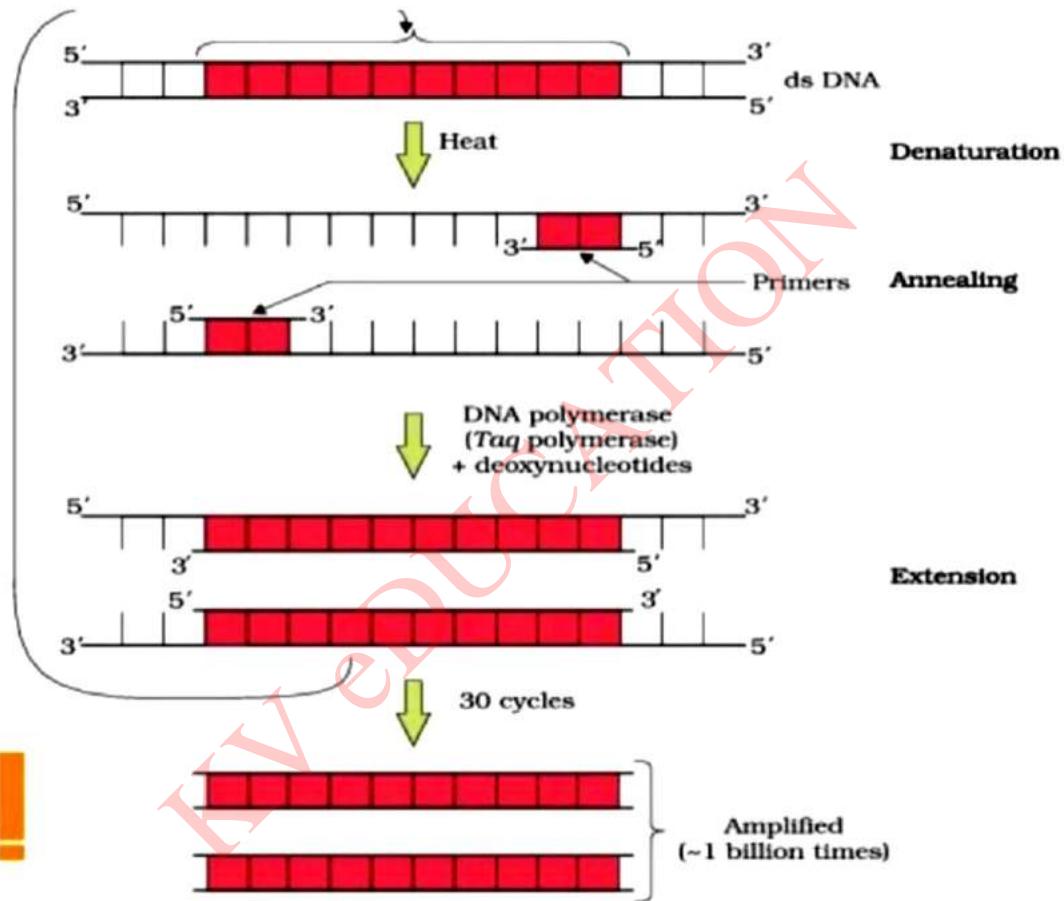
Separated DNA fragments → Stained with Ethidium Bromide → UV exposure → Bright Orange Band



## #TRANSFORMATION [Vector $\rightarrow$ Host cell]

- \* Divalent Cation ( $Ca^{++}$ )
- \* Heat-Shock Method (ice, 42°C)
- \* Microinjection (Animal Cell)
- \* Biostatic/Gene gun (Plant Cell) Gold Tungsten

# PCR (Polymerase Chain Reaction)



**"Taq polymerase"** is  
a thermostable DNA  
polymerase

To produce large quantities of products



## BIOREACTORS

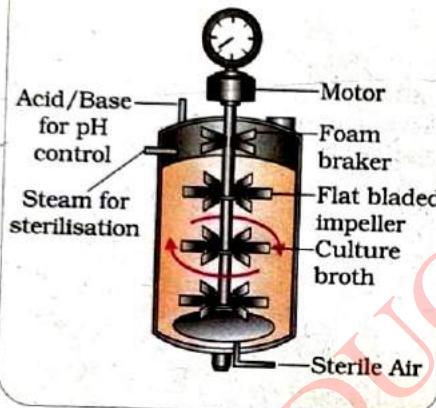
(100-1000 Ltr culture can be processed)

SIMPLE STIRRED TANK

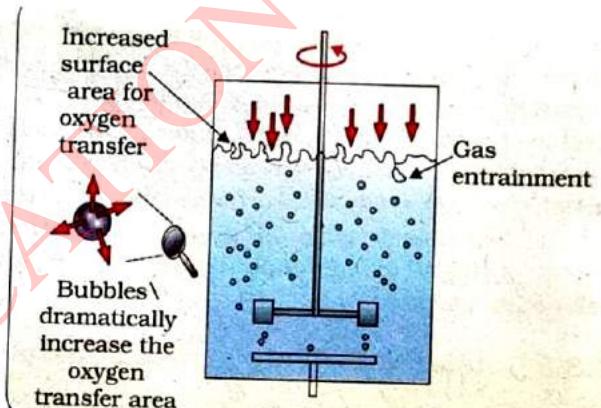
Bubbles (X)

SPARGED STIRRED TANK

Bubbles (-)



(a)



(b)

Figure 11.7 (a) Simple stirred-tank bioreactor; (b) Sparged stirred-tank bioreactor through which sterile air bubbles are sparged

## BIOREACTORS PROVIDES :-

- Optimal conditions (Temp, pH, salt, vitamins, oxygen)
- Stirrer facilitates mixing of oxygen

**DOWNSTREAM PROCESSING** :- Separation and Purification