Evolution

Origin of Universe

Mainly galaxies present.
- star
- Gaseous cloud
- dust.

Big Bang theory
(Abbe Lamaitre)

* 20 bya there is everything in a single point :: ∞ density
↓
Big Bang (a huge explosion unimaginable in physical terms)
↓
expansion → temp. decreases. → H_2 and He formed Sometimes later → due to gravitation gas condensed formed galaxies.

* in Milky Way Galaxy,
Earth formed 4.5 bya.

Origin of atmosphere on Earth

Earth initially → molten mass → gases released

CH_4
$H_2O_{(g)}$
NH_3
CO_2

→ UV rays broken H_2O vapour in H_2 and O_2

O_2 absent in initial atmosphere.

$H_2O \xrightarrow{UV} H_2 + O_2$

H_2 lighter ↳ escapes.

* O_2 combine with CH_4 and NH_3

$CH_4 + O_2 \longrightarrow CO_2 + H_2O \xrightarrow{UV} H_2 + O_2$

$NH_3 + O_2 \longrightarrow N_2 + H_2O$

* UV rays act on O_2 forming ozone.
↳ entry of UV rays decreases.
↳ temperature decreases.

$CH_4 + O_2 \longrightarrow CO_2 + H_2O$

$NH_3 + O_2 \longrightarrow N_2 + H_2O$

→ Condense and fell in form of rain.
↳ filled the depressions on surface forming oceans.

O_2 is absent.
↳ atmosphere is reducing.

* Molten Earth → NH_3, H_2O v, CH_4, CO_2 → UV act → $H_2O \rightarrow H_2$ → leaves + O_2 → $N_2 + H_2O$ (UV) → $CO_2 + H_2O$ → $H_2 + O_2$

fell as rain ↑ H_2O v ← condens ← temp dec. ← Ozone formed

=

Initial condition
↳ Suited for chemical evolution.
↳ O_2 absent (reducing atmosphere).
↳ temperature high
↳ volcanic storms.

Origin of life — how first cell evolved? → Chemical evolution.

Life evolved 400 bya.

Theory of Eternity :- (rejected) life can't be created
↳ present since ~~begain~~ beginning.

Theory of Special creation
↳ Supported by mythological texts.
* ~~life~~ all life forms created as such
* Diversity in life form is constant.
* Earth is 4000 years old.

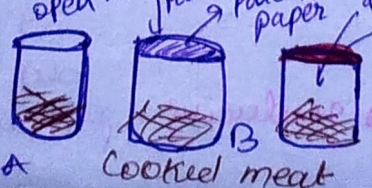
Darwin rejected this theory → evidances from his voyage to Galapagos Island.
* Life forms share similarities from life forms in present day and existed earlier
* life forms show changes
* 4000 years is very small for these change.

Theory of Spontaneous generation / Theory of abiogenesis.
from non-living Organic matter → life evolved Spontaneously.

Straw + mud → life evolved

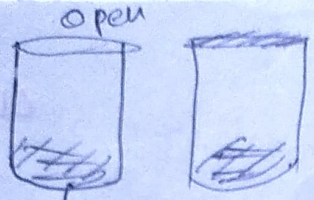
rejected by.

a) Reddi :-



→ life didn't appear in B & C
in A life came from outside as it's open

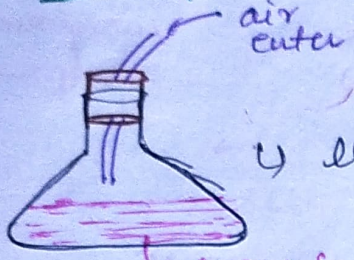
Spallanzani



→ life evolved in open.

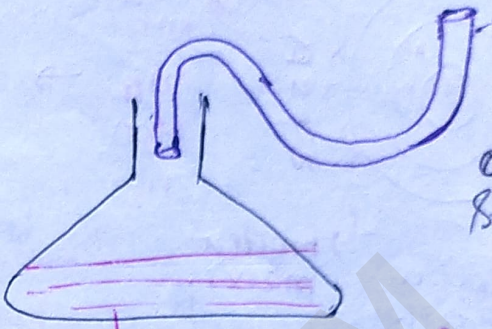
↳ fruits & vegetable broth

(iii) Louis pasteur



↳ life appeared

↳ sugar syrup + yeast extract.



↳ sugar syrup + yeast

↳ no life appeared

* hence theory of spontaneous generation is rejected.
* but supported the theory of biogenesis.

Theory of biogenesis

life evolved from pre-existing life.

supported by Reddi, Spallanzani and pasteur.

Silent over how first cell evolved.

Theory of pan-spermia / Cosmozoic theory.

* life on earth and other planet transfered in form spore from outside.
* accepted for long time.

limitation: not possible for life to come from hostile environment on earth.

Theory of chemical Evolution [most valid]

oparin and Huldane theory

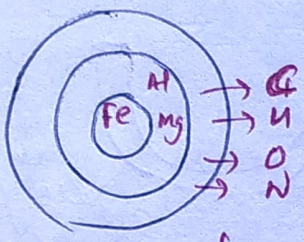
England
HERO → oparin.
Huldane ↳ Russia

* life originated from pre-existing non-living organic molecule
* non-living organic molecules evolved from inorganic molecule.

* Environment was reducing
* high temperature
* volcanic storms.

CH_4 → first organic compound

NH_3 → first inorganic compound

i) 

→ CO_2, NH_3, CH_4, H_2O, H_2

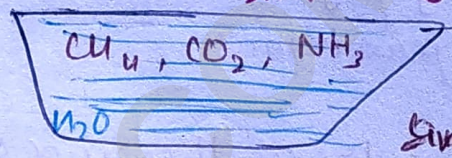
↳ molten masses.

Molten Earth

ii) atmosphere
hydrosphere (ocean)
lithosphere.

↓

Simple inorganic

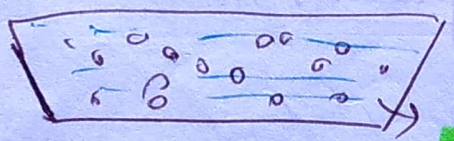


→ ocean high temp

Simple organic and inorganic compounds

Supported by Miller's experiment

8000°C
Reducing atmosphere



Hot dil. soup
(prebiotic soup)
↳ Haldane

Simple organic compounds

Amino acid
Sugars
pigments.
nucleotides.

↓

Complex organic compounds formed
polysaccharide
polypeptides
nucleic acids (DNA, RNA)
lipids

↳ some aggregation of complex organic molecules.

* Oparin developed such aggregation of carbohydrates and protein in lab called coecervates.

↳

Coecervates
↳ aggregate of polysaccharide & protein.
↳ some metabolism occur
↳ lipid absent
↳ can't reproduce.

Similar experiment
~~Stphen~~ sydney fox.
↳ lipid aggregate
↳ microsphere.
↳ reproducing.
↳ metabolism occur.

Evolution of single cell

Elements (C, H, O, N)
↓
Compounds (CH_4, CO_2, NH_3, H_2, H_2O)
↓
hydrosphere
Atmosphere
↓
simple inorganic (CH_4, CO_2, NH_3, H_2)] Supported by Miller experiment (1953)
↓
simple organic — Amino acid, Sugar, nitrogenous base, fats
↓
complex organic — Carbohydrate, polypeptide, nucleic acid, lipids

Prebiotic soup or (Hot dilute soup) — Haldane

→ aggregate (coecervates) — microspheres (Sydney Fox), Oparin.

3 bya — Protocell (noncellular) → dividing
↳ RNA world evolved
↳ chemoheterotroph

RNA → DNA evolved

2 bya — First cell (chemoheterotroph) → dividing, ↳ DNA genetic material, ↳ chemoheterotroph, ↳ anaerobic (O_2 absent).

* First inorganic mol. NH_3
* First org. mol. CH_4
* First cell Chemoheterotroph anaerobic.
* First autotroph Chemoautotroph.

Chemoautotrophs
make its own food.
anaerobic

* Chemoheterotrophs keep extincting as Chemical exhausted.

Pigment evolved.

Photoautotrophs — anoxygenic

→ oxygenic photoautotrophs (cyanobacteria) — prokaryotic cell.
produce O_2
↳ environment become oxidizing atmosphere
O_2 evolved.

* As soon as O_2 appeared, i.e environment become oxidizing ↳ chemical evolution stop.

↓
Endosymbiotic theory
↳ a small prokaryotic cell got inside large prokaryote
Eukaryotic cell.

Miller's Experiment → Supported Chemical evolution

(1953)

S.L. Miller

conditions

800°C electric discharge.

Reducing

Gases

H_2O vapours →

Hydrogen H_2

Ammonia NH_3

Methane CH_4

H A M
2 1 2

18 days

Amino acids formed

Glycine

Aspartic acid

Alanine

* glutamic acid not formed.

Other supports

Similar experiments proved formn of amino acids nucleotides, sugar pigments.

* Chemical analysis of meteorites → prove chemical evolution.

=

* cyanobacteria filled atmosphere by oxygen.

=

ORIGIN OF SPECIES → Organic Evolution

Theories of organic evolution

1. Theory of inheritance of aquired character (Lamarkism)
(Use & disuse of organ)
2. Theory of Natural Selection (Darwinism)
3. mutation theory / Modern Synthetic theory
(Hugo de Varies)

=

1. Theory of Inheritance of Aquired character Lamarkism.
(Use & disuse theory)

* by Lamark (French)

↳ published in book 'philosophy Zoologique.'

Enviroment changing ⟶ developed new needs.
↓
to fulfill these needs.
→ new character develop
↳ existing character → more use
↓
get more developed

↳ existing character → less use
↓ (disuse)
less developed.

This aquired character is inherited ⟵
↓
origin of new species.

Support

(i) Girrafe vegetation near ground finish → need of long neck to eat vegetation at hieght.
↓
long neck developed ⟵ inherited

(ii) webbed toes in aquatic birds
↳ need of swimming.

(iii) loss of limbs in snakes
↳ as they move to underground habitat. ↳ disuse.

(iv) Amphibian developed lungs as they moved on land.

★ Criticism of lamarkism

(i) 'Theory of germplasm' → Weisman
Only those aquired trait is inherited which effect germplasm (germcell)
Experiment :- cut tail of mice till 22nd generation.
still mice with tail born.

(ii) all organ don't grow with use.

'Neolamarkism' :-
★ not all aquired traits are inherited. only those inherited that effect germplasm. (germ cell).

2. Theory of Natural Selection (Darwinism)

basis → Natural Selection
main force for evolution.

→ Branching Decent
↳ Evolution of new species occur from existing.

Darwin 1831 to 1836 → Voyage by H M S Beagle (Ship) → Galapagos Island (living laboratory of evolution)
group of small islands in South American Continent.

* found 13 species of birds differ in beak.
↳ Darwin finches.

* Thomas Malthus
↳ essay on overproduction in population (1840)

* Alfred Wallace (1858)
↳ voyage to Malay Archipelago.

↳ 1859 → 'Origin of species'.

1831 ↓ 1836 ↓ 1840 ↓ 1858 ↓ 1859

assumptions :-
(I) Resources are limited.
(II) Stable population.
(III) variation in population
(IV) variation is inheritable.

Darwinism

'overproduction' → organism can multiply very fast.
* slow breeder like elephant can grow enormously.
↓
'Resources limited'
↓
intraspecific competition or Struggle for existance.

→ variation not useful to utilize more resources ↳ don't give more progeny
→ variation which help to utilize more resources → more progeny.

Useful Variation → more progeny → Sexual selection → new species.

Overproduction → Limited resources → competition (Struggle for existance) → Useful variation → more progeny (Sexual selection) → new species

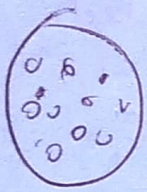
* Support of Darwinism

* Domestication of Animals & plants by Human

man-made selection or (Anthropogenic action)

↳ human evolved new breeds in just few years. then why not nature in millions of years.

* microbes colony



microbial colonies → grow in given resources → medium change → only those survive which have variation to utilize new resources. → Colonies of new species formed in small time.

microbes have shorter life span ↳ fast reproduction ↳ Speciation in short period of time.

* birds → take more time to evolve.

* longer life span → more time to evolve.

* Co-evolution

* two organism evolve together because of more efficient resource utilization.

* Mimicry & warning colouration

↳ Special variation to survive from predators.

* limitations

↳ Darwin discussed abt small & continuous variation.

Can't explain large, sudden discontinuous variation.

mutation.

↳ never talked about somatic and germ cell.
later given Theory of pangenesis ~~to correct~~ in attempt to correct this.
which say → from every somatic cell small bodies called 'pangens' move to germ cell through gonads.

↳ Silent on source of variation.

Neodarwinism source of variation is mutation.

Other Supports for Darwinism

① DDT ↳ gene for resistance against DDT already present in insect population.
* when DDT used extensively → DDT resistant insect selected.

② Industrial Melanism example of Natural selection.
Supports → natural selection.
white winged moth → Biston Bitularia Bitularia] Subspecies
black winged moth → Biston bitularia Carbonaria]

England before 1920 → lichen grow on tree
↳ white winged moth Camouflauged.
↳ not visible to predator
↳ black moth
↳ visible in contrasting surrounding.
white winged moth are more in number → selected.

after 1920 industrialization due to industrial smoke & soot → lichen don't grow on tree.
↳ Black soot cover tree trunk.
* black winged moth ↴ Camouflauged.
* white winged moth → easily visible due to contrasting surrounding.
Black winged moth incr → selected.

Use of weedicide

Excess weedicide use Select those weeds which are resistant to weedicide.

Mutation theory / Modern Synthetic theory

Hugo de Varies → Dutch scientist.

on Oenothera lemarkiana ↳ evening primrose

* large, single, discontinuous variation responsible of evolution of species.
* Single step large variation called Saltation.
  ↳ ~~main~~ Reason for speciation.

Support

* Short horn cattle
* Hairless dog
* Ancon sheep → sheep with short leg appeared.

* Limitation

↳ Can't explain co-evolution

↳ Can't explain overspecialization of many organs.

Darwin	Devaries
↳ Small ~~continuous~~ fluctuating variation	↳ Large single step variation
↳ Continuous	↳ discontinuous.
↳ Directional	↳ non-directional
↳ Silent on source of ~~evolution~~ variation	↳ ~~Main~~ mutation is source of variation.
↳ Main force of evolution ↳ Natural Selection.	↳ Main force → mutation.

Mechanism of Evolution of Species

Speciation:- How new species evolved?

* **Gene pool** Sum total of all different type of allele in a population of one species in common geography.

Gene pool = common genes + uncommon gene
(same species.)

↳ Speciation is the formation of new species due to change in allele frequency / gene frequency of existing gene pool.

Integrity of Gene pool

↳ to maintain existance of any species — Integrity of gene pool is important.

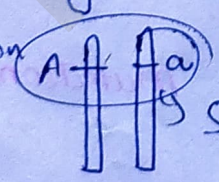
It's maintained by

a) **Isolation of gene pool.**
↳ reproductive isolation.

b) **Random mating within species**

Hardy Weinberg Equilibrium

↳ frequency of allele of a gene locus remain constant in a gene pool.
(no change in frequency; no new type of allele)



Same gene locus.

frequency of A and a remain const. over generation

* Sum total of all allelic frequencies of a gene locus is one. (=1)

* Disturbance of allelic frequency causes evolution

maintain genetic equilibrium we require.

Large population size

In small population, slight fluctuation can disturb equilibrium

(ii) **Random mating** Each allele get equal chance.

(iii) **Sexual reproduction**

(iv) **Biparental reproduction**

A → allele
AA → individual.

$p + q = 1$
(A) (a)

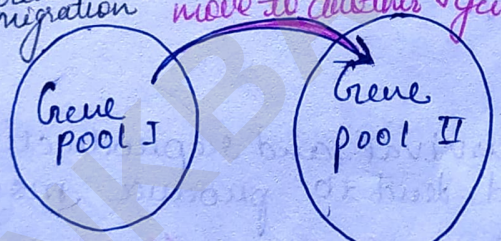
$p^2 + 2pq + q^2 = 1$
(AA) (Aa) (aa)
individuals

Some forces cause disturbance in equilibrium.

1. **Mutation**

2. **Gene flow/gene migration** → individual of one gene pool move to another gene pool. and reproduce there.

multiple time gene migration



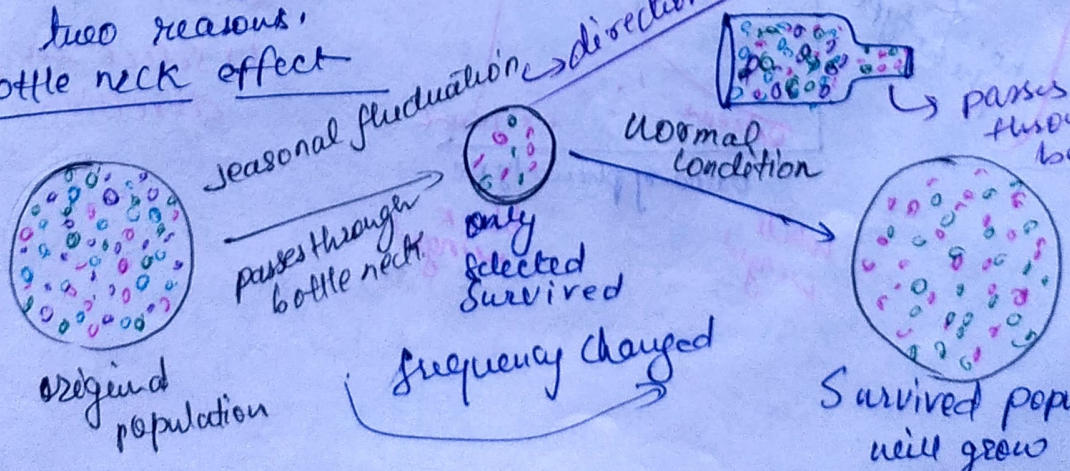
* Continuous gene flow between two isolated population will give an average common population not the new species.

3. **Genetic Drift** (Sewall wright effect)

Random change in allele frequency in small population.

two reasons.

① **Bottle neck effect**



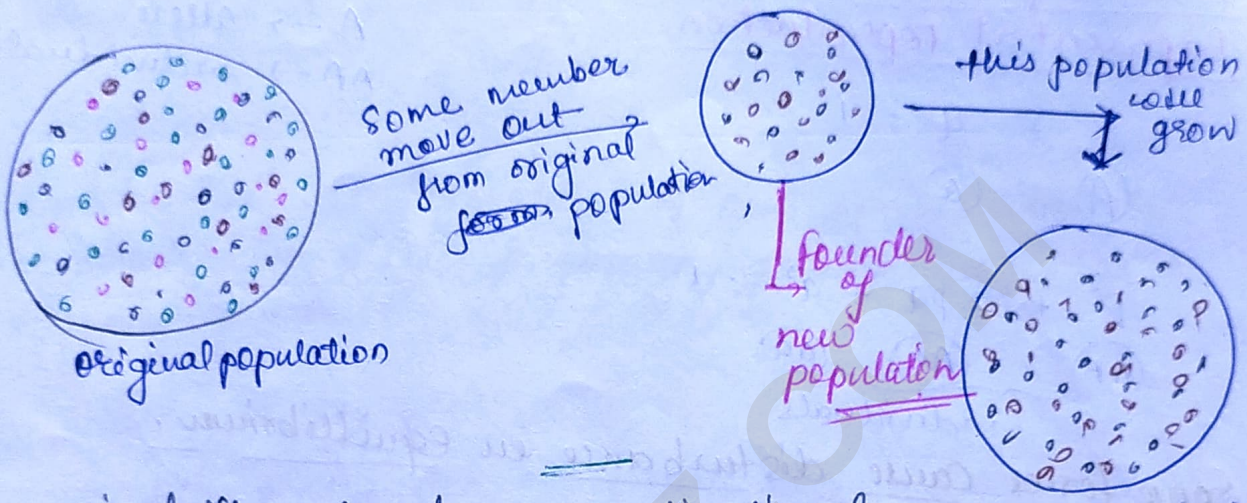
↳ Seasonal fluctuation

↳ population randomly passes through bottleneck.

↓

the survived population will grow.

founder effect



genetic drift → random, non-directional or may be non-adaptive.

but large fluctuation.

new population alleles.

✱ have members of migrant population

Natural Selection

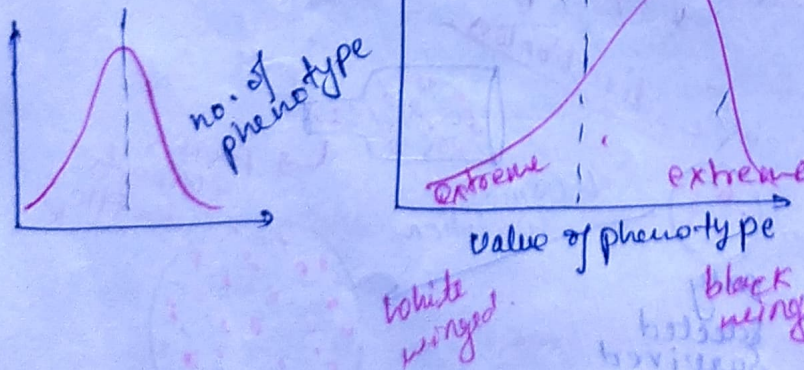
differential success in survival and reproduction individual which are better suited tend to produce more progeny.

✱ Natural selection acts on population.

✱ Three types of natural selection.

Directional:-

number. shift either side of mean average value. ↳ on changing environment.



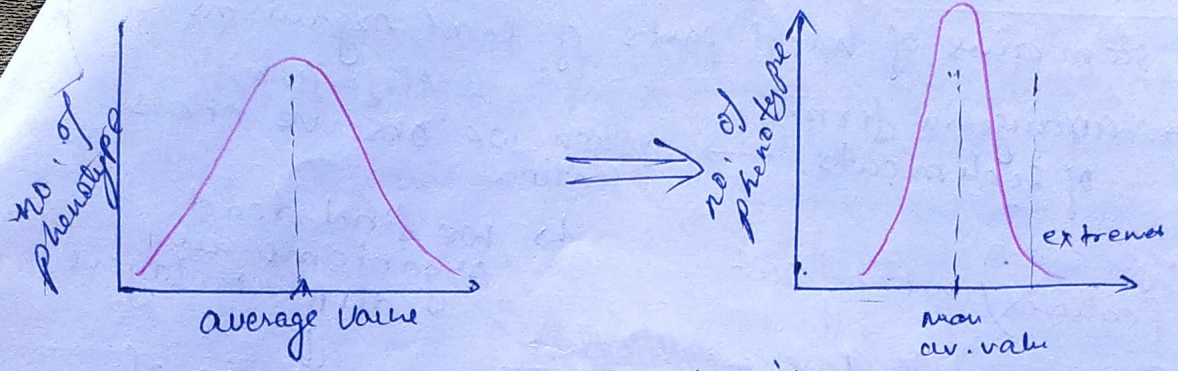
eg. DDT

industrial melanism.

↳ select in particular direction

Stabilizing

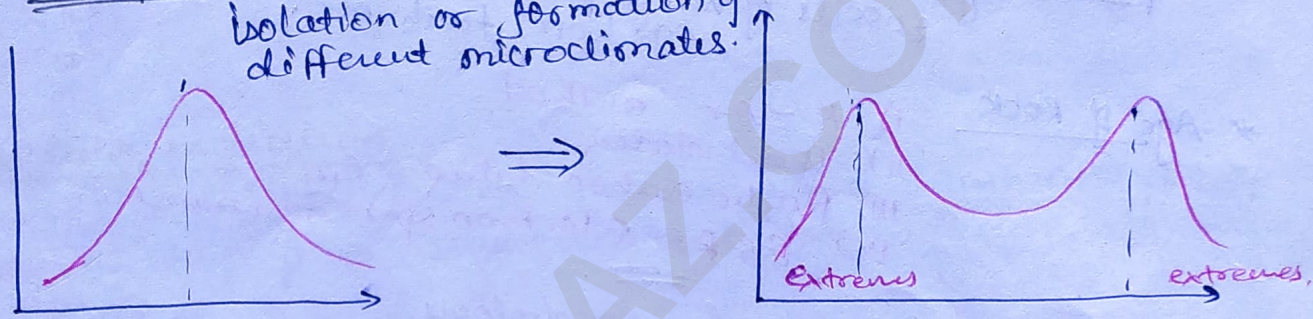
↳ constant condition.



mean value is more selected. → peak get narrower.

(III) Disruptive

↳ split in population due to geographical isolation or formation of different microclimates.



extremes are selected

↳ population split

=

B

r- Selection

→ short life span

↳ Resource utilization is very fast.

↳ Small size

↳ fast reproduction

↳ totally nutrition dependent.

K- Selection

↳ long life span

↳ Resource utilization slow

↳ large size

↳ fast reproduction

↳ well suited in environment

* Recombination

gene frequency fluctuate due to different combination of gene formed by sexual reproduction.

↳ two gene can effect each other.

Evidences of Evolution

① Palaeontological Evidence (Fossils)

Fossils are remains of hard parts of dead organisms (life form)

Rocks → arrange in form of sediments → when we observe cross section
↳ we find dead organisms in different layers
↓
find age of Rock.

Fossils → age, features → Find out
↓
Compare with other fossil or life forms exist today.

* Petrified fossils
↳ Fossils of hard parts. eg. bone, teeth, etc.

* Age of Rock
i) K - Ar method
ii) lead dating
iii) Radio carbon dating C_{14}
iv) ESR → Electron spin resonance.

② Comparative Anatomy & morphology
Structure like anatomy & morphology
↳ compare to find common ancestory.

Homology → Similarity in origin or basic structural organization or similarity in basic embryonic development.
↓
common ancestory
Homologous structures are the result of divergent evolution.

* Mammals Forelimbs
Humerus, radius, ulna, carpel, metacarpel.
→ Cheetah forelimbs
→ ~~bird~~ bat wings.
→ whale flippers
→ human hand

* Vertebrate heart
↳ Chamber changes → basic str. is same.

* Vertebrate brain

* Stem tendril (Cucumber) and thorn (Citrus, bougenvillia) (Axilliary bud)

phylloclad and cladode
(Stem modification)

Analogy

different structures evolve similarity in similar habitat. for ~~common~~ similar functions.

Analogous structures are due to convergent evolution

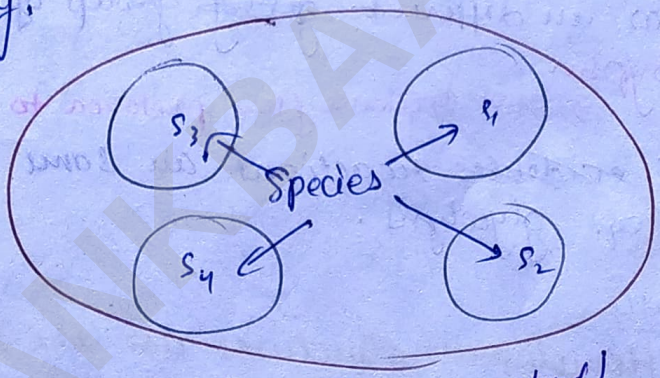
eg

* wings of bat
  wings of bird → flying
  wings of butterfly

* fins of whale and fish.
* potato (stem) & sweet potato (root)
* eye of mammals and ~~eye of octopus~~ and eye of octopus.

Adaptive radiation

process of evolution of new species in a common geographical area starting from common point & Radiating new area of geography.



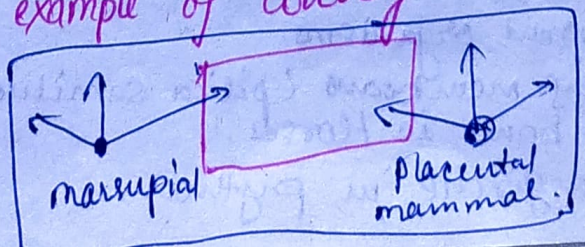
Same geography ki different habitats.

eg (i) Darwin finches (Galapagous Island)
Bird → seed eating → insectivorous
→ other changes in beak.

(ii) Marsupial in Australia

(iii) placental. Mammals in Australia.

* When two or more adaptive radiation occur its the example of convergent evolution.



↳ Marsupial and placental mamal. converge to the same habitat in common geography

eg.

	convergent	
mole	⟷	marsupial mole
Anteater	⟷	numbat
mouse	⟷	marsupial mouse
lemurs	⟷	spotted cuscus.

* marsupial rat and mole → convergent evolution.
* marsupial rat and kangroo → adaptive radiation.

* Difference b/w Adaptive radiation & divergent evolution

Adaptive radiation	divergent evolution
↳ fast	↳ slow
↳ not much difference many features are same	↳ accumulative difference slowly
Diversification of species.	

Biochemical evidence

↳ many gene → compare sequence in different organisms.
↳ similarity eg. Hexokinase gene from bacteria to human

↳ protein → Similar in different ~~group~~ group of organisms
eg. Trypsin
↳ same sequence from protozoa to human.

* many biochemical ~~evidence~~ reactions are same in many organisms. eg. glycolysis.

Embryological evidence

Recapitulation Theory Earnst Haeckle.

→ ontogeny recapitulate phylogeny.

↳ Embryological development of any organism copy/repeat evolutionary history

↳ Von baer Reject this theory.

Some Embryological stages are common in many groups.

Vestigial organs

↳ not useful in current organisms.
eg. ↳ Nictiating membrane (pilica semilunaris)
↳ Splint bones in Horses.
↳ pelvic girdle in python.

* muscle of pinna
* coccyx
* wisdom teeth (third molar)

Connecting links

↳ features match b/w two groups.

Cyanobacteria (chromatophore → membrane extension)

Euglena (plant & animal)

Neopilona (Annelida & mollusca)
→ segmented ↳ mantle, shell.

Peripatus → (Arthropoda & annelida)

Archaeopteryx → Bird → Beak, feather
→ reptile → teeth
↳ keel absent
↳ muscle connecting sternum & wings.

Hardy-Weinberg's principle

Q ~~11~~

A → allele A → p
a → allele → q
] frequency of allele

AA → individual p^2
Aa → individual $2pq$
aa → individual q^2
] individual frequencies.

Q 98 out of 200 individual express the recessive phenotype, what % of population would be heterozygous.

$aa = \frac{98}{200}$ = $aa = 0.49$

$q^2 = 0.49$

$q = 0.7$

$p + q = 1$

$p = 0.3$

frequency of heterozygous. $= 2pq$

$= 2 \times 0.3 \times 0.7$

$= 0.42$

∴ % = 42%
of heterozygous.

Evolution of Man

Hominid:- close to human
↳ Much similar to human
↳ chimpanzee are close relative of humans.

changes in evolution of humans.
↳ Bipedal locomotion
↳ Cranial capacity increase.
↳ Upright (Sideway movement)
↳ opposable thumb.
↳ Binocular vision.

4 Stages of human:
↳ Ape stage Dryopithecus
↳ Ape man stage Ramapithecus.
↳ primitive Man
↳ Modern man

(i) **Ape stage**

Dryopithecus:- more ape like (proconsul)
Arboreal
herbivore
5mya
first Ape-man stage.

(ii) **Ape-man stage.**
Ramapithecus

(iii) **Australopithecus** (3-4 mya) [400-600] cc
first erect posture.
→ not more than 4 ft.
→ Taung cave → South Africa + fossils (Taung baby)
Ethiopia } fossils.
tanjania }

Primitive Man

Homo Habilis :- first human like Homonid.
Stone tool / Handy man

⇒ 2 - 2.5 mya
⇒ 650 - 800 cc

Homo erectus — first group to move out from Africa.
1.5 mya
900 cc

Java man
1891 fossils in Java
↳ used fire.
↳ hunting
↳ cave dwellers

Pecking man
↳ cannibalism
↳ eat own species.

Neanderthal man
↳ 40000 - 1 lakh years
most close to modern man.

Cranial capacity :- 1400 cc
↳ buried their dead ones.
↳ use hides

IV Modern Man → Homo Sapiens.
Homo Sapiens
Cromagnon :- max cranial capacity → 1650 cc
↳ cave paintings
↳ domestication.
cromagnon ↳ sub species
Bhimbetka rock Shelter
Risen, MP.

Homo Sapiens Sapiens. (We) 1400 - 1450 cc
↳ agriculture → 10,000 years ago

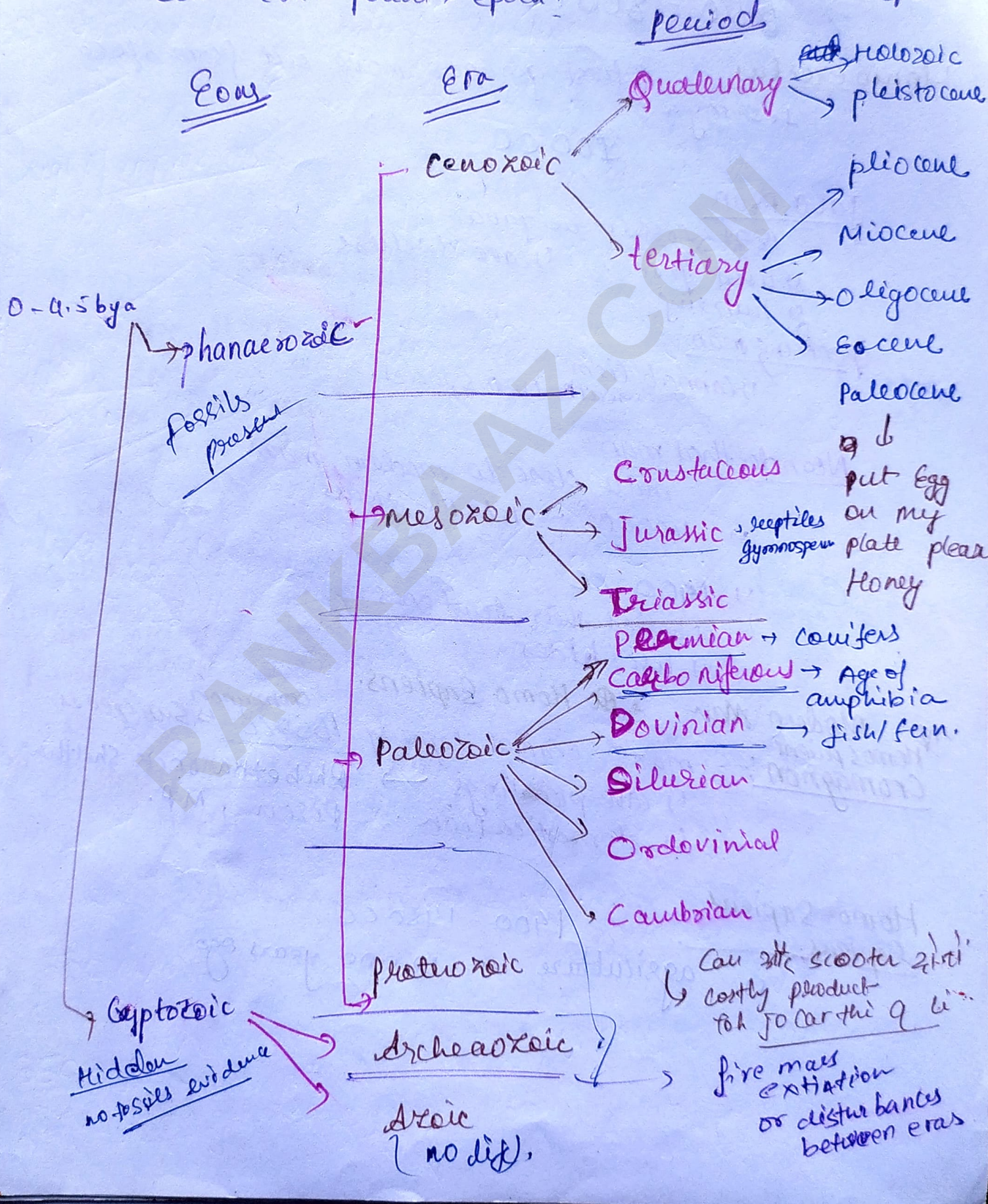
Geological time scale

Earth → 4.5 bya

↳ divide into time scale → on the basis of fossils.

4.5 → 0 current

Eon > Era > period > Epoch.



Evolution of Amniotes

Vertebrata
- agnatha
- gnathostomata
  - pisces
  - tetrapoda
    - Amphibia
    - Reptiles
    - birds
    - mammals

] Amniota → have amnion.

Skull have a hole called fenestra at ~~edge~~ junction of frontal and temporal bone, ~~bord~~.
↳ reptiles are divided on the basis of no. of fenestra

Early reptiles

Sauropsids
no fenestra or two fenestra.

- Anapsids — ~~no~~ no opening
  - turtle
- diapsid — two opening
  - Lapidosaurus
    - lizards
    - snakes
    - tuatara
  - Archosaurus
    - crocodile
    - aligator
  - Thecodont
    - Dinosaur
    - Birds.

Synapsids
single fenestra

Pelycosaurus → Therapsids → Mammals

Brief account of Evolution.

2000 mya → first ~~cell~~ cellular form of life
↳ chemoheterotroph

Inbetween: chemoautotroph → Anoxygenic photoautotroph → oxygenic photoautotroph

500 mya (Cambrian period) — invertebrates formed & active

350 mya (Devonian) — Jawless fish evolved

320 mya → active fish with stout & strong fins → can move on land & go back to water

↳ 1938, fish coelacanth caught in South africa

* plants are first organisms to go on land.

300 mya
coelacanth → called lobefins.
↳ evolved into first amphibians
Carboniferous
lived on both land and water.
↳ resembles modern day frogs and salamanders.
Age of amphibians

↓↓

reptiles evolved from amphibians
↳ have thick celled egg
don't get dry in sun.

↓↓

Mesozoic era
Age of reptiles
reptiles dominated. →
* Giant ferns present
↳ fell to form coal deposits.
* gymnosperm evolved.

Some reptiles went back to water → developed into fish like reptiles → 200 mya
(Ichthyosaurs)

* Land reptiles → dinosaurs
↳ biggest Tyrannosaurus rex
20 ft height
↳ dagger like teeth.

* 65 mya dinosaur disappeared
↳ may be climatic changes.

↓↓

Some evolved into birds.
eg. Archeoptrex
(connecting link)

↓↓

first mammals are like Shrews.
viviparous ∵ protect young ones inside mother
* intelligent in sensing.
* South America → horse, hippos, bear rabbit
↳ extinct due to overridden by North American fauna.

Continental drift → Mammals of south America
extinct
↳ overridden by North American fauna

Isolated
↓
mammals of Australia
Survived due to lack of competition.

* aquatic mammals
↳ Whale, dolphin, seal, sea cows.