ABHIJIT RAY AIR 50 UPSC CSE 2021

ANTHROPOLOGY PAPER 1 - 1.4 to 1.8

If you have made your own notes, please do go through mine once and note down the value addition and extra things. Trust me, you will be benefited as these notes are made from extensive sources.

1.4

LAMARCKISM

(1)

Jean Baptiste Lamarck (4)

"Philosophie Zoologique (1809)"

1) Living beings keep growing due to internal forces of life (Vague)

Bio Ji ∝ internal forces (i) Heredity (ii) Environment

from (ii) it is clear that he meant environment as a force

Humans grow till 18 yrs of age.

2) Evolution is predestined — need based. Brain → Muscles → New organ

Criticism: ~~Third molar, ear pinna, nictating membrane, appendix.~~

Today we know new organs come up by mutations.

3) Principle of use and disuse:

more use → organ grows

less use → organ eliminates

Criticism: grows till a limit, more use leads to anomalies

Third molar, ear pinna, nictating membrane, appendix should have disappeared.

These (3) were not criticized earlier.

4) Principle of inheritance of "acquired characters":

All changes in a life time → pass on to next generation

Highly criticized. (Blind à ctors Blind)

Lamarck's theory was neither scientific nor based nor supported by facts. But, he worked in dark age and hence must be credited for atleast attempting it.

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Diagram given in Black Didn't

DARWINISM

give any theory, but wrote a book.

"On the Origin of Species by means of natural selection" (1859)

Obs 1

Malthusian principle (1798)
"an essay on popⁿ"

Popⁿ GP, Resources AP

Informal

→ Struggle for existance

Struggle

Direct

food, shelter, mating
Interspecies + Intra
intra species

Indirect

against the environment
(Both Lamarck + Darwin)

Hence, n (Survival) = f (resources available)
n ↓ Number

Obs 2

Concept of variations — Members of same generation/species vary from their previous generation and minutely and he called these small/continious diff. as VARIATIONS

VARIATION

Advantageous — Disadvantageous.

Larger the n (Adv), greater chances of Survival
〃 n (disadv), 〃 〃 elimination

Variations by themselves are neither adv nor disadv. but it the environment that decides that a particular variation is adv or disadv.

Eg. Obs → Adv in Malarial environ
dis Adv in non-malarial environ.

natural urge
↓
env changed
↓
new needs
↓
use
↓
dev more
↓
inheritance of acq characters
↓
new speicl

disuse
↓
disappear

2nd Inference: Natural Selection. Depending upon resources available and as directed by N.S., a small group would survive with large no. of adv. variation.

small grp → Large grp with new adv. variations
↓
face Struggle
↓
new group with even more adv. variation than predecessors ← Small grp survives

└→ Repeated n times → small variations accumulate and individuals become markedly different from parent generation

Marked morphological difference means new species has arrived.

3rd Obs: Transfer of variations over generations followed by N.S. & Struggle in every generation.

3rd Inference: Origin of Species

Criticism: (I) What causes these variations?
(II) How do they spread?
(III) How variations are restricted [illegible]?

(I) Popn GP?
(2) Cultural fitness?
(3) Genetic & Somatic diff.
(4) Pangenesis
Just N.S.

Today Neo-darwinism tried to answer these 3 question

Causes:
1. Gene mutations
2. Change in chromosome no. (Anaphase)
3. Genetic recombination / Crossing over. (Prophase)

Spread:
1. Hybridization
2. Migration

Restrict:
1. Isolation
2. Chance factor

mutation, Inbreeding, hybridiz", chance factor, variations

This serves as intro for Synthetic Theory and unclear for Neo-darwinism

Pop^n dynamics: T. T. Thompson & Wagner
Mutation dynamics: Dobzansky
Pop^n Genetics: Weinberg, Hardy
Sewall Right

Neo-darwinism / Synthetic theory

Essential factors

1) Gene mutation
2) Δ in Chromosome No.
3) Genetic recombination
4) Isolation (inbreeding)
5) Natural Selection

Non-essential factors

1) Migration
2) Hybridization
3) Chance factor (Genetic drift)

1. **Gene mutation**: Sudden changes in nature of a single gene.

Cause: Temp, Chemical, radiation.

1908 Hugo De Vriel

In man Δ ↑ lethal → can only lead to mutation in mean mostly harmful, only some useful

Thus, in man gene mutation is the only source of new variation.

E.g. Δ in 1 amino acid in (β) chain of HbA → HbS

Rate of mutation: 1 to 50 variation / 1 million gene

2. **Δ in Chromosome No.**:

Two ways

(i) **Euploidy**: ↑ or ↓ in multiples
2n, 3n, 4n ... n

(ii) **Aneuploidy**: ↑ or ↓ in certain odd chromosome.
2n+1, 2n±2 etc

Both type of changes can not result in variations in man because either they are fatal or affect all the survives, fertility and maturity is compromised, so no reproduction.

Euploidy → Spontaneous abortion

Aneuploidy → still birth, neonatal death, infant mortality

If aneuploidy occurs in small chromosome / sex chromosome then Severe mental retardness / infertility.

But in plants and animals lower species of animals both type of changes in chromosome no. can result in micro and macro evolution.

3. Genetic Recombination:

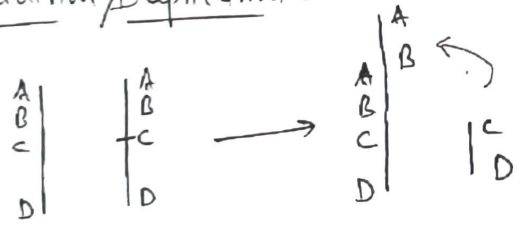
No. of chromosomes same but sequence of gene changes. This can happen via 4 modes —

(a) Deletion:

Placer Willi 15q father
Angel 15– mother

Cri-du-Chat Syndrome (5–p)

(b) Addition/Duplication:

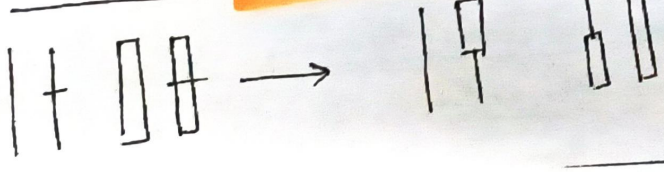


(c) Inversion:

(d) Translocation: 2 non-homologous chromosome

So different from crossing over

deletion exchange position



Effects are same as that of Δ in chromosome no. In case of plants and lower animals it can result in micro and macro evolution. But in higher species it results in such a situation whereby either individual does not survive or if he does it is infertile at maturity.

Thus, out of the 3 possible causes of variations only radiation induced variations can lead to evolution and that too micro evolution in ~~MAN~~.

~~Plants~~ & lower animal—species all 3 can lead to macro & micro evolution.

4. **Natural Selection :**

NS is differential survival and repⁿ of individuals due to differences in phenotype

Natural Selection

OPERATES IN TERMS OF:

- Fertility
- Fecundity

actual

fertility → ~~capacity to~~ reproduce

fecundity → ~~Chances of survival till maturity~~ Capacity to reproduce (Ability to become parents)

Variation via gene mutations is SLOW

1-50 gene per lakh genes

for a gene 1-50 individuals / million individuals.

So, variations takes generations to express themselves

Spread / Restriction depends upon how advantageous or disadvantageous it is in a particular environment

Herent
om wrong
over

Greater advantages → ↑ Fertility & Fecundity

Semi lethal gene → ↓ Fertility

Lethal gene → 0 Fecundity
Sub lethal

No. operates on phenotypes and not genotypes.
Thus it has an instant operation during inbreeding
while delayed operation during hybridization

5. **MIGRATION:**

It in itself is not a factor. It is of 2 types—

Temporary
No effect on evolution

Permanent
Has effect on evolution
(in terms of Hybridization)

6. & 7. **Isolation and Hybridization:**

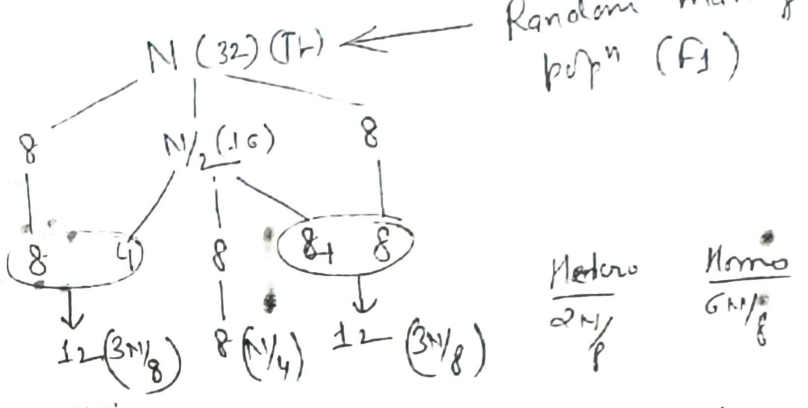
- Geographic
- Cultural
- Genetic

All result in Inbreeding.

Inbreeding refers to mating within the defined (Social) units
Hybridization refers to mating outside the defined Social Unit

Inbreeding refers to mating b/w similar genotype (combination) individuals and hybridization refers to mating of diff

Both in definition and effect they are diff (opposite)



In every successive generation no. of popn of heterozygotes will be halved.

Thus, Inbreeding ↑ homozygosity and reduces genotype variability. N.S. acts instantaneously

Hybridization ↓ homozygosity and ~~reduces~~ ↑ genotype variability. N.S. (action on phenotype) is delayed.

m

Jump

Hybridization Vs Inbreeding

1. Mating in & out
2. — " — the same genotype and diff genotype
3. Homozygosity — diagram
4. Genotype variability ✓
5. N.S. action.

↓

Explain, N.S by autosomal recessive lethal, sublethal

genotype → phenotype

Hetero. Homo.

lethal → immediately

sublethal → fertility low

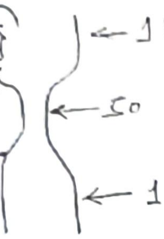
So Chance Factor / Random Genetic Drift

(Sewall Wright effect)

Bottle Neck effect	Founder's effect

(N.E. Seals)

British Columbians (when European brought diseases)



natural calamity, disease etc

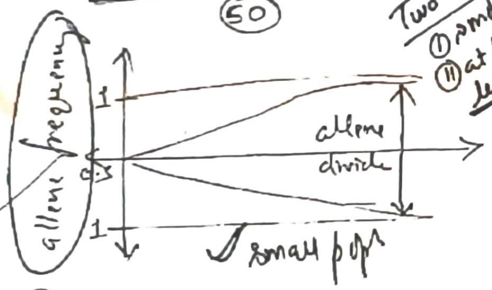
not advantageous gene

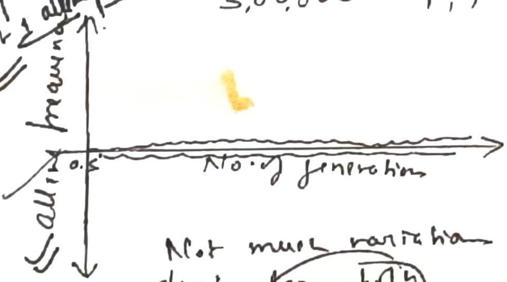
Sudden random change in gene frequencies w/o the role of mutations and N.S. are covered under these.

Eg In a family of only girls (daughter), fathers' Y chromosome gets automatically eliminated.

Genetic drift only operates prominently in a small population. P, Q, (50) 5,00,000 p, q,

Two condn
(i) small popn is even smaller
(ii) at least 1 allele frequency zero





Not much variation due to large popn

FOUNDER's effect :

Group	Allele frequency
O	0.7
A	0.2
B	0.1

10 people separate and successive inbreeding

Gp	Separate popn	New gen
O	1	10
A	2	20
B	7	70

Eg Colour Blindness in Island

eg: Retinitis pigmentosa in Tristan de Cunha island (those who stayed after Napoleon) (Founder effect + inbreeding)

Blood Gp	Allele V in any pop	Allele V in separated pop	New Generation (100 people)
O	.7	.1	10
A	.2	.2	20
B	.1	.7	70

Conditions are must

1. Population must be small (part of it getting separated must be proportionally smaller)
2. Frequency of atleast 1 allele must be very low
3. Long term effect → ↓ in genetic variability

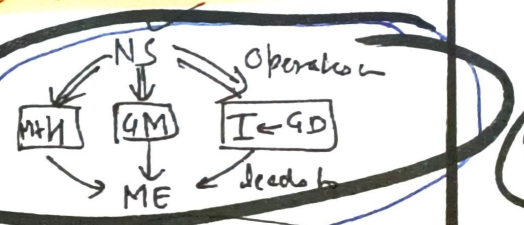
Man's evolution

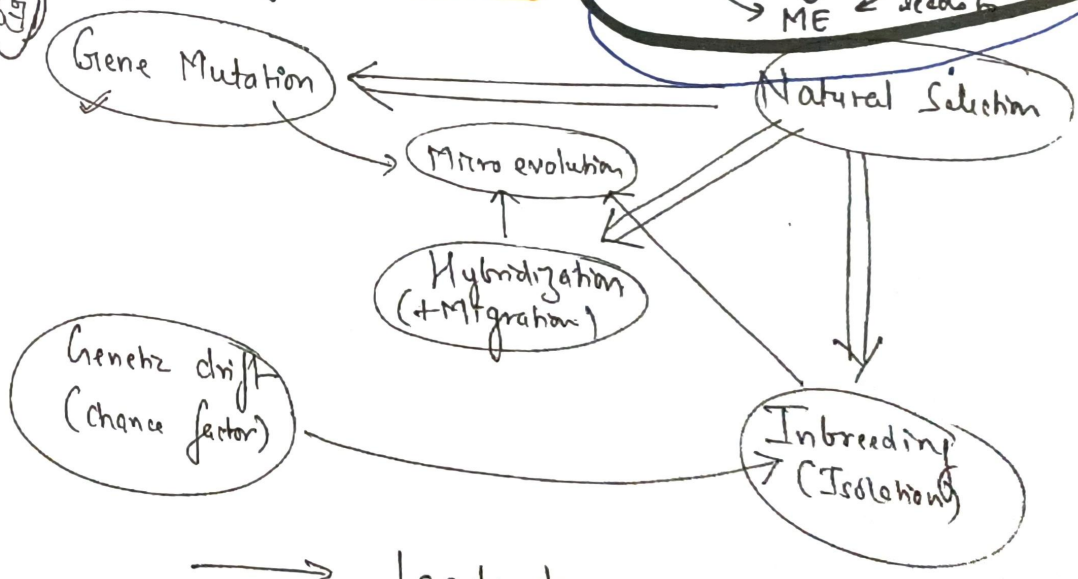
Only Micro evolution (Gene mutation via radiation)

Also ~~Macro~~ evolution

Only 5 factors involved

Concept of micro evolution given by Goldschmidt (1940)





→ Leads to

⟹ Operates on.

polymorphism → Balanced

I become dominant and start replacing others.

Balanced Polymorphism

Polymorphism means when a gene occurs in 2 or more forms (alleles) resulting in 3 or more genotypes or 2 or more phenotypes.

Balanced polymorphism is a situation when these genotypes maintain a fix proportion over generations.

Conditions

(I) The frequency of least occuring allele must not be less than 1% or 0.01.

(II) These allele frequencies must be maintained naturally by reproduction.

RBC → rounded, biconcave. At surface → Hb

Hb oxy → delivers O_2 to cells.

Now, Hb has alleles.

HbA → Normal

HbB

HbC] Thalassemia

HbE]

HbS → Sickle cell Hb

Due to sickle shape, SA is reduced, thus O_2 capacity reduced.

Genotype	Sickling	Decline in oxygen carrying capacity	
HbA/HbA	—	—	
HbA/HbS	8-15%	5-10%	Death
HbS/HbS	60-75%	more than 50%	

Usually HbS is harmful as homozygous HbS → death

HbA/HbS → reduced O_2 capacity

But HbS has malarial resistance.

So, lets evaluate HbS in Mediterranean / African env.

HbA/HbA → premature death due to Malaria

HbS/HbS → —"— —"— reduced O_2.

HbS/HbA → 100% Survival ✓

Hence, there are many popn around mediterenean where 10% adult survivors are HbA/HbS (ie allele frequency of 0.5 each). This is ideal eg of Balanced Polymorphism.

Relevance:
1. Genetic variability
2. Adaptation to environmental changes.
3. Hinders organ or blood donation. (polymorphism)

Micro Vs Macro Evolution

distinction given by Goldschmidt (1940)

Evolution is ~~study of change in life~~ change in gene frequency
Genetics is the study of heredity
for the sake of convinience it has been divided into macro and micro.

Micro evolution:
- small variation
- No morphological evidence
- Can be studied in living pop^n
- Can not be studied by naked eye
- Max. limit is Race formation
- Studied under pop^n genetics

Population Genetics

Macro evolution:
- large scale changes
- Morphologically marked, can be studied by museum evidence
- Cannot be studied only in living pop^n as it takes time.
- Fossil evidence required
- Studied under Paleo Anthropology
- Minimum limit is Species formation

Paleo – Archeology

Conclusion: This classification is done for the sake of convinience, actually there is no difference, Micro evolution gradually leads to macro evolution

(i) Scale
(ii) Naked eye
(iii) Morphologically evidenced
(iv) living population study
(v) Maximum limit Race formation and minimum limit species
(vi) Studied P.G. & P.A

#1 Is Evolution ongoing?

Ans Define Evol^n → Δ in ~~heredity~~ genetic frequency

Types → Micro & Macro

By title it is a reference to Micro.

This can be answered at 2 levels

Theoritical level:

Hardy-Weinberg principle in the form of several statements, in brief state that, "If there is no meaningful mutation, genetic drift, hybridization, inbreeding then there will be no evolution."

Even if no meaningful mutation or genetic drift happening, Inbreeding & Hybridization are opposite and hence either is always happening. and thus, the Natural Selection.

Hence, at any point of time Inbreeding or Hybridization togeth with N.S. if functional.

Hence, evolution never stops So, the question should be if the evol^n is happening at slow or fast rate. This is explained ahead.

2) Meaningful mutations are caused by radiations and last 6-7 decades have witnessed sharp ↑ in radiations

Key

★ Radiations → Industrial
→ Nuclear

resulting in very High rate of mutations. N.S. acts on mutation and hence rate of NS. has ↑.

★ Inbreeding, Hybridization & Genetic drift are cultural factors in man and in past 6-7 decades Hybridization has ↑, Inbreeding ↓ due to ↑ transportation, telecommunication & S&T development. Hence, not much role is left for genetic drift

Only Mutation can ~~only~~ cause variation in man. NS is omnipotent and Hybridization spreads variation and all these factors have increased their effect. Inbreeding and genetic drift limit variations and ~~hence~~ has seen a decline.

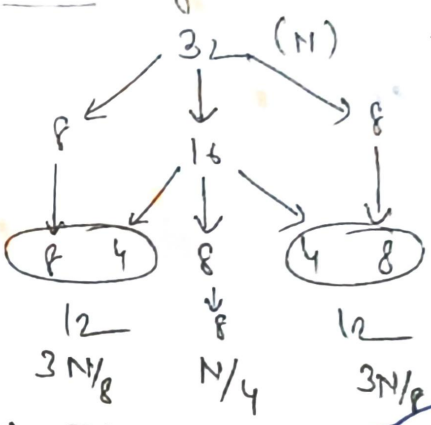
Hence, evolution must be going at a much faster rate today

Best eg disappearance of third molar.
1960s - Jaw → erupted in teens
Now → 40-50 Yr age
Next gen → No eruption
Feature of 32 teeth for last 30 million years
It will be lost in 3 generations.

Is Inbreeding harmful

Define inbreeding → mating within a defined population between similar genotype

Leads to Homozygosity ↓ genotype variability. N.S action instantaneously.



→ F1 Generation Random mating popⁿ

Thus, ½ If at all autosomal recessive lethal semilethal allele present, then it may prove to be fatal.

Ex Great Andamanese (300 popⁿ 100 yrs ago, reduced to 30 today (1971 census)) decline in popⁿ attributed to inbreeding

Now,

① Use of "if" → for presence of recessive lethal gene this tells us that inbreeding in itself is not harmful. Presence of autosomal recessive lethal gene makes it harmful.

② Claim that ¼ popⁿ eliminated in every generation but Mathematician → popⁿ/GP

(5) Reduced genotype variability reduces survival chances in changed environments. But no such scientifically proven study.

It can be harmful only if the survivors cannot compensate the loss caused due to recessive autosomal alleles.

Eg- (i) Plants interbreed — no problem

(ii) Many island tribes practice inbreeding and now they have eliminated all their recessive alleles and thus, enhanced their survival chances.

Criticism of Synthetic Theory

(i) It does not explain adaptation → Speciation/Reinforcement

(ii) Fails to explain future evolution

(iii) Unnecessary importance to Chromosome No & Genetic recombination (in men) 21 Trisomy, 18, 13, XXX, XXY, XYY, XO → Sexuality, fertility

(iv) Role of Hybridization & Genetic drift highly underminimized

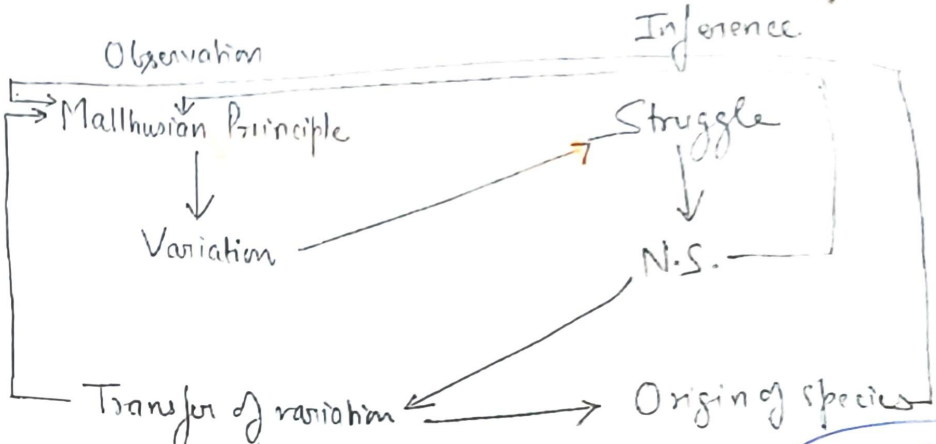
(v) Migration → useless
Gene migration → important

2 Studies

(1) Ansari Muslims — Bhagalpur (Bihar) Shah & Sinha (1982)
↳ Neo-converts (400 yrs ago) (1984)
Intred → 36% mortality Outred → 28%

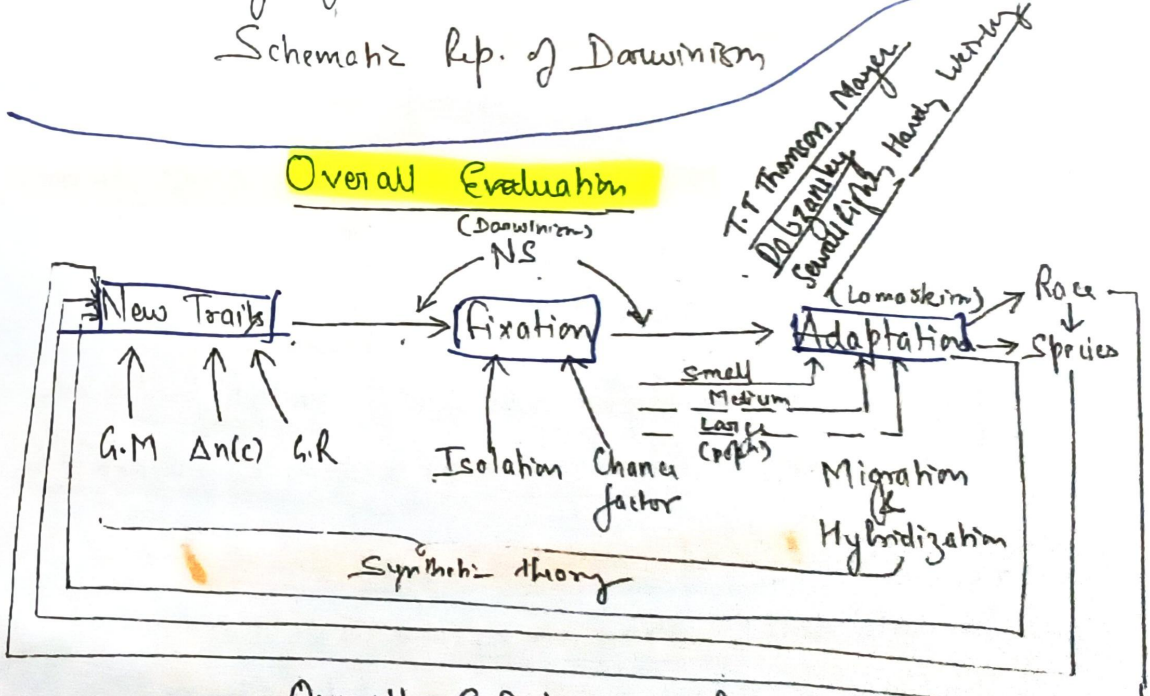
(2) Brahmins of ~~Tamil Nadu~~ — Rao & Inbaraj (1977, 79, 80)
↳ inbreeding since thousands of years and thus have eliminated almost all recessive traits (lethal)
No considerable rise or fall in infertility or mortality of the inbred people were noticed

Darwinism



Schematic Rep. of Darwinism

Overall Evaluation



Overall ~~Evolutionary~~ forces

Synthetic theory only explains ~~the~~ Migration and Hybridization (small, medium and large pop^n) but not adaptation (explained by Lamarck factor). Thus, S.T does not fully explain evolution. It does not discuss race and speeie formation. Thus, no singh theory ...

Lamarkism V/S Darwinism

1. Both Lamarkism and Darwinism are early theories although lamarkism is strictly an unscientific theory.

2. Lamark explains long neck of Giraffe by his theory of use and disuse and need based evolution. While darwin explains long neck by his theory of struggle, advantageous variations and natural selection.

3. Both Lamark and Darwin are credited for their consideration of role of environment in evolution. Although Lamark did not specifically mentioned environment.

4. Both tried to explain evolution by a single factor
   - Lamark → Adaptation
   - Darwin → Natural Selection.

5. Lamark → considered variation in vertic feature only
   Darwin → considered variation is same as well as diff Gen.

6. For both 'aquired characters' were inherited
   Lamark used strong words → criticised,
   Darwin used 'variation' → escaped criticism

7. Both failed to distinguish Mu Somatic and Germinal variations. Lamark did not explain how variations were inherited. Darwin tried to explain by his theory of pangenesis but failed.

Parallelism and Convergence

Similar structure, similar adaptive relationships, or similar behaviors occur in different groups of animals as they result of similar evolutionary opportunities.

Similar environment → some evolutionary opportunity

Similar behaviour or similar structures ← Similar adaptive relations

As per evolutionary biology, (Adam Smith 1700's)

Close similarity of the total morphological pattern of two organisms, there is reasonably close phylogenetic relationship b/w them.

similar morphological pattern → similar/close phylogenetic relationship → Parallelism / Convergence

Now, such similarities are Parallelism or Convergence?

- The term phylogenetic Parallelism refers to similarity in structure and adaptive features in animals that are related.

Thus parallel resemblances are the realization of a genetic potential that is present in entire group.

Eg. Song of Indri Indri, diurnal lemur of Madagascar & Howl of Gibbon of SE Asia and other —hence parallelism

- When 2 animals, not closely related, develop similarities in adaptive relationships and structures, they are said to converge.

Eg. Bat & Bird → Wings ✓

Fish, Dolphins, Whales → Streamlined

Incisor dentition of 'flying lemur' and the rodents, prosimian primates is clearly a case of convergent evolution.

But, not all cases of similarity are easy to classify as convergence and divergent. Parallel

Many parts of anatomy, protein structure, metabolism are similar in diff. animals. If we insist that all these are parallelism and convergence we are emphasizing diff. rather than similarities. It is always simpler to find differences than to demonstrate affinities.

Eg. Eye — 2 photoreceptors

CONE
low light
No discrimination
less sensitive

ROD
High Intensity light
Discrimination
more sensitive

Rod are also found in nocturnals owls frogs and those living in dim light whales fish

Now, in which animals is it convergent and in which is it parallel.

∵ The animals are diff. → convergent

or derived from same part of basic eye of vertebrate → parallelism

Conclusion: What is important is the way these situations illustrate the opportunism of evolution. Similar environ^{al} / evolutionary opportunities are exploited by different organisms → similar solutions to environmental problems. Debate and classification of these changes as parallels & convergence are obscure at this point

Evolution

HOMOLOGOUS
Same descent + divergence
wing of bat & forelimb of monkey
Same ancestral structure

ANALOGOUS
Similar function diff descent
wing of bat and wing of butterfly

It would be better to approach parallelism in homologous evolution and convergence in Analogous evolution

Adaptive radiation

↑ in (i) no. (ii) kind

A rapid increase in numbers and kinds of any evolving group of animals.

Eg. Mammals radiated to all parts of earth as environment grew colder during Paleocene

Reptiles were at disadvantage
↳ cold blooded — could not maintain same body temp.

eg

Darwinian fitness + Climate factor
led to radiation of mammals and extinction of many reptiles.

eg

Human ↔ Hill-short Cold Classical NM
Pygmies NM

AR need not be pen planet. Spread of old World monkey in Tropical forests is also AR

Basically taking advantage of new places due to changes in environment and developing niches is AR.

"जहाँ पहले नहीं जा सकते थे, वहाँ जाना & settle is AR."

Ques Janusch: Rapid ↑ in (no.) & types of any evolving groups of organisms several distinct eco niches to which each particular group is adapted particularly & called AR.

Neo-darwinism

Pelvis

Method to study
(i) Morphology
(ii) Comparative anatomy

Mechanism
(i) Species → form / order
(ii) Macro mutation
(iii) Micro mutation

Features
(i) AR results in evolutionary Δ:
(ii) Produces specially adapted animals
(iii) It results in specialisation streamline ETC

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Concepts of Evolutionary Biology:

1. Dollo's Rule — Doctrine of Irreversibility of Evol.

1893 Louis Dollo

Many times, advanced organisms have returned to ancestral habitat and modes of life

Can evoln be reversible?

Study shows, due to commonality of environment and resultant functional adaptation, always a gross similarity b/w ancestral and descended structures is achieved w/o any genuine reversal.

Loss of gills

① Thus, reptiles and mammals went back to aquatic life. They assumed streamlined body, small webbed feet yet the skeleton is always distinct from fish

Reptiles Mammals

② Angiosperms returned to water and assumed leaf like appearances but still flowering, vascular parts

Angiosperms

Sequence of micro variations (by chance) ⊗ Exactly reverse

Thus, such a sequence, occurring by chance once, should by chance be exactly reversed would be most extraordinary. If not impossible, it is improbable.

Application of Dollo's rule to individual character has failed because these are reversible by mutation.

2. # COPE'S RULE

Edward de Cope — American

Common trend of evolution → increasing size

Tendency seen in vertebrates, invertebrates & plants.

Paleontology shows, larger in groups are not the earliest ones; though not necessarily the last ones.

Horse, camels, Tortoise, Dinosaurs.

But this tendency of size increase is by no means universal.

Rise of Herbs from Trees

Progressive size decrease in vertebrates is a reverse trend in Quaternary period

Flying bat — smaller, lighter

Extinction of Gigantopithecus

Why larger? multiply eff. larger old

• recent study — Jurameio (10 cm) ↓ elephant

3. # Gause Rule

Russian — Gregory Gause — 1934

~~Competition: 2 species in same trophic level~~

~~Adaptation, variation in ... may lead to~~

~~Same niche development → Competitive Exclusion~~

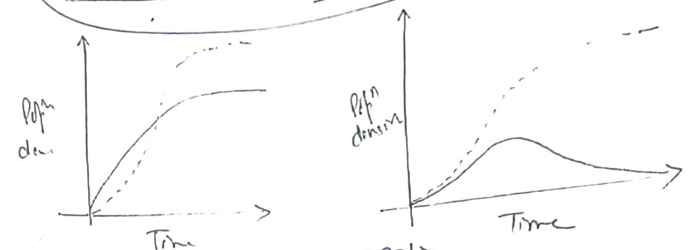
~~Diff. niche development of weaker species~~

competitive exclusion principle

Eqm situation

Paramecium aurelia, caudatum (eliminated)

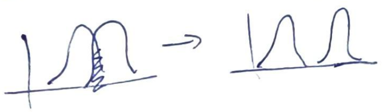
Gause in 1934, Paramecium → aurelia, caudatum



caudatum, aurelia — ① Cultured separately — ② Cultured together

inclusion: Under natural circumstances — some aspect of env changes so less successful species rarely becomes extinct, it becomes rare and even ↑ in no. before achieving eqm.

No extinction but eqm



Criticism — Gause speaks in term of structural adaptation not biotic, organic adaptation

Applicability to culture — eg: in regality theory — HnG groups surrounded by other HnG in same niche — will fight occasionally, but HnG surrounded by diffⁿ subsistence groups can coexist peacefully.

"2 species competing for same econiche cannot coexist @ constant popⁿ value. even if one has small advantage, it will dominate in long term — either extinct of weaker (competitive exclusion) / adaptation to diffⁿ eco niche (adaptive radiation)

Mosaic evolution

- popularised by Sir Gavin De Beer and Raymond Dart.

Definition

- concept that major evolutionary changes tend to take place in stages and not all at once.
- differential evolution of component parts of an organism or structure
- The theory seems to suggest that natural selection acts differently upon various structures and functions of evolving species.
eg: in humans, need for bipedalism took precedence over complex brain.

Examples

- human evolution → early evolution of bipedalism in australopithecus and modification of pelvic girdle took place well before there was any significant change in skull or brain size.

concept from paleontology

eg: darwin finches
eg: evolution of horse
eg: carpolettel - hand before eyes.

Importance

- plays a key role in macro evolution.
- brings stage by stage changes in different parts of organs.
- not only shows differential evolution but also overall adaptive pattern of evolution of organism.

1.5 Primatology

- for years, primatology's presence in anthropology has been questioned because it does not directly study humans in "study of humans"
- but anthropology is holistic study of man and man is member of order primates, so primatology is very essential

Importance of primatology in anthropology

- understand biological relationship b/w living and ancestral primates. - biological phylogeny
- primate behaviour can be used to understand human behaviour more clearly → study disease patterns eg: covid
- adaptations of non human primates can help us better understand human erect posture and bipedalism
- study of primate social intelligence, individual decision making and Behavioral
- social learning in capuchins (S. Perry - "what cultural primatology can tell anthropology about the evolution of culture" - investigate the progressive evolution of cognition in anthropoids

Primate taxonomy

kingdom — animalia
phylum — chordata
class — mammalia
order — primates
family
genus
species

Kevin Peterson created order for grown stuff.

primates
- Suborder prosimii
- Suborder anthropoidea

Suborder prosimii
- subfamily lemurinae
- subfamily lorisinae
- subfamily tarsidae

---

today 426 species and subspecies of primates

Hominoidea (apes + man) (superfamily)
- Hylobatidae (gibbon) 1 genus
- Pongidae (chimp, gorilla, orang) 3 genus + 3 fossil (Dryopithecus, Sivapithecus)
- Hominid — family
  - 1 living — H. sapiens
  - 3 fossil — H. sapiens neanderthalensis, H. erectus

Characteristics of primates

- order primate is mainly tree dwelling or arboreal.
- as a result, some unique changes are seen which cannot be found anywhere in the animal kingdom Imp

General mammalian features

- pair of pectoral mammae (boobs)
- suckling of young ones with breast
- warm blooded
- social relation b/w mother and offspring
- differentiated teeth - 4 types.

* neocortex * specialized teeth
* warm blood
* middle ear - 3 bones

Specific primate features

- prehensile hands + opposability (1) of thumb
- claws replaced by nails (2)
- so ability to grasp objects
- generally herbivores and frugivores, some are carnivores.
- reduced sense of smell - due to reduction in olfactory lobe - in tree branches smell is of less use - sight is very crucial
- clavicle or collarbone (3)

eat visual acuity
- colour
- 3 dimensional
- eyes encased in bony socket (not seen in other mammals)
- orbits shifted from lateral position to the front.

(4)

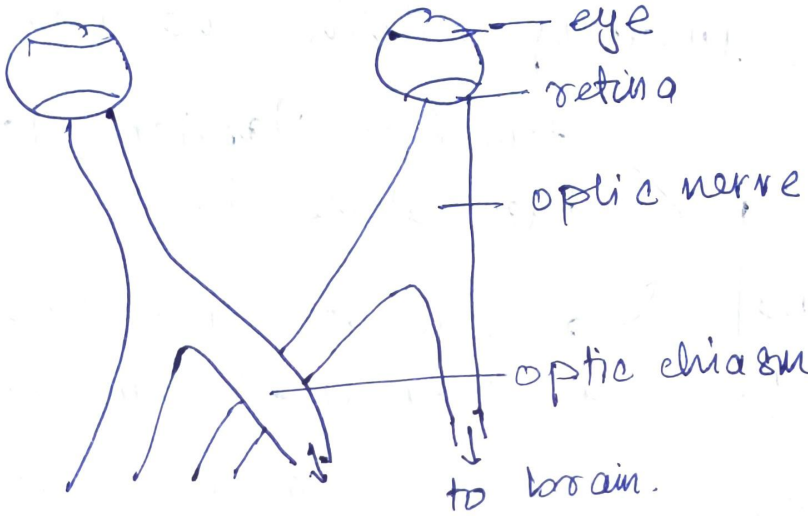


Fig positioning for stereoscopic vision.

- skull and brain
  - increase in size of frontal, parietal and occipital lobes
  - increased cerebellum for sound
  - increase in brain to body weight ratio

(5)

- reproduction
  - reduction in no of offspring.
  - prolonged dependency of offspring on parents
    - huge dependence on maternal care
    - sexual maturity takes longer

(6)

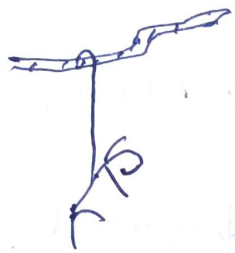
Arboreal and terrestrial adaptations

Arboreal adaptation

- varied forms of arboreal adaptations and locomotory variations such as vertical clinging, quadrupedalism and brachiation

vertical clinging and leaping

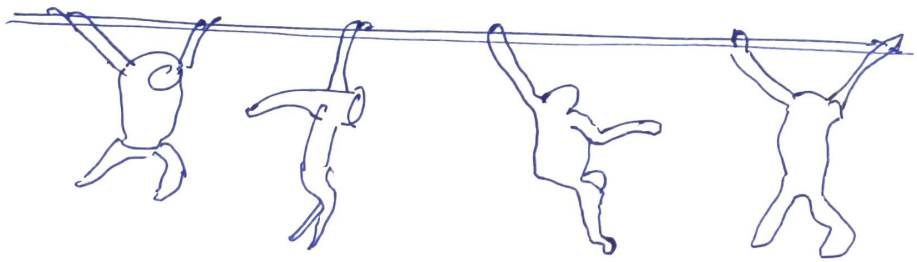
- found in Tarsiers, lemurs, bushbabies etc.
- animal at rest - clinging to branch - body vertical.
- jumps from branch to branch landing vertically
- long tarsal bone - spring while jumping
- long hind limbs



brachiation

- primates swing from tree limb to tree limb using only their arms
- found in gibbons
- body alternately supported by each forelimb
- can reach terminal branches for food

- short lumbar spine
- freely rotating wrists
- long forelimbs
- can be primitive brachiation (alternatively) or true brachiation (flight in the air)



Quadrupedalism - both arboreal and terrestrial adaptation

- monkeys - both hands and legs are prehensile.
- apes - terrestrial quadrupedals
  - palm/feet - orangutang
  - knuckle - chimp/gorilla.

small to moderate body size

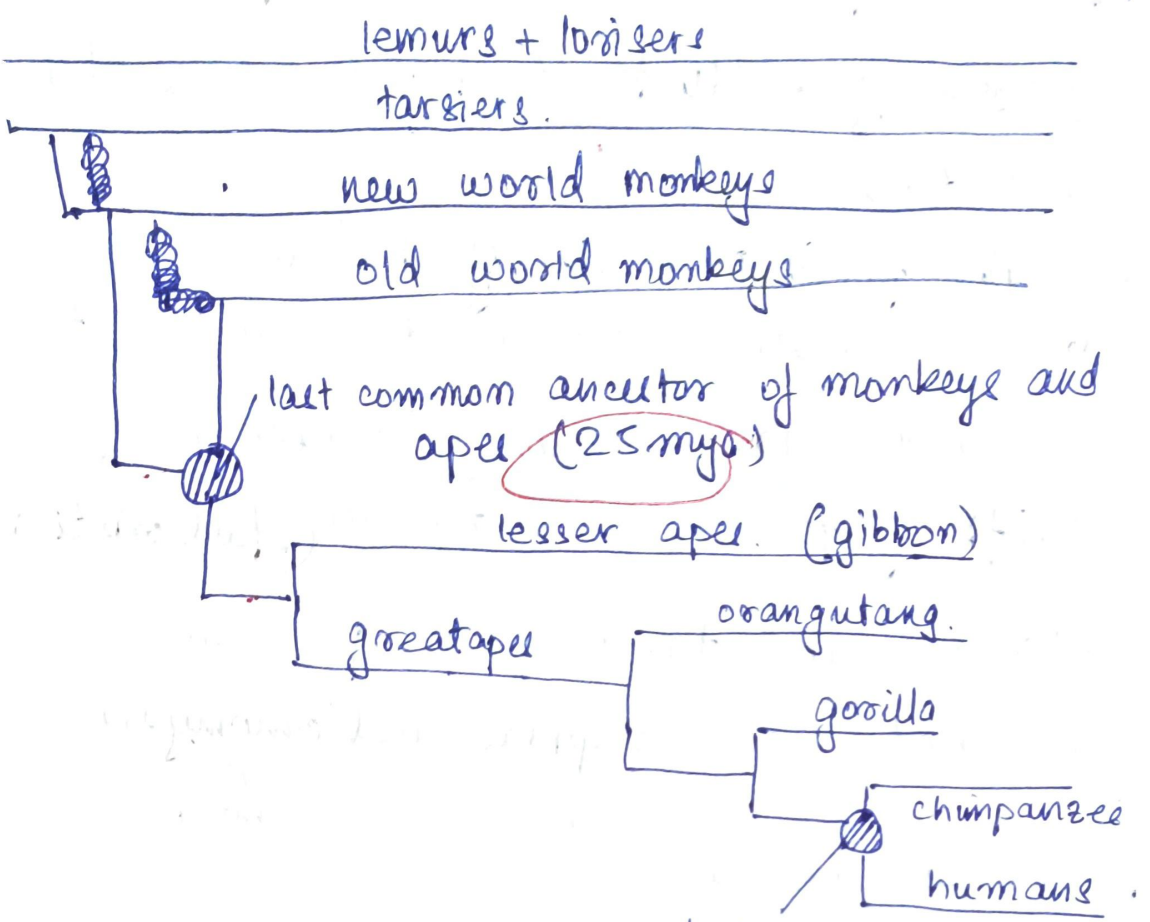
pronograde - walking // to ground

Bipedalism — exclusively in humans.
- several biological changes
- also led to culture

Fossil primates

Era	Period	Epoch	
Cenozoic	Quaternary	Holocene	0.01
		Pleistocene	1.8 mya
	Tertiary	Pliocene	5.3
		Miocene	23.8
		Oligocene	33.7
		Eocene	55
		Paleocene	65 mya

today



fossil primates of the tertiary period are mostly represented only by teeth and fragments of jaw and in some cases parts of skull. (Paleocene) continental drift - so different caused Paleocene mammal radiation climate + angiosperm

Paleocene primates DF - 2133

- evidence of earliest primates did not have stereoscopic vision

geography - mountainous regions of North america and France in Europe Europe + NA was connected

eg: Plesiadapidae, skull remains, eg: carpolestes

Eocene primates most widely of cenozo

- geography - North America, parts of Eu. and Asia.
- unlike fossil primates of Paleocene epoch, these animals of Eocene time were true primates - larger brain, bigger eyes, shift of foramen magnum, fixed orbits
- lemurs and tarsier like primates were abundant. adapidae and omomyidae
  2143 SD
  2133 no SD

Oligocene primates

geography - most remains from Egypt, Africa, rare in America.

parapithecus
- small animal size of squirrel monkey
- dental formula 2, 1, 2, 3
- intermediate b/w prosimians and anthropoids.

both discovered in Fayum, Egypt.

propliopithecus
- considered primitive anthropoid - closely related to gibbon
- jaw size of a small gibbon.

...ene Pliocene primates

- considered together as there seems to be continuity

geography - Asia, Europe, Africa.

Pliopithecus
- gibbon like animal in terms of teeth, narrow snout.
- other characters like upper limbs, spinal column - like monkey

Dryopithecine relations determined on the basis of dental anatomy mostly.

dryopithecus
- Siwalik, China, Europe, Africa.
- dryopithecus pattern - out of 5 cusps in lower molar - 3 along cheek-side, 2 along tongue side
- most likely ancestors of gorilla and chimpanzee, orang

Y5
167cc
diastema
V arcade

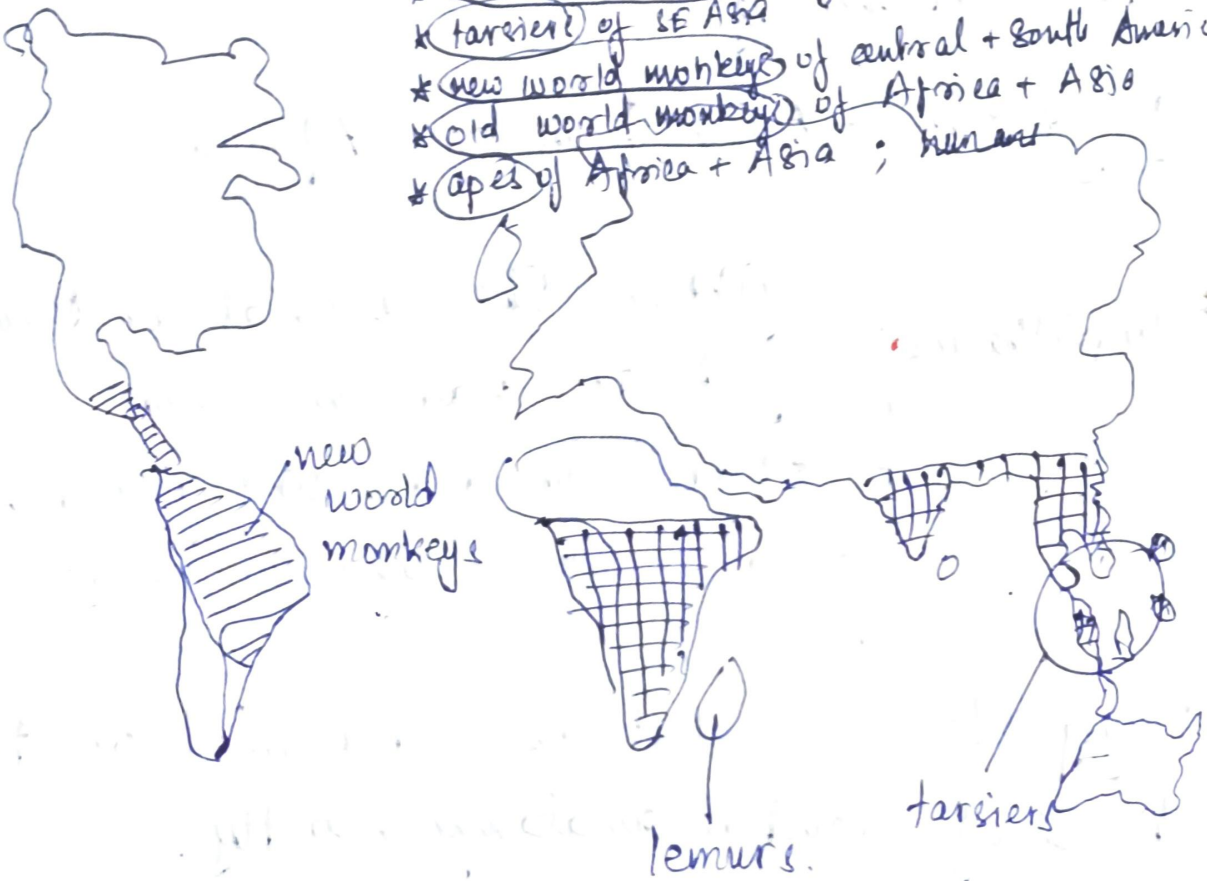
proconsul
- Kenya, Uganda
- most remains discovered by Leakey
- African variety of dryopithecus

Ramapithecus

Major living primates

Martin 1994 - primates in 6 natural grps:

* lemurs of Madagascar
* lorises & bushbabies of Africa + Asia
* tarsiers of SE Asia
* new world monkeys of central + South America
* old world monkeys of Africa + Asia
* apes of Africa + Asia ; human



▦ lorises, old world monkeys, apes.

Lemurs
- found in Madagascar, Africa, South and east Asia.
- eg: Aye-aye, lemur.
- descendent feature: dental combs (lower incisors teeth together as grooming tool)
- lateral eyes, arboreal, diurnal

Lorises
- found in Sri Lanka, Africa, South India.
- eg: slow loris, bush baby
- no tail, 2nd toe with claw, arboreal, nocturnal

iers ← found in Philipines, Celebes.
└ eg: Tarsiers.
└ large ears, rat size, rotate head by 180°, arboreal; nocturnal.

new world monkeys	old world monkey
- refers to America.	- refers to Africa, Asia.
eg: marmosets, tamarins, capuchins, spider monkeys.	eg: macaques, baboons
- mainly arboreal	- can spend time on ground.
- prehensile tail	- not so
- not so.	- paide in humid region
- 3 premolars	- 2 premolars

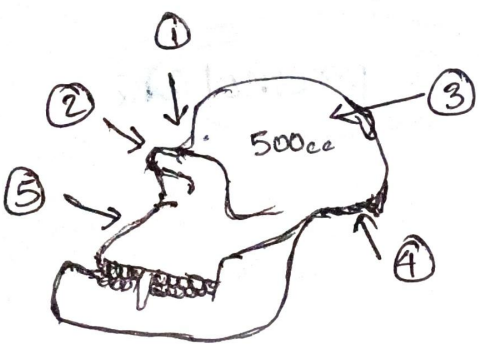
Hominoidea → man, apes.

Changes during Hominic evolution

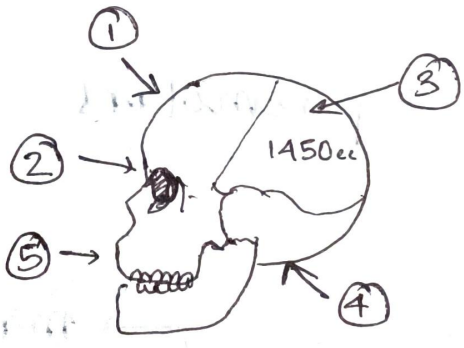
Hominid evolution consists of evolutionary transformation of hominoids into hominids.

Skull

- forehead got well developed
- Supra orbital ridges became more prominent
- size of saggital crest decreased (jaw muscles attachment)
- foramen magnum shifted anteriorly and downwardly (due to bipedal erect posture)
- orbits became rectangular
- braincase became larger.
- smaller brow ridge



gorilla



man

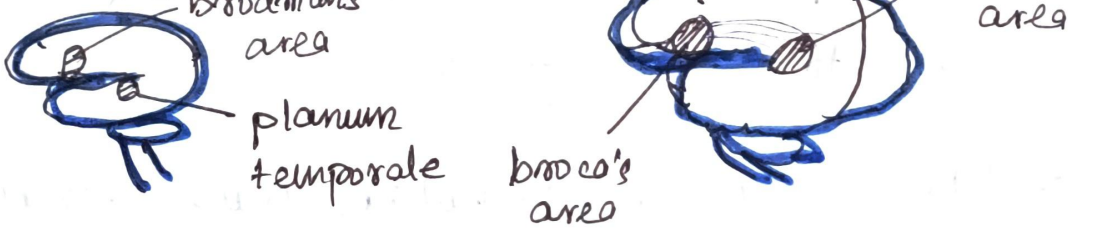
(1) no forehead vs well developed forehead
(2) large brow ridge vs small brow ridge
(3) vs small sagittal crest

(4) large vs small nuchal crest (for attachment of neck muscles)

(5) prognathism vs orthognathism

Brain

- increase in size of brain from 500cc cranial capacity to 1400cc cranial capacity



chimp – reduced frontal lobe
– no Broca's or Wernicke's area.
– Brodman's area - calls may originate but no speech.
– Planum temporale - calls received but not processed as language

Dentition

- retention of fairly simple teeth structure
- reduction in size of teeth.

humans $\frac{2123}{2123} \times 2 = 32$ [1 CPM]

- affected all 4 types of teeth

incisors - reduction in size due to less in eating processed food

canine - tool use - so use of canines for antagonistic display reduced - so smaller

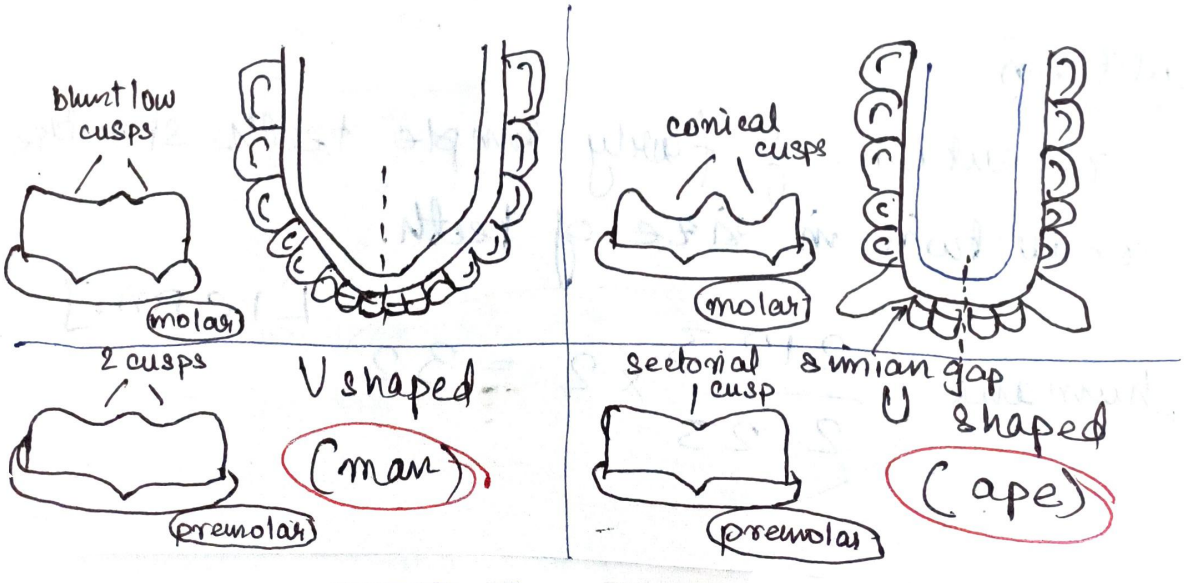
premolars - first lower premolar is bicuspid - in fossil hominids, extra cusp(3) due to hard food

molars - no of molars have remained same - 3

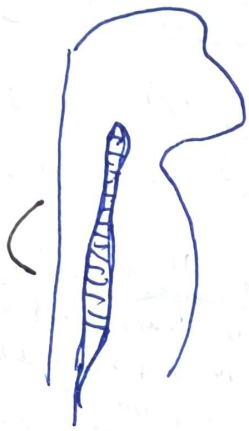
upper molars - 4 cusps

lower ——— - 5 cusps - forms Y shape (Y-5)

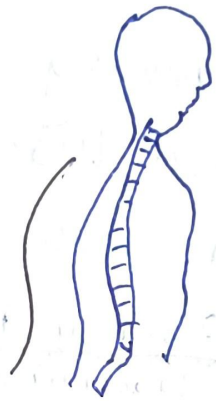
evolutionary pattern of reduction in number of molar teeth of primates is continuing.



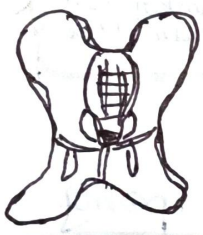
- spinal cord and vertebral column became curved from straight
- pelvic girdle became short and broad
- femur angle became greater.



C shaped



S shaped
(keeps trunk centred over pelvis)
(lumbar curve)



longer and narrower
(chimp)

broader.
(human)
(maintains COM over one foot while walking)

Social behaviour in primates

- many primate societies are organised into hierarchies, which impose certain degree of order by establishing parameters of individual behaviour.

- lower ranking animals unlikely to attack or threaten higher ranking one, also dominant animals are able to exert control simply by making a threatening gesture

Large part of primate behaviour is learnt, not innate

(1) Jane Goodall (chimpanzee) - how similar chimp behaviour is to human and close evolutionary relationship of the 2 species

(2) Dolhinow (Indian langur monkey)

(3) George Schaller (mountain gorilla) - far gentler. In case of early mother loss other langur monkeys become caregivers

(4) C.R. Carpenter (gibbons and howler monkeys) - 1st scientific field study - 1930s

S. Perry - social intelligence in capuchins

rank — access to resources
- food
- mating partners

decides

high rank female — more food → more survival → faster maturing offspring

Primatologists used the following behaviours:

(1) group living eg: baboons live in group whole life whereas chimp social group keeps changing

(2) communication

(3) dominance + hierarchy eg: in chimp if two males go after same food then subordinate holds back

(4) dependency and dev & infants observe more

(5) learning and learning eg: termite fishing using grass stalk

(6) sexual behaviour eg: gibbons monogamous but chimps are promiscuous

rank is decided by
- sex
- age
- level of aggression
- time spent in groups
- sometimes, mother's social positions

- infants pick up from their mothers how she responds to every other member

Pleistocene / late pliocene epoch @ 2.5

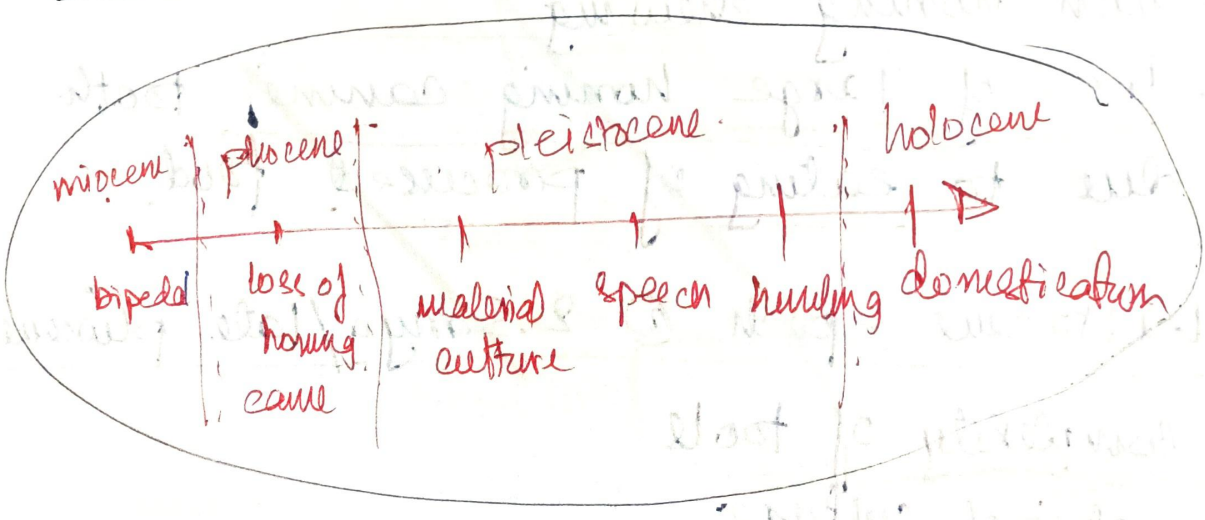
- development of speech in Homo
- shape of hyoid bone is unique to hominids
- increased cognition, intelligence and brain size expansion.

Pleistocene epoch @ 1 mya

- hunting
- need for animal protein for more energy for large brain.
- also employs cooperative strategies

Holocene epoch @ 10000 years ago

- domestication of animals and plants
- huge impact on our biology.



Extinction crisis of primates

60% of primate species are threatened with extinction due to human activities.

- habitat loss
- hunting
- illegal trade
- climate change - ↑ temp, so more shade ref + less foraging + less sociality

Indonesian deforestation → palm oil.

conservation needed — anti poaching patrols
— relocation
— reintroduction

challenges - can't assume that what works for one species will work for all

may live in dense forest, poor visibility, difficult access - so tough to count them

we need "primate specialist groups" like A.SESG

"IUCN Primates in Peril Report" 2018

- eg: Javan slow loris
- wild primates in 90 countries but 65% in Brazil, Madagascar, Indonesia, DRC
- 60% threatened with extinction

but Brazil / Madagascar have only 40% range

Theories of bipedalism

must have been favoured by natural selection — why bipedalism arose

- speed - can't be as humans aren't fast runners.
- tool use as hands are free - as believed by ~~Darwin~~.
  but earliest stone tools 3.3 mya long ~~before~~ after bipedalism emerged so were earlier tools of wood - then how cut?
  Sherwood Washburn, David Pilbeam] advantage due to ability to carry tools.
- more efficient - Savanna based theory
  - vigilant stand up in tall grass
  - phallic display.
  - midday tropical sun - so bipedalism will make less area exposed + lesser heat exposure from ground.
  - less energy expended in bipedalism than quadrupedalism
  - believed by Raymond Dart
- postural feeding hypothesis
  - bipedal movmt helped in feeding and obtaining food - so dev into bipedalism
  - eg: chimps only bipedal when they ate

- A afarensis had hand and shoulder for hanging but hi for bipedalism
- proposed by Kevin Hunt

→ thermoregulatory model

- bipedalism would increase the amount of body surface area, so faster heat dissipation
- better access to greater wind flows
- proposed by Peter Wheeler

→ food carrying advantage / provisioning model

Owen Lovejoy - Gordon Hewes suggested
Gordon Hewes - able to carry food - more food for nursing mother - more survival
- evolutionary advantage
- provisioning male would get more sex
- greater reproduction

Hominisation process

hominoids → hominids

(1) bipedalism — A. afarensis - non habitual bipedal.

list all adaptations.

- Laetoli footprints of afarensis.
- erectus, neanderthals - habitual bipeds

(2) hand manipulation + tool use — A afarensis - digits curved → power + precision grip.

H. habilis → tools (Oldowan industry)

differentiates pongid apes from hominids

erectus - tamed fire, social org

(3) speech / language — subglottal system, larynx, supralaryngeal tracts

Lieberman 1992 - supralaryngeal tracts dev in erectus, but fully dev in hominids in Israeli skls

only circumstantial, no fossil evidence

(4) brain

(5) jaws / teeth

Earliest hominins

1.6

- Sahelanthropus Tchadensis - in Chad
7 mya - hominoid skull + hominin teeth (Michel Brunet)
but no evidence of biped.
- Orrorin Tugenensis - western Kenya (Brigitte Senut)
femur shows bipedal adaptation - long, angled "head"
6 mya
- Ardipithecus Ramidus - Ethiopia - Awash (Tim White)
apelike dentition. but bipedal evidence - foramen magnum
5.5 - 4.5 mya
all three not sure bipedal - but sure

1.6 Phylogenetic status, characteristics and geographical distribution of the following : (a) Plio-preleistocene hominids inSouth and East Africa— Australopithecines.

(b) Homo erectus : Africa (Paranthropus), Europe (Homo erectus (heidelbergensis), Asia (Homo erectus javanicus, Homo erectus pekinensis.

(c) Neanderthal man—La-chapelle-aux-saints (Classical type), Mt. Carmel (Progressive type).

(d) Rhodesian man.

(e) Homo sapiens—Cromagnon, Grimaldi and Chancelede.

1) 2) (2-1.5 my 3) 4) 1924

⇒ introduction
⇒ time
⇒ geo distn & discovery.
⇒ phys features
⇒ cultural features
⇒ phylogenic status
⇒ conclusion.

genus of early hominins

AUSTRALOPITHECUS

1) Name and meaning: Australo + Pithecus (Ape of South Africa)
South Ape

2) Species:

- A. boisei (East Afr) (2-3.5 mya) (includes A. robustus, Paranthropus) (Mary Leakey) Swartkrans
- A. afarensis (Johanson et al., 1974, 3.1 mya) Hadar, Ethiopia
- A. anamensis (Mary Leakey et al., 1994, 4 mya) Kanapoi, Turkana, Kenya
- A. africanus (Raymond Dart, 1924, 2.5 mya) Taung
- A. garhi (Tim White et al., 1994) 4-5 mya
- A. habilis (LSB Leakey, 1964, 2.0 mya)
- H. erectus

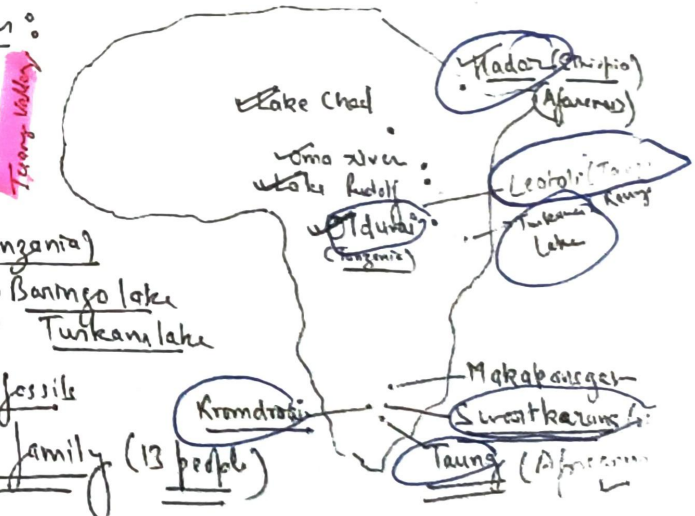
3) Time: 5.5 mya — 2 mya (Pliocene period)

Habitat: Open fields and forests too
Home base — cultural

4) Geographical distribution:

All in Africa only.

- Raymond Dart (1924) skull of juvenile 6 yr old, Taung Valley
- 1924
  - Mary Leakey → Olduvai (Tanzania)
  - Richard Leakey → Kenya → Baringo lake, Turkana lake
- Hadar, Ethiopia → 1000 of fossils
  - LUCY & first family (13 people) (3.2 M)
    - Donald Thorsan 1974 (Hadar, Ethiopia) 3 ft 8 inch



5) Taxonomy : Pliocene to Middle pleistocene → 1 genus

(i) Some consider Homo Habilis as a member of genus Homo

(ii) Many other consider Australopithecus has 2 species Africanus and robustus.

6) Physical features :

- Brain size : 375 – 775 cc, 450 Avg

Ape max	650 cc
A. max	775 cc
Man min	823 cc

(A. max and Man min: closer)

Frontal lobe – vision, motor control; Temporal lobe – speech; Parietal lobe: more developed than Apes.

- Skull : (a) Emergence of fore-head

Prognathism → gradual sloping fore head; no chin

A. — He — Hs (Vision, Speech)

(b) Mastoid process : inverted pyramid just behind ears emerged in A. and dev. fully in H.E

(c) Away from man :

- Presence of prognathism
- Supra orbital torus
- lack of Chin

(d) Like man :

- presence of mastoid process
- forward placement of foramen magnum
- lowering of inion
- downward movement of occipital condyle
- Small teeth, cranium, parabolic dental arcade
- nuchal plane ...

(e) Dental arcade

- Parabolic
- Incisors not rounded
- Premolars were bicuspid
- Y-5 cusp in molars
- Molars crown downward
- Simian shelf absent
- Nondivergent big toe

M_3 M_2 – M_1 — A

M_2 – M_1 – M_3 / M_1 – M_2 – M_3 — Human

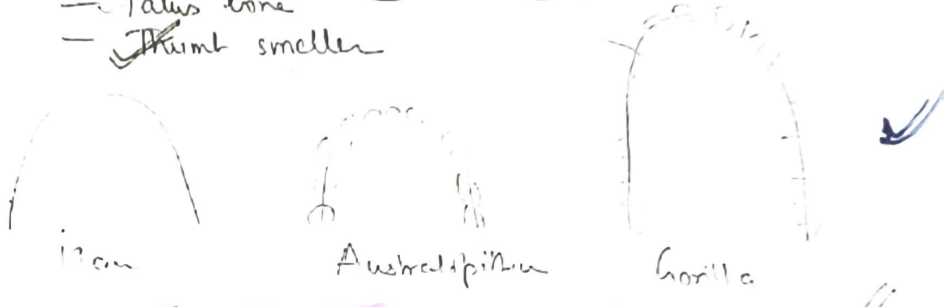
- molars down
- Y-5 cusp M
- bicuspid PM

Nondivergent big toe

7)

Scanned by CamScanner

- **Bipedalism and erect posture:**
  - Fractured, position of foramen magnum, presence of groin
  - Distance b/w hallux & II finger ⇒ closer to one
  - Talus bone
  - Thumb smaller



- Lumber curve in vertebral column
- Short & broad pelvic bone
- Linea aspera on femur
- short broad ilium
- weight bearing structure of ankle bones.

1918 By Broom from Kromdraai

7) Cultural features:

Pilbeam (1992)
Broom (1948)

Evidences

- Temporal lobe developed → Speech → language
- Absence of large canines → Must be hunting
- Erect posture
- Delayed eruption of teeth → handicap on mother
- Longer childhood
- Trapping large animals through the use of bolas ⇒ group activity
- Home base
- Division of labour - sex based
- Vertical openings of animal bones → bone marrow → use of tools.

Mainly
(i) Hunting - killing
(ii) Home base

ODK

Raymond dart ⇒ Osteo-danto-kerath Culture

Bone, teeth, horns as tools

Vertical spanning

A. Ghanhi (2.6 my.o), tools found associated with it.

Primary flake

Pebble tools

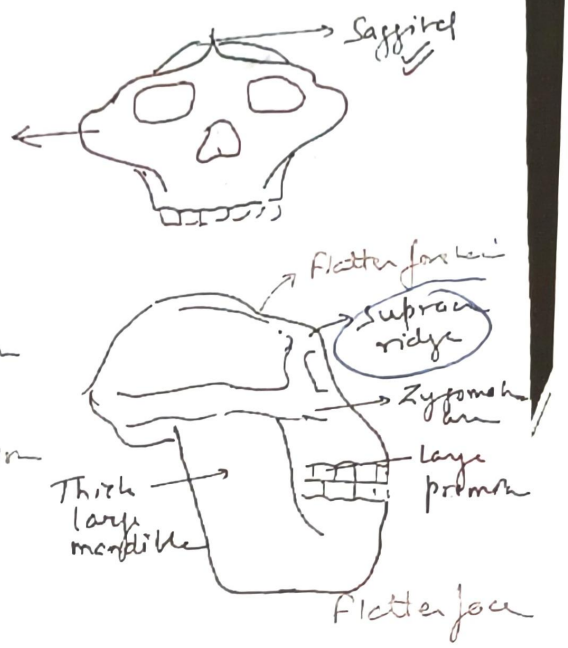
In a cave near Alchuvad lake, stone wall was built at the entrance as a wind break or a hunting technique.

Cut marks on sharp stone tools → crushing, Hammering

Stone was flaked

Edge wear on flakes show that flakes were used to cut meat, wood, plants etc.

On broken bones → cut marks on meaty and non meaty parts.



Australopithecus

Paranthropus

Trait	Australopithecus	Paranthropus
1. Cranial capacity	✓ 440 cc	✓ 500 cc
2. Cranial vault	✓ High / expanded	✓ low / not expanded
3. Saggital crest	✓ absent	✓ present
4. Temporal fossa	Medium	✓ Large
5. frontal region	✓ Rounded & well developed	Underdeveloped
6. Supra-orbital	✓ Lacks development	✓ Developed.
7. Jaws	✓ Large	✓ massive
8. Simian shelf	✓ Absent	✓ Present in some
9. Zygomatic region	✓ Moderately large	Massive
10. Dentition	✓ Parabolic	✓ Parabolic
11. foramen magnum	✓ lower	✓ forward
12. Pelvis	✓ hominid	✓ gorilloid
13. Foot	✓ Non divergent big toe	✓ Divergent big toe
forehead	✓ steeper	✓ flatter.

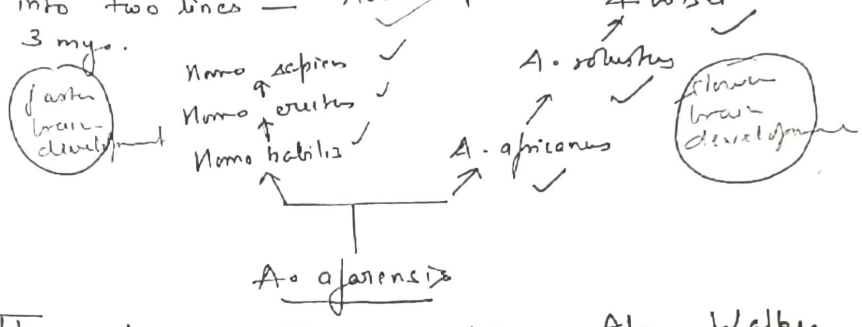
6

2 S T F Chang

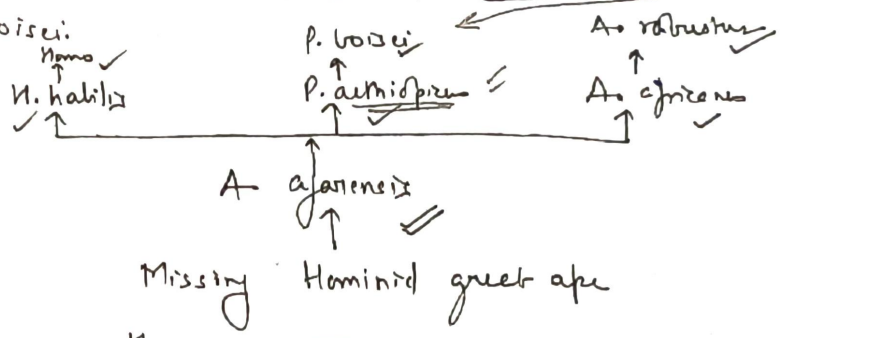
more like man

Phylogenetic status

1. Two branch theory : 1979-85 Johanson and White. Acc. to this theory, A. afarensis split into two lines — Australopith line and homoline. 3 mya.



2. Three branch theory : 1985, Alan Walker found a new hominid skull A. aethiopicus resembled P. boisei.



Missing Hominid great ape

3. Current theory : It is a variant of two branch theory.

— A. afarensis is the ancestral hominid from which both robusts and graciles evolved

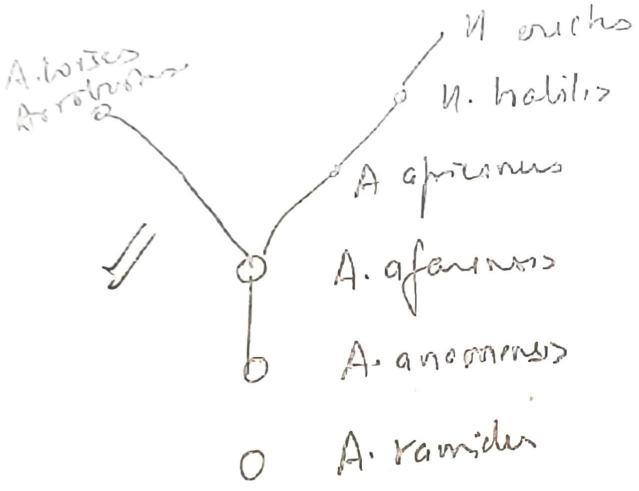
— A. afarensis evolved in Homo via A. africanus, A. garhi, A. sediba.

— A. garhi → Tool culture → Homo habilis
A. sediba → closer to Homo features
} immediate ancestors of Homo.

— A. ramidus and A. anamensis seems to be ancestors of A. afarensis. Recent reports show they had hand bones similar to A afarensis and A. sediba.

— Most concerned scientific community today agree that all gracile (A afarensis, Afric..., A. garhi, A... A. ramidus and A anamensis/ evolved in regions whereas all robusts evolved in side bran...

Conclusion



some say = H. rudolfensis

Leakey 1964

Homo habilis

1964, Olduvai Gorge, Tanzania — fragmentary — Tools were found associated

2 myr — L.S.B Leakey — 2.5 myr → (Ultra pleistocene)

Stone wall in front of cave

1964 Controversy, whether to put it in Australopithecus genus.

Body size poorly known, but weight around 10-50 kg

Cranial capacity 650-800 cm^3 → towards Homo > Australopithecus (823)

CC in between

Endocast shows → some frontal lobe features not seen in australopithecus, thus close to H. Sapiens (Higher mental ability) → ~~Speech Capabilities~~

FE TL

Dentition in between

Big incisors and canines, with large teeth (cheek) but smaller than that of Australopithecus

Post cranial like Pelvic and leg bones differ from Australopithecus and similar to Homo. Erectus

Cultural: Pebble tools — (i) Scrapping (ii) Tool making (iii) Cutting tool

There are doubts about dimorphism degree and brain size of Homo Habilis.

It is usually considered under genus Australopithecus.

(i) Stone flaked (ii) Pear bn cutting area - meat, wood (iii) cutmarks on bones in meaty and non-meaty areas.

Primary flakes + cutmarks on bones meaty areas.

Pebble tools

Oldowan Industry

(Wilfred Le Gros Clark)

Features of Genus Homo

According to Le Gros Clark

CC — large cranial capacity — (900cc - 2000cc) → mean 1100cc

Supra — Supra orbital ridges variably developed in H. erectus & H. neandert. and showing redn in H. sapiens.

face — face → orthognathous or moderately prognathous

OC — Occipital condyles situated at centre of cranial length

Mental eminence — Mental eminence marked in H. Sapiens but absent in H. erectus; feeble or absent in H. neanderthalensis.

Dental arcade — Dental arcade evenly rounded — no diastema

canine reduction — Canines small, (no overlapping) *

Bicuspid — First lower premolar bicuspid *

redn in last molar — Relative redn in last molar

fully erect — fully erect posture. — 4 curves (not arches) for erect.

It is also called Bio-cultural stage of evolution

Pithec Anthropus = **HOMO ERECTUS**

(Java) Mr. Dubois (1891) man

1. Name and meaning: Man of erect posture

2. Sub-Species : H. erectus pekinensis
H. erectus javanicus & H. erectus erectus
H. erectus narmadensis

1891
1921

3. Time period : 1.8 mya to 0.2 mya, Pleistocene

4. Geographical distribution:

E. Dubois, 1891 found cranium & a femur from Java and named it Pithecanthropus erectus (ape man)

Asia : (I) Java — H. Erectus erectus

(II) China — H. Erectus pekinensis

Zhou-Kou-Dien — 40 individuals, 14 skulls
Associated finds — stone tools, evidence of fire

(III) Vietnam

(IV) India — H. Erectus narmadensis. Swanscombe & Tuxkon

Due to different ecological conditions they developed different adaptations.

W.C. Lei (1920-21) studied by Davidson Black

Zhou Kou Dien

Africa : Turkana lake (Kenya)
Olduvai Gorge (Tanzania)
Ethiopia (Hadar)

5. Physical features:

Africa 750-900 | Pekin 900-1200 | Narmada 1300-1400

Cranial Capacity 750 cc — 1260 cc (Avg 1000 cc)

Narmada men

minimum is more than Australo-pithecus and max near sapiens.

Bones of skull were thick

Cranial vault flat platycephaly

Eyebrow ridges were big and prominent projection.

Scanned by CamScanner

erects in E. Africa
co existed with P. boisei, A. africanus
and H. habilis — but survived as could
eat hard grasses of grassland

Y-5, Premolar bicuspid

- Parabolic dental arcade
- Teeth smaller but still bigger than man.
- Shovel shaped incisors
- Presence of mastoid process ⇒ bipedal
- Smaller diastema.

Peking man showed signs of chin

- Post cranial anatomy of modernman and H. Erectus is same.

Special features of H. Erectus —

(i) Shovel shaped incisors ✓

(ii) Presence of Taurodontism ✓ in premolar & molar

Pulp cavity extension

Dentine

Pulp cavity

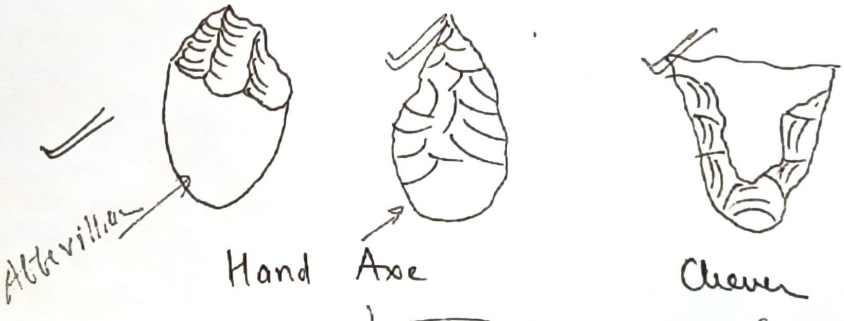
- Teeth stronger due to extra enamel layer for horizontal chewing motion

6. Cultural features: — lower palaeolithic culture.

First developed culture

(a) Acheullian Tools. 1.5 mya, Hand Axe, Cleaver

Crude massive and infrequent



Acheullian (Levallois flaking) technique

Mud holes → Hunting

(b) **Hunting**: Broken long bones → hunting
Lion, Deer, Elephant, horse found associated
at Zhou-Kou-Dien — China.
mud-holes → 40 elephant trapped

(c) Use of **fire**: Evidence of use of fire, 1.5 mya
Turkana & Baringo lake (Kenya)
Swartkrans — definite evidence

(d) Possibility of rudimentary language
(e) Hunting → group activity → Social organization

(7) Evolutionary Status: Homo sapiens is direct descendant of Homo erectus. However, some fossils of erectus dated b/w 53,000 & 27000 years ago and advances in molecular biology put a question mark on the evolutionary lineage of erectus.

Rituals: No direct evidence. Pech de le Adze Spain
But in Spain at Pech d'le Adze we have discovered the fossils of Homo erectus, his stone tools and bones of animals — rib of bison with two (||) lines engraved suggesting some probable use in ritual.

Scanned by CamScanner

Homo floresiensis
— lived till 12000 years ago.

1. Name
2. Geograph
Otto Sc
3. Time
4. Physi
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— D
Jaw (Simian)
Dentition (Human)
— 1st
mor

Schoteusack 1907

Homo Heidelbergensis

Mauer Jaw

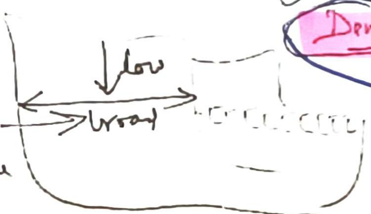
1907.

1. Name and meaning: Man of Heidelberg
   - Place in Germany

2. Geographical distribution: (1907), Dr. Otto Schoetensack
   - Otto Schoettensack (1907) — Human lower jaw at Mauer
   - Complete with all its teeth
   - Also, fossils of (ancient elephant), (horse), (boar), (bison) — + animal fossils.

3. Time period: Chellean age, Lower pleistocene.
   - (0.35 – 0.45 mya)

4. Physical features:
   - Jaw large, massive
   - Ascending rami - broad and low and almost square in shape



   - Jaw → Simian
   - Dentition → More modern than human

about 1200cc skull

   - Sigmoid notch is shallow
     It represents closeness to (Gibbon).

Gibbon — Ramii → V → Square, Low, Broad; H → High, massive
— Sigmoid Notch

   - Horizontal ramus is very high and massive, much more than in modern man.

post cranial like H.n.

   - Angle of jaw, truncated as in Neanderthal man Gorilla
   - Dentition:
     - Parabolic arcade
     - No diastema
     - Dental series regular & continuous.
     - Teeth normal size
     - 5 cusp in lower first molar

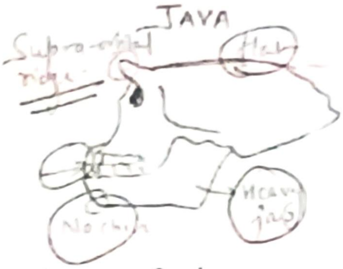
(Jaw (Simian)
Dentition (Human))

- 1st to live in colder climes
- most recent common ancestor b/w H.n and H.s

go.

General: Platycephaly, thick skull, rudimentary chin, Prognathism — Broken Parabolic, Y5, bicusp, shovel shape incisors, taurodontism — Post cranial like us.

PECKING MAN VS JAVA MAN



	JAVA	PEKING
Found by	Dubois (1891) Java	W.C. Pei (1920-21), studied by D. Black, China, Zhoukoudian
Basic	Robust	Smaller, shorter, lighter, smarter, with chin
	Legs long and erect but body bent	More upright
Prognathism	Slight	less marked
Vault	Lower (platycephalic)	High
frontal sinus	Large	small
Chin	⊗	slight
Occipital knob	extreme	less pronounced
Supra-orbital ridges	prominent	Present but seperated from forehead.
Skull bones	less thick	thicker skull bones.
Cranial capacity	800-1000 cc	850-1300 cc
Jaw	Heavy	lighter
Canine	some projection	non projecting
Incisors	protruding	not protruding
Diastema	present	⊗
Tools	less advanced	Tools more advanced

more human like

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CV CS JD
dikhaya mila celebrate

Phylogenetic discussion of Homo erectus

diagram / cast / present

Away from modern man —

1. Cranial bones thick
2. Receding frontal bone
3. Small mastoid process
4. Slight prognathism
5. Massive jaw
6. Prominent supra-orbital ridge
7. Large upper incisors

Platycephaly
Chin rudimentary
Sagittal

Closer to modern man

1. Cranial capacity closer to H. sapiens.
2. Relative size of face reduced.
3. Erect posture — post cranial features.
4. Foramen Magnum positioned anteriorly
5. Parabolic dental arcade
6. Slight chin
7. Dental morphology similar to modern man
8. Culture
9. Shovel shaped incisors and taurodontism.

Thus, Homo erectus is more advanced than even the most evolved australopithecine i.e. Homo habilis but less evolved than Homo. sapiens.

Recent moroccon (Ne)
MP at Attirampakkam
Shorter Paffu.

Neanderthal Man

1. Name and meaning : Homo Neanderthalensis.

2. Geographical distribution: Skull cap with upper margins of orbits. Parts of pelvis, 2 femurs, two humeri 2 ulna, 5 ribs, scapula, radius.

1908 L.C-A.S
1931 Mt C., Palestine.

1908
1931

In Neanderthal, Germany

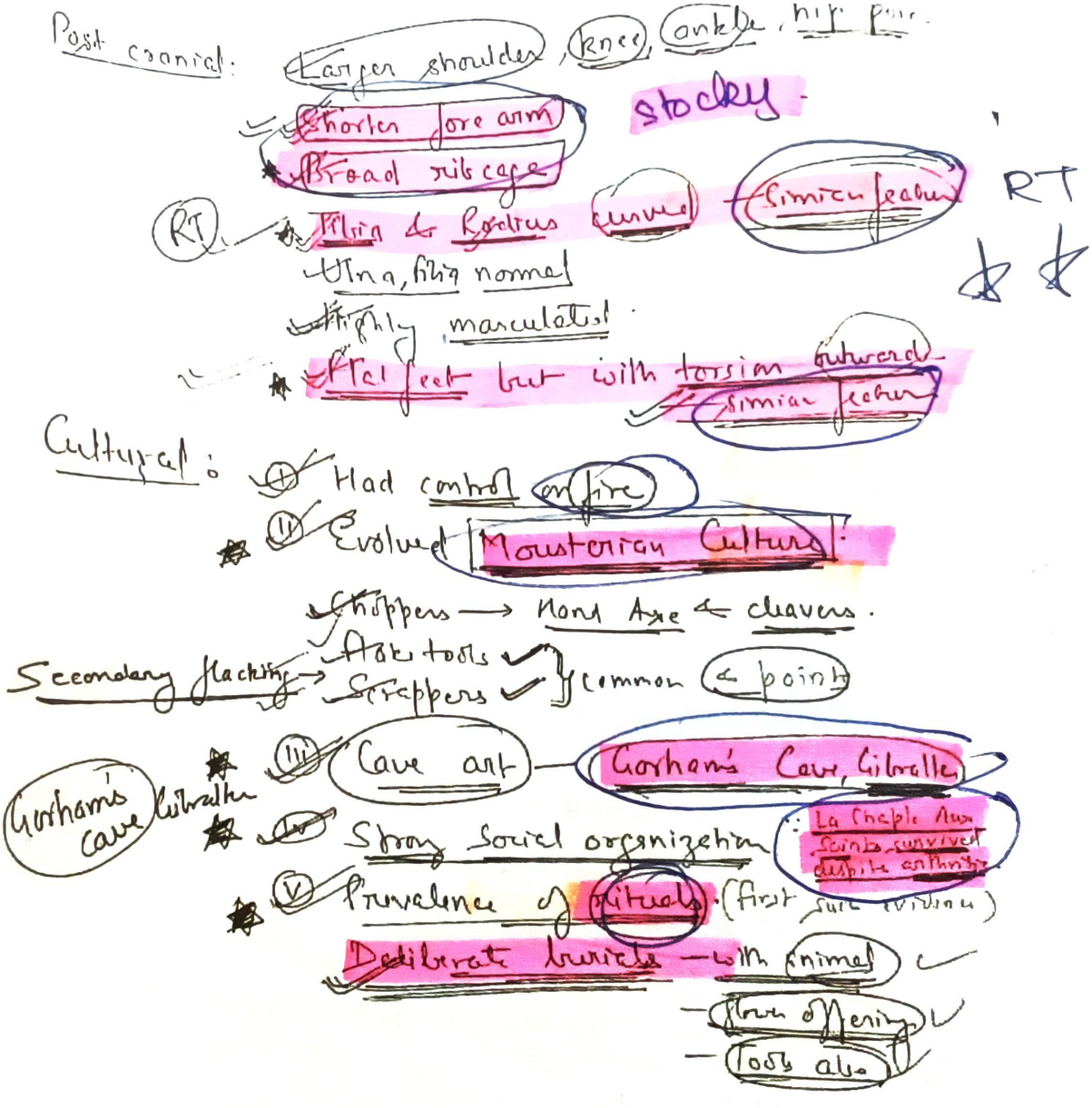
But today they are found in, Europe — Spain, Yugoslavia, Czech, Slovakia, England, France, Italy, Israel, Iraq, Libya, Lebanon, Morocco, Russia, Java, Pakistan, China

Middle east
Europe
Africa
Asia

3. Time period (0.185 — 0.04) mya — Middle pliestocene

4. Physical features:

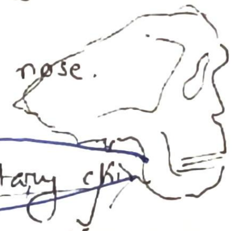
Skull: Increased brain size
- Cranial capacity → 1700 cc
- Dolichocephale
- Broad ridges
- Heavy chinless jaw
- Occipital → prognathism
- Frontal part not fully developed
- Broad nose
- Large orbits
- Forwardly projected upper jaw



read this then → ② ①

PROGRESSIVE V/s CLASSICAL NM

PROGRESSIVE	CLASSICAL NM
— Mount Carmel Man Palestine (1931)	— La Chaple Aux Saints France (1908) (A. Bouyssonie, J. Bouyssonie, Bardon)
— Africa, Middle East, Asia	— Europe
— 2.5 lakh years ago - 50k	— 75k to 40k years ago
— Robust	— Short and Stout (due to cold weather)
— Cranial capacity 1400 cc	— 1600 cc
— Skull high vaulted	— Skull platycephalic
— Forehead less receeding	— Receeding forehead
— Occipital region was slightly projecting	— Occipital region protruding
— Supra orbital taurus slightly present	— Markedly present
— Nose less broad and nostrils not much seperated.	— Broad nose.
— Had a distinct chin	— Rudimentary chin
— Smooth skull	— Rough skull
— Maxilla not like muzzle	— Maxilla projected in a muzzle like fashion



⑥

more may like

TVC NFC

chin
vault
time period
cc
nasal
forehead

According to Poirier

Scanned by CamScanner

Neanderthal Man V/s Modern Man

Similarities:

(I) Similar cranial capacity
(II) Dentition fully human
molar I ($\frac{1}{4}$ cusp)
In — I — $\frac{1}{5}$ cusp
Shovel incisor
(III) Simian shelf absent
(IV) Large face, depressions in nose — australoids
(V) Broad nose bone → Australoids
(VI) face below orbit bears straight profile
(VII)
(VIII) Evolutionary Status:

Differences:

Human features
(I) Height
(II) Flat feet inward torsion
(III) Tibia, Radius → not curved
(IV) Zygomatic arch less protruding
(V) Foramen magnum backward placed in NM
(VI) Mastoid process rudimentary in NM
(VII) NM had flat skull (Platycephaly)
(VIII) Proportion of limbs different
(IX) Chin not so prominent
(X) Ribs less prominent

*maxilla
*skull
*limbs
*chin

Disagreement: Diff. skull arrangement in East to W. Europe

According to Stringer et al. (1991)

Morphologically some specimens are intermediate b/w *H. sapiens* and *H. sapiens sapiens*.

1. European N were replaced by modern *H.s.s* 35000 yr ago. Thus some say *H.s. neanderthalensis*.
(sub species.)

2. Stringer and Andrews (1988) argue that NM did not contribute to modern population

(Morocco Jbel) *H.s* of Africa predates NM → this leads to possibility that NM evolved to modern man. But no evidence of evolⁿ of NM to *H.s.s*.

- Evidence from Qafzeh cave in Israel suggests that H.s evolved outside Europe. Evidence dates to 92,000 Yrs ago and suggest H.s.s lived in Middle East. Thus, contradicts NM evolv to H.s.

- If NM and H.s.s lived Levant for 60k years and maintained separate gene pools then, members of NM & H.s.s are of separate species.

Hence, Homo neanderthalensis is more appropriate.

- Supported by the fact that tool tradition of NM was unchanged for a long time while that of H.s evolved very fast.

There is recent evidence and genetic evidence to suggest that H.s.sapiens arose outside of Europe, in Africa, and that the Neanderthals should be excluded from the H.s.sapiens evolutionary lineage. But, recent DNA studies reveal that N & H.s interbred because some Euro natives have 4% N genes. Yet to be confirmed.

3 possibilities of fate of neanderthals
- interbreeding — Lagar Velho, + DNA evid
- genocide deliberate
- extinction

Homo Denisova

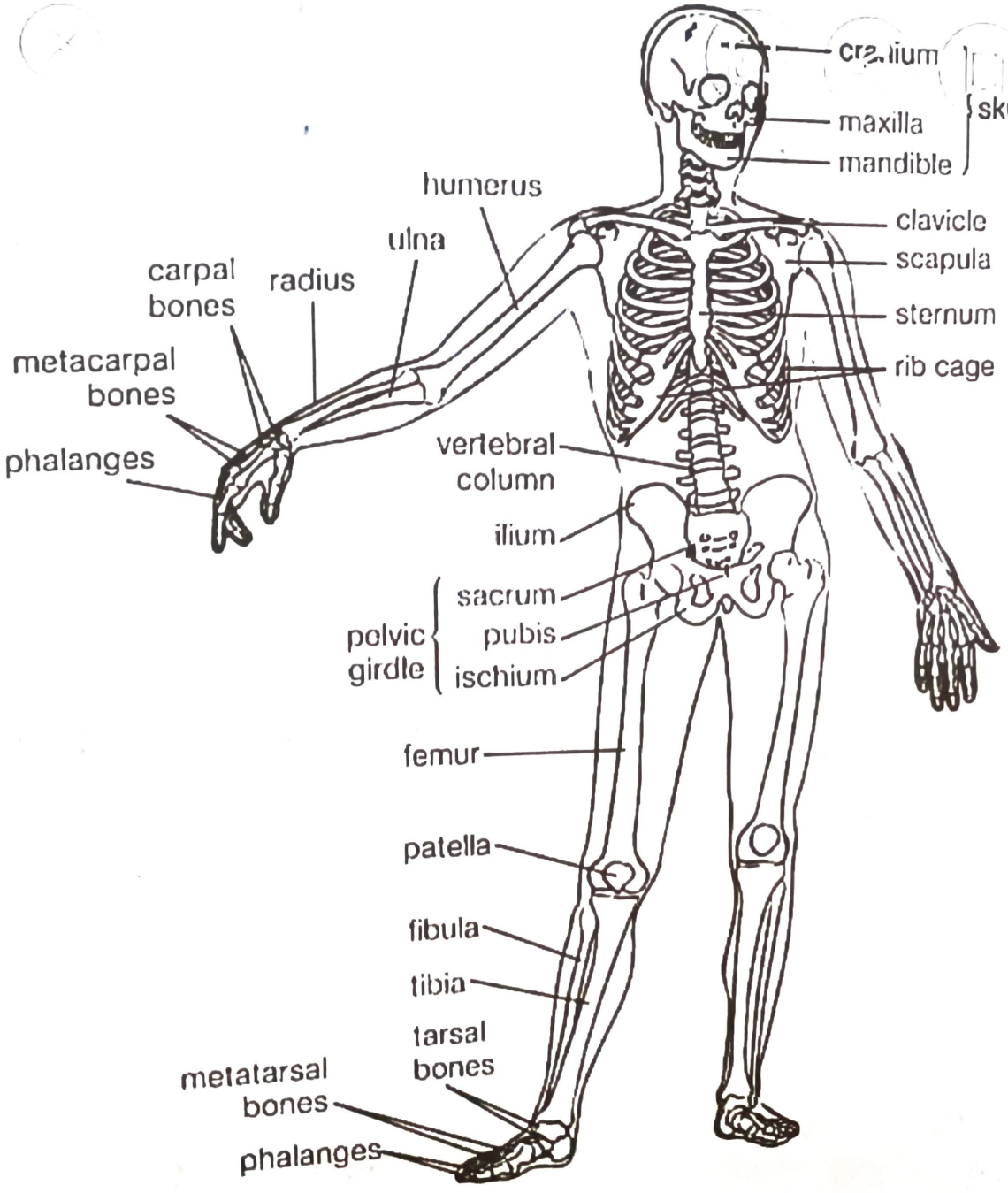
Siberia - Denisova cave - fossilised finger bone → genetic analysis
2010.

Denisovans are sister grp of NM split from common ancestor 390000 yr ago.
and lived till 40000 y.o. (Siberian cave)
Altai mountain

~~4%~~ of Eu.'s DNA → NM ~~2010 study~~
4-6% of Melanesian DNA → Denisovan

separated a little earlier than Neanderthal

Lagar Velho, Portugal evidence 24000 yr old.
+ DNA evidence



0.32 to 0.27 my a

RHODESIAN MAN

Twigelar 1921

→ Skull NM
→ Dentition & Portion of Humerus

1. Name and meaning: ~~Broken Hill Man~~
Homo Rhodesiensis

Zambia a Kabwe cranium

2. Geographical distribution: Africa, Rhodesia

1921 — 1921 F. Twigelthan — Skull with lower jaw, sacrum, femur, tibia, pelvis
1925 Pycraft et. al — Skull broken

Associated finds: Some bone of animal and stone implements → Similar to Bushmen

3. Time period: Definitely Upper Pleistocene.

4. Physical charactors:

Like NM

Skull: Long : ~~210~~ mm
Breadth : ~~145~~ mm
dolichocephalic

Height of cranium: 130mm

~~like~~ Neanderthal

Cranial capacity: 1250 to 1400cc

But endocranial cast study show brain ~~low~~ type

Prefrontal and ~~temporal~~ parietal regions are reduced.

Better auditory region

~~Orbital~~ arches prominent > Neanderthal man.

Forehead extremely receeding.

Face remarkably long

Cheek bone strongly developed.

Dentition: Human like, canines normal, wisdom teeth rudi...
affected by caries.

affected by caries.

Post cranial:

All human like
- Sacrum → human like
- Femur & Tibia diff from Neanderthal man and similar to modern humans
- Foramen Magnum at centre downward, forward. unlike Neanderthal man, showing erect posture

5. Cultural features: Due to lack of evidence not much can be said conclusively. Stone tools like Bushes were found.

6. Phylogenetic status: Debatable
- ~~Skull~~ resembles Neanderthal man ~~modern~~ [illegible]
- ~~Rest~~ Dentition & Post-cranial features human (Austra...
- ★ Found in middle of Africa — No relation to N.M & Australia

But today, it may be admitted that RM, NM & modern Australian man have a common origin as they have a common stock of primitive characters.

Phylogenetic status

- Woodward ~~human~~ gave name H.r on the basis of position of foramen magnum — so Homo rhodesiensis — pre 1950 – H. erectus subsumed
- but Pycroft argued that it did not still have true erect posture as indicated by pelvis — so Cyphanthropus Rhodesiensis — post 1950 H.r
- Hooton says, there is sufficient likeness b/w neanderthal and rhodesian man, so as to regard the rhodesian man as variant of neanderthal. — ~~[illegible]~~ today synonym for Heidelberg man
~~[illegible]~~

[Homo luzonensis] – earlier thought modern humans but 2019 – more specimens – so new species
- Luzon, Phillipines; Callao Cave – traits similar to modern man, archaic homo, australopithecus
- 50000 years ago
- could have descended from early H. erectus or even descended from entirely diff^n homo species before erectus
- premolars like Paranthropus, molars are smaller than H. floresiensis
- mainly deer hunting, pig

Scanned by CamScanner

Scanned by CamScanner

Homo Sapiens

Men of late pliestocene — Grimaldi, Cromagnon & Chancelade (Neptune)

Grimaldi:

Remains were discovered in a cave called as GROTTE DES ENFANTS at village Grimaldi on Mediterranean Sea.

Material: Skeleton of women of about 30 Yrs.
Boy of about 15 Yrs

Manner of skeleton showed intentional burial.

Associated finds: Artifacts of Aurignacian type.
knifes, scrappers, saws etc.

Time period: Late pliestocene

Physical features: Cranial capacity 1265 cc woman
1400 cc boy

Long, High, Narrow → hyperdolichocephalic

~~small~~ large face, ~~wide~~ short

All small
- Mastoid process small
- Chin is small
- Supra orbital ridges are feebly developed
- Orbits are large and sub-rectangular
- Nose broad
- Prognathism is marked
- Jaw is strong & thick
- Low ascending ramus

Teeth are large. Molars — 4 cusp, lower molar 5 cusp.

female height 5'2", Boy 5'1'

Lower limb forearm are very long in proportion to arm and thigh. respectively.

All the characteristics of Gaimaleli resembles to that of a Negroid

Australoid

Culture: Burial

Knife, tools

- present found in Groanchos of ~~Canary Island~~.

- did not get extinct.

- head
- cc
- mastoid.
- orbit
- prognathism
- asymmetry
- lower jaw.

developed triangular

2. **Cro-Magnon**

Cromagnon cave — Also discovered Dryopithecus in 1856, South France. McGregor

1868

Discovery: France, M. Louis Lartet, 1868

- Adult man, woman, an infant and an old man

Age & Culture: Late Pleistocene

Culture:
- Bone & Stone tools mastered
- Cave paintings, Sculpture, ivory ← stone statues — Aurignacian
- Animal bones found

Features: 30000 – 40000 y ago

Skull: Large and massive

Dolichocephaly

- Long (200 mm), Breadth (150) — dolichocephalic
- Cranial Capacity 1660 cc. > Grimaldi
- Forehead broad & moderately high
- Supra orbital ridges low and wide
- Face broad short flat
- Orbits → rectangular
- Zygomatic region is strong
- Marked prognathism
- Lower jaw strong.
- Ascending rami not very wide
- Femur → well developed linea aspera
- Long bones → Athletic physique
- Negroid proportion of limbs.

- head
- cc
- orbits.
- prognathism
- lower jaw
- not wide as. rami.

Jaw strong
Marked prognathism
dolicocephalic

Athletic

hominins

Evidences suggest that they survived even now.
People in France show characteristics of Cro-Magnon and have cultural similarities too.

Cro-Magnon v/s Grimaldi

1. Pentagonal contour — Elliptical contour
2. Less marked facial prognathism
3. Less dolichocephalic head
4. Absolute longness in head.
5. Tall stature
6. Limb proportions.

Cranial capacity >
Orbit more rectangular
Ascending rami less wide
Athletic
Linea aspera fully developed
Tools more civil
later presence

1660 vs 1400 cc

- head
- cc
- orbits.
- prognathism
- lower jaw
- not wide as. rami.

– didnt get extinct
Ranchos of Canary Island, Spain.

both Cro and Gri show Negroid features
so late incursion of Afric H.S in Europe — good Negroid all^m in Grimaldi,
diluted in Cromagnon
so Cro got early Negroid character

3. Chancelade

Discovery: (1888) Rock shelter near Chancelade, France

1888

A human skeleton with arms folded on its breast and knees touching jaw.

Suggest burial method.

Time period: Lower Pleistocene.

Description: Skull is Long, narrow (dolichocephalic)

Cranial capacity 1530 to 1710 gm

Vault is high

Supra orbital ridges is slightly marked.

Mastoid process fully developed.

Face → long & broad / flat

Orbits are large, quadrilateral in shape

Nasal prognathism

Cheek bone prominent & strong

Lower jaw strong and narrow.

Ascending rami very high & broad

Age → 55–65 yrs.

Height → 5'1".

Limb bones strong and massive

Upper limb > lower

Femur is bent

Tibia is platymeric

Foot is large

Magdelian culture

Cro-Magnon V/s Chancelade

1. Taller
2. Head disharmonic — harmonic
3. Orbit rectangular — Quadrilateral

Chancelade man resemble modern Eskimo because:

- Short stature
- Dolichocephaly head
- Elevated sagittal region + High cranial vault
- ~~Flat face~~
- ~~Prominent cheek bone~~
- ~~Powerful masticatory apparatus~~ (No need prognathism)

~~Cultural~~ similarities:

Post glacial period, reindeer, Chancelade people moved northward and ultimately reached North America and descendents are Eskimos.

Magdelian culture

- Head
- CC
- Mastoid.
- Orbit.
- Vault.
- No progn.
- lower jaw
- as rami high + broad

elkillo

7

1.7

The cell

Robert Hooke in 1665 first observed dead cork cells.

Organisms are unicellular (amoeba) or multicellular.

Cells → Tissues → Organ → Organism

Parts of cell:

3 basic components → cell membrane, cytoplasm, nucleus

1. Cell membrane — separates cells, selectively porous gives shape and holds all parts together.
2. Cytoplasm
3. Endoplasmic reticulum → SER / RER (have ribosomes attached to them) attached to Nucleus membrane

   RER → ~~Protien~~ protein synthesis.
   SER → Synthesis of lipid and steroidal hormones.
4. Golgi apparatus — disc shaped. Its function is to pack
5. Lysosomes — formed at golgi apparatus. They have enzymes capable of digesting cart, protein, lipids etc.
6. Mitochondria — Power houses, aerobic. It is double membraned.
7. Ribosomes — RER or spread in cytoplasm

* The cell - Rober Hooke 1665
* DNA structure - meischer 1869
① double helix 1953
③ * DNA replication - matthew meselson, franklin Stahl 1958 - semi conservative
② * Protein synthesis - George Palade 1955 - happens on ribosome
* Chromosome - Sutton & Boveri 1902

* cell div - Strasburger 1870, Fleming 1882, JB Farmer 1905
* Metabolism - Hugo de Vries 1908

Ribosomes are made up of two large complexes of RNA and protien. They are located at cytosol. They are assembly line for tRNA, mRNA for the process of translation. They are also found in cytoplasm, chloroplast, mitochondria, RER.

8. Centrosome and Centrioles — spindle fibres

9. Nucleus. nuclear membrane is porous.
Nuclear material → chromatin & Nucleolus
↓ condenses
chromosomes during cell division

Prokaryote → no nuclear membrane
Eukaryote → has nuclear membrane

DNA structure

DNA as acidic material was first identified by Friedrich Meischer in 1869

James Watson and Francis Crick proposed a Double Helix model in 1953.

Chargaff's rule — ① A = T, G = C ② A+G = T+C

There are two types of nitrogenous bases —

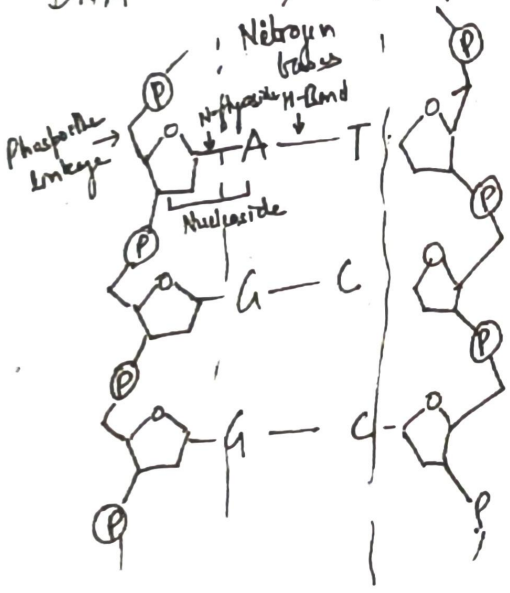
ⓐ Purines —	A, G	Adenine
		Guanine
ⓑ Pyrimidines —	T, C	Thymine
		Cytosine

This N-base is linked to pentose sugar (deoxyribose) via N-glycosidic linkage

A — Deoxy Ribo nucleoside → Adenosine, Guanosine, Cytidine, Thymidine

Phosphate group is linked to 5'-OH of nucleoside via phosphoester linkage to form Deoxy Ribonucleotide.

DNA consists of four Deoxy Ribonucleotide



* phosphate
* pentose
* base

Imp Agar.

#

Backbone is provided by sugar and phosphates.
Two polynucleotide chains are held together by H-bonds. Always purine base pairs with pyrimidine
Strands run anti parallel. direction

Relevance of DNA structure:

1. New realm of molecular biology
2. Helps in understanding how genes operate, cell division
3. Biotechnology and genetic engineering
4. Protein synthesis.

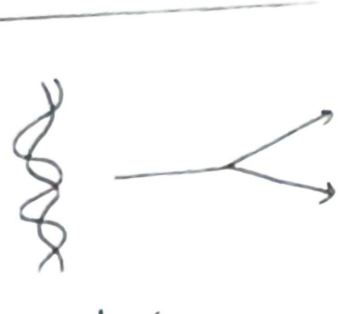
DNA can be double stranded or single stranded
On the basis of nature of nucleotide sequence —

1. Palindromic DNA
2. Repetitive DNA or Satellite DNA (absent in Prokaryotes)

DNA REPLICATION

Parental DNA synthesizing identical daughter duplex

Mathew Meselson & Franklin Stahl 1958
- showed semi conservative rep^n



original parent molecule.

first gen daughter molecules

M

Steps in DNA replication:

1. Recognition of origin
2. Unwinding of the parental duplex
3. Holding of the template strands apart
4. Initiation of new daughter strands
5. Elongation
6. Rewinding

2 complimentary strands

unzipping of strands

enzyme (Helicase)

Replication fork

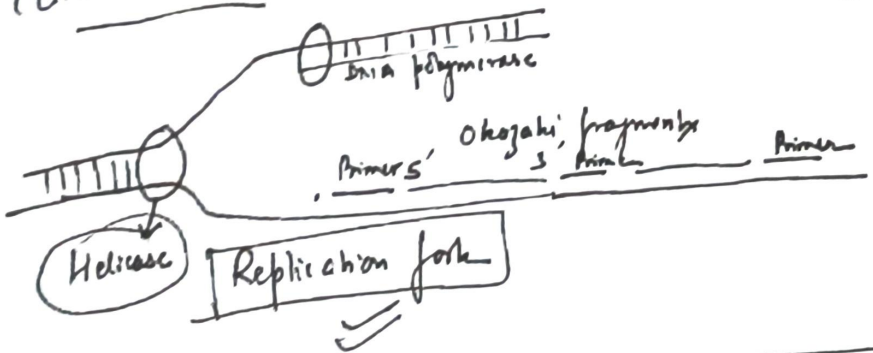
Replication fork

enzyme (Primase)

makes a small piece of code (RNA) (Primer)

DNA polymerase enzyme binds to (Primer) (dirn 5'→3')

finally ligase seals fragment

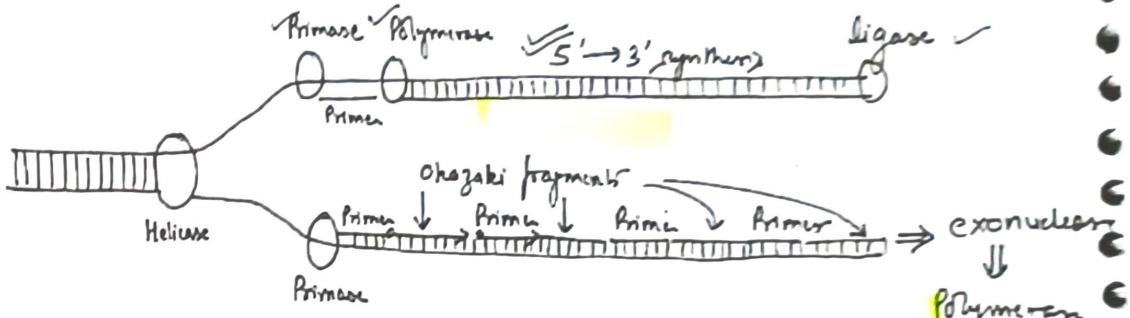


Enzyme exonuclease removes all Primer strands

It is called semi-conservative method because in the new DNA 1 strand is conserved from older DNA.

Enzymes: Unwinds Helicase → Primase → Polymerase (Binds with primer, 5'-3' direction) → exonuclease removes primer ← ligase seals

HPPEL



Replication fork of semi conservative replication proposed by J. T. Taylor 1956

Error: Correction in Human cells.

Relevance:
1. Error may lead to a generation of mutated cells mutation due to error
2. Many chemotherapy agents target S-phase of the cell cycle. Cancer treatment

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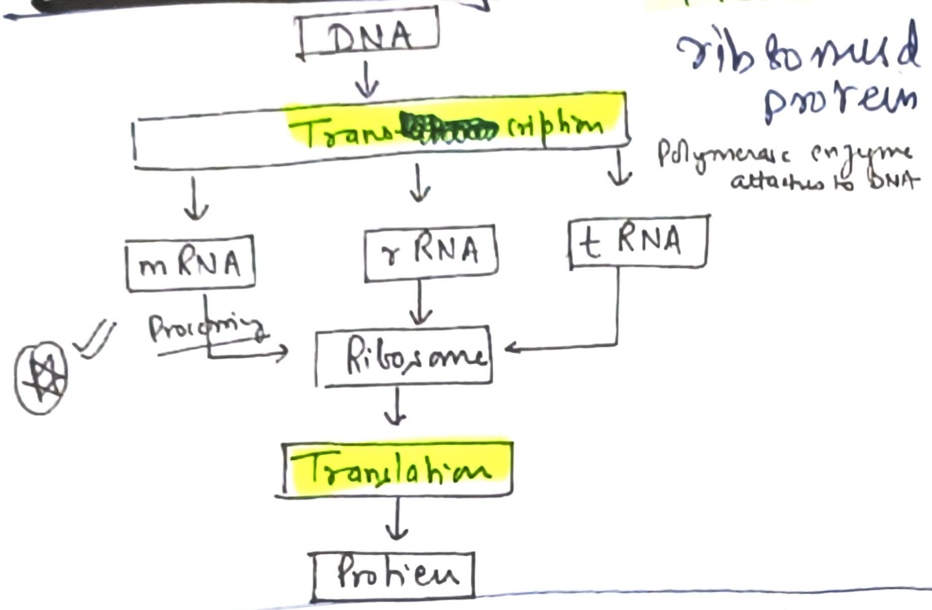
1974 Nobel
George E Palade
1955 discovered ribosomes did protein synthesis

Protien synthesis



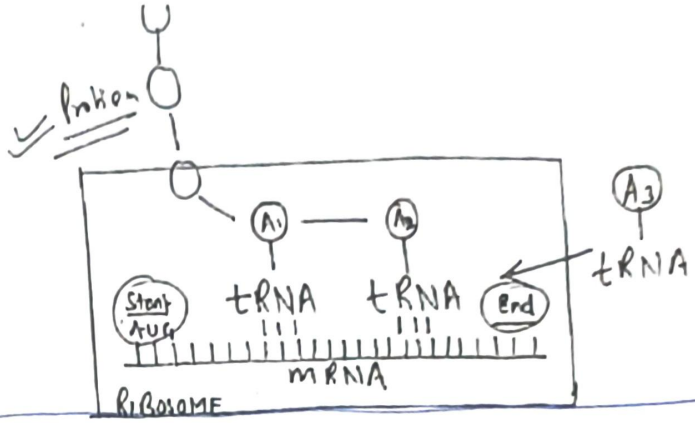
The process by which genetic information in mRNA molecule is converted into protien with specific amino acid sequence taking help of tRNA molecules is known as translation or Protien synthesis.

Process:

Within nucleus ① Transcription: Polymerase enzyme attaches to gene and moves along it making mRNA strands.

② Processing: mRNA before being used as a template is processed by adding or deleting sections of RNA.

③ Translation: mRNA ⟶ ribosome ⟶ tRNA reads codon in sets of 3 and puts right tRNA in sequence ⟵ last anti-codon



There are 20 types of amino acids and a chain in particular sequence is a protein.

Relevance:

1. CRISPR CAS 9
2. DNA profiling
3. Genetic studies
4. Understanding genes, their functioning.
5. Medicinal probes

DNA Vs RNA

DNA	RNA
• Deoxy ribose	• Ribose
• T	• Uracil
• Many nucleotides	• less nucleotides
• Replicates	• No replication
• Not much role in protein synthesis	• Protein synthesis
• Molecular wt. more	• less
• Nucleus	• Cytoplasm

Functions of gene:

1. Expression of characters → Enzyme, Harmone, Antigen, Antibody
2. Protein synthesis.
3. Inheritance
4. Regulation of gene action

Chromosomes: Described in 1875 but role in inheritance was given by Sutton and Boveri in 1902

Functions of chromosomes:

1. Contains genetic information
2. Protects genetic information
3. Maintains equal no. in daughter cells and from 1 generation to another.
4. Regulates gene expression

CELL DIVISION

Two ways, Mitosis
Meiosis

Mitosis: All organisms grow from a single cell. They increase in no. via cell division. Division of a cell into two daughter cells is called mitosis.

Cell cycle

A Dual I Strasburger 1870 Flemming 1882 ... 1905

It was first observed by Strassburger (1870) in plant cells and Flemming (1882) in animal cells

2 phases

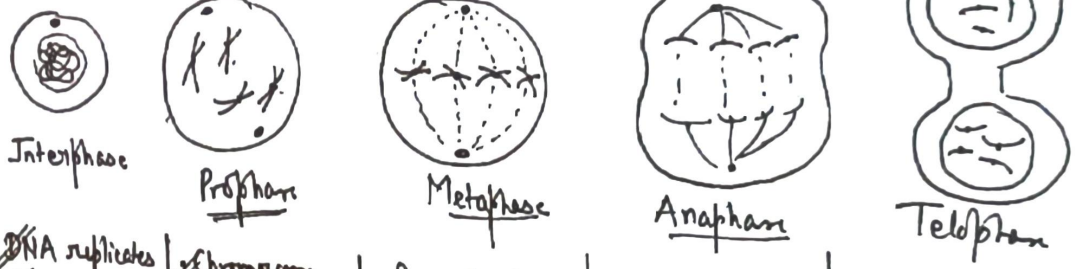
- Strassburger, 1870
- Flemming, 1882

① Interphase
- G1 → cell grows metabolically
- Synthesis → DNA replication
- G2 → RNA, mRNA, cell division proteins & RNA.

95% time

In interphase volume of cell gets doubled, DNA is replicated and cell division is initiated.

② M-Phase → Mitosis
- Karyokinesis
  - Prophase
  - Pro-Metaphase
  - Metaphase
  - Anaphase
  - Telophase
- Cytokinesis



Interphase
- DNA replicates
- Volume x 2
- Prepare for cell division

Prophase
- Chromosome condenses
- Spindle fibres appear

Metaphase
- Pro metaphase
- Spindles attaches
- Chromosomes align at the centre

Anaphase
- Centriole divides
- Sister chromatids moves towards opposite poles

Telophase
- Nuclear membrane reforms
- Chromosomes decondense
- Spindle fibres disappear
- Golgi apparatus & ER reappear

Cytokinesis → cytoplasm divides

Significance

1. It ensures eq. no. of chromosomes in all cells.
2. It caters to growth of a multicellular organism.
3. During mitosis damaged cells are either repaired or they die out.
4. Sexual reproduction depends on mitosis after zygote formation. (4) → eq. no. of chromosome, growth, damage repair/removal, sexual repro.

Meiosis — J. B. Farmer 1905

It is a process by which diploid germ cells through specialized cell division reduces chromosome number to half to form haploid gametes.

Diploid → Meiosis → Haploid → fertilization → Diploid

gametogenesis

Meiosis ensures production of haploid cells or gametes whereas fertilization restores diploid phase.

Meiosis occurs during gametogenesis.

2 ϕ of Nuke+cyto division

Meiosis involves two sequential cycles of nuclear and cytoplasmic division but only one

1 ϕ of replicat. phase of

chromosomal replication

Interphase
↓
Meiosis I — PMAT.
↓
Meiosis II — PMAT

Prophase I involves — Leptotene, Zygotene, Pachytene, Diplotene, Diakinesis } LZPDD

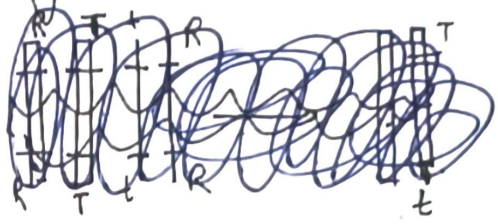
Crossing over

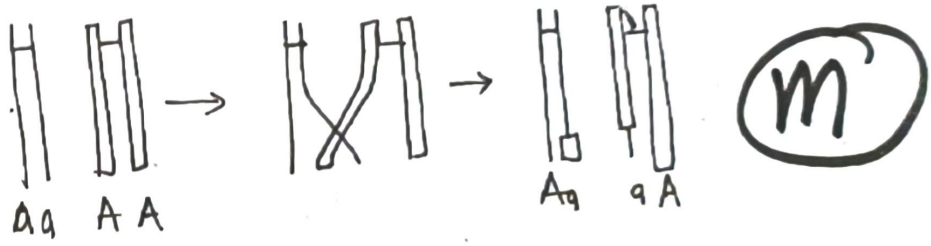
During pachytene of Prophase I, crossing over takes place between non-sister chromatids of homologous pairs of chromosomes.

Recombinase

Crossing over is an enzyme mediated process and the enzyme involved is called recombinase.

Crossing over leads to recombination of genetic material.





Relevance: Crossing over is an important source of genetic variability

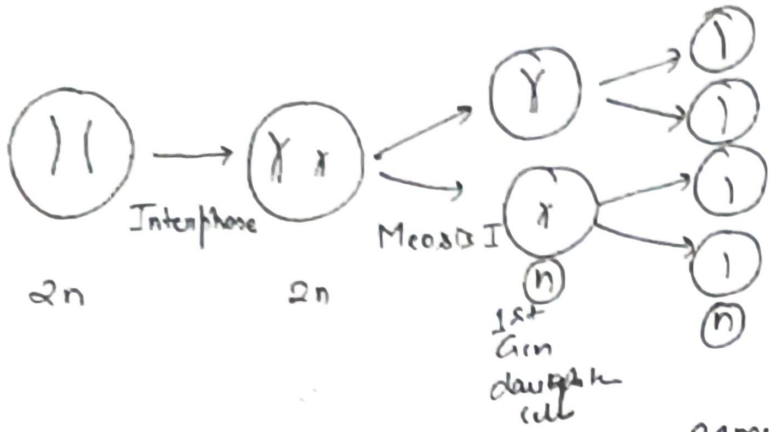
Prophase I → Metaphase I → Anaphase I → Telophase

LZPDD

Crossing over

Non disjunction can happen

Meiosis II resembles Mitosis



Relevance of Meiosis

1. Conservation of chromosomal number from one generation to another in a species.
2. Crossing over during Prophase I leads to increase in genetic variability.
3. It also plays role in transfer of mutations from one generation to another and thus leads to evolution.
4. Non disjunction during Anaphase I leads to many genetic disorder caused by reduced fertility and fecundity.

Gene mutations

- 1901 (Hugo De Vries)
- Mutations are changes in genetic makeup of an organism, which can be qualitative or quantitative.
- mutations are random in location
- effect of a mutation can be positive, negative or neutral.
- mutations can be classified according to
  - type of cell
  - size and quality
  - origin.

Somatic vs gamelic mutations

Somatic mutation

- occur in body cells - non reproductive cells.
- evolutionary consequences are insignificant.
- but if occurs during embryonic stage, large proportion of cells are involved
  eg: cancerous growths.

gametic mutation
- in sperms and ova
- immense genetic significance
- raw material for natural selection

Point and gross mutations

- occur in very small segment of DNA, single nucleotide or pair. - then point mutation

deletion
CTGCAG
CTAG

insertion
CTGCAG
CTGC|ATG|AG

substitution
CTGC|A|G
CTGC|G|G

deletion results in frameshift - causing wrong protein to be encoded.

~~T~~HE FAT CAT SAT
HEF ATC ATS AT

- gross mutation - involves a large portion of a gene or entire gene - can occur.
- due to rearrangement of genes within genome.

Spontaneous and induced mutations

Spontaneous - occur naturally / randomly in nature and their origin is unknown.

induced - certain environmental conditions can induce mutations.

...agents that cause mutation - gamma rays, X-rays, benzene etc.

DATING TECHNIQUES

- Absolute (or Chronometric)
- Relative

Dating techniques are employed to determine the age (on a specified chronology.

Absolute dating techniques provide a numerical age or range in contrast with relative dating which places events in order w/o any measure of the age between the events.

Absolute: 9

1. Radio Carbon Dating 5730 yrs
2. K–Ar dating 1.3 my H.e. H.h, As.
3. Thermoluminescence – 15 y.
4. Dendrochronology 4570 y (C14)
5. Amino-acid dating – D, L
6. Uranium-lead method (m/m.m) – Dr. S.
7. Electron spin resonance – Hominoid
8. Varve Analysis – end of Pleistocene
9. Fission crack dating – glass

Relative 6

1. Seriation – ships
2. Paleomagnetism
3. Pollen dating (AP/NAP x100)
4. Fluorine dating (Fluorapatite) Piltdown man 1953
5. Stratigraphy (river terraces)
6. Marker fossils – speciation of elephants

Absolute dating methods: (15 M)

- Def
- Principle
- Application
- Limitation

1. Radio-Carbon dating:

Willard Libby

Atmosphere – $N_2 \xrightarrow{h\nu} C^{14}$ → inhaled by living organism → Till eq^m b/w C^{14}, C^{12} is equal to that of environment and body

But once organism dies C^{14} inhalation stops starts loosing C^{14} as N_2.

Half life → 5730 yrs

Thus, range → (5k, 50k)

Limitations: ① Fossils belonging only till [illegible] yrs be identified and dated.
H. sapiens
② Environmental concentration of N may [illegible] have remained same throughout the time.

2. **Potassium – Argon dating:**

Principle: $K^{40}_{(S)} \xrightarrow{decay} Ar^{40}_{(g)}$

Australopithecus (Hominoid) H.e H.h

Half life 1.3 million years

Dating range: (5 Lac – 5 million years)

Molten rock → Ar escapes

Cold rock → Ar(g) gets trapped.

Limitations: ① It is possible only on volcanic rock and ash and sites older than 5 myo cannot be dated reliably.

3. **Uranium-lead method:**

$U^{238} \longrightarrow Pb^{80}$

Half life = 3 million years

Dryopithecus Sivapithecus

1 gm of U forms $\frac{1}{7,600,000,000}$ gms of lead. 7.6B

If quantity of U = m_1 (g)

Pb = m_2 (g)

$$\text{Age of fossil} = \frac{m_2 \times 7,600,000,000}{m_1 + m_2} \text{ years}$$

4. **Dendrochronology:** Tree rings in Cambium

Concentric rings maintain minute differences of structure for each year depending upon Temperature, humidity and age of tree.

Bristlecone pine has provided different ring structures for 4,900 years.

Any prehistoric sample of unknown date is compared for its ring structures with the already identified structures and thus their age is determined.

It played a very critical role in correcting the C-14 dating method.

5. **Varve analysis** : Summer — glacial lakes have more water
Winter — less water

Thus, thickness of fine clay deposition will be more in summer and less in winter

Physical counting of these darker varves can give exact age of the deposits with respect to glaciation events

It is this method that gave the exact date for end of Pliestocene.

6. **Fission track dating** :

U^{238} decay → α particle → cracks on glassy surface

Amount of U^{238} and density of α cracks can tell us the age of sample as the rate of decay is a predetermined constant.

0.01 - 500 mya

See with microscope

Limitation: glassy surface.

7. **Thermoluminescence**

Principle: All objects absorb radiation from n. environment.

Materials trap energy by trapping electrons ($e^{\ominus}$) from impurities

M. Aitken

$\Delta \rightarrow e^{\ominus}$ released as light → measured to find out the last time the material was heated

↓

Cooling → Reabsorption of energy (rate) is calculated

- wide range
- upto 0.5 mya

limitations: ① Accuracy (5%) because

- Repeatedly reheated sample may not give accurate results
- Sample may be absorbing the energy if the previous environment too.

- used to analyse first fired clay

8. **Electron spin resonance (ESR):**

Radioactive materials in rock induce electrical charges in the adjoining fossils which can be measured by ESR.

Hominoid fossils

This method has been found to be accurate in determination of age of hominoid fossils.

1.7 - 2.3 mya

M

Q. **Amino acid Racemization:**

D L

Polarized light (hν) → D → Turn right
→ L → Turn left

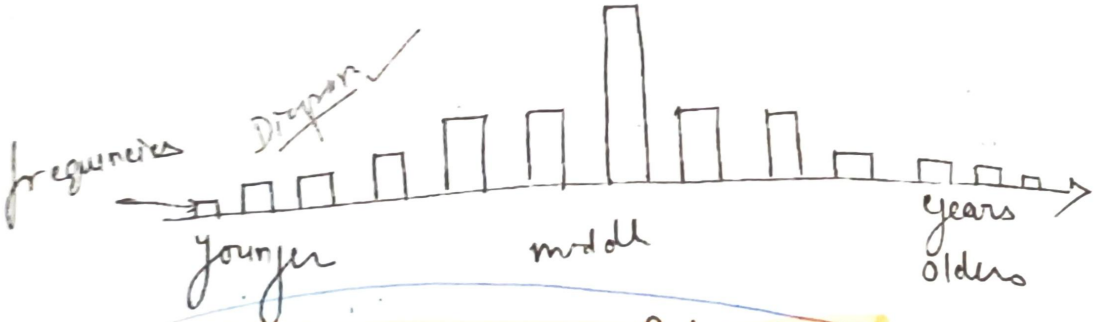
Living → mainly L
Dead → L to D transformation — racemization

Aspartic acid takes place in 5k - 100k years

Relative dating techniques:

Shows events in order w/o determining the age of each.

1. **Seriation:** It is based on the principle that any "style" initially starts with low frequency and then increases and finally decreases.
Eg tools of a particular types.
"Battle ship"



2. **Pollen grain dating or Palynology:**

Pollens → excellent preservative ability
→ diff. for diff. types of plants

Leonard Von Post

eg: Thekkadi in Kerala

Arboreal Pollens → AP → Trees
Non Arboreal Pollens → NAP → Grassland

$\left(\frac{AP}{NAP}\right) \times 100$ can give the environment from Tundra to Tropical.

3. Fluorine dating method:

Bone / Teeth → Phosphate → Hydroxyapatite
Ground Water → Fluorine

Bone + GW → Fluorine + Hydroxyapatite

⇓

Fluorapatite

Amount of fluorapatite can be found out and fossils can be dated relatively.

Because not all fossils absorb F at same rate the accuracy of this methods is questionable

- In 1953, this method was used to test 'Piltdown Man' and to scientifically conclude that it was a forged fossil.

But by accomodating the chances of error this method can be used for relatively dating fossils.

4. **Paleomagnetism**: Polarity of earth's magnetism changes and hence the magnetic induction of the rocks on the surface at those time exhibit polarity as induced by earth.

It has been proven that earth has changed its polarity almost 10 times. The polarity and stratigraphy can help in relative dating.

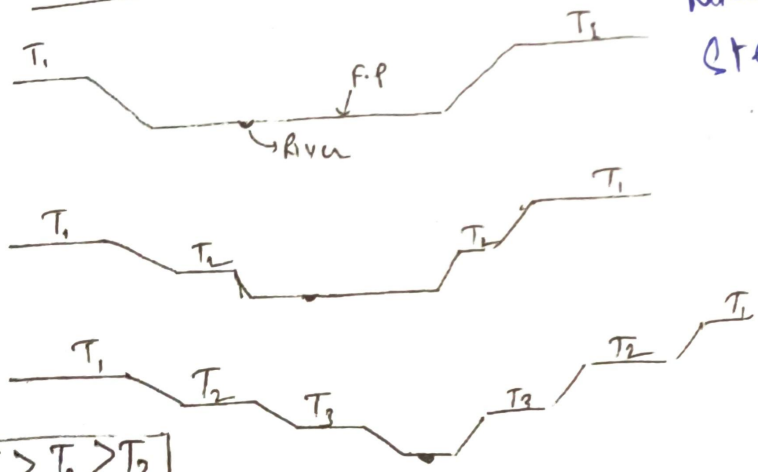
Karewa deposits in Kashmir

5. **Stratigraphy**: It is based on the principle that the lowest layer in any natural process of deposition is older than the layer on top given, there as been no disturbance.

— River terraces:

Soan valley

Nichulai strata



$T_1 > T_2 > T_3$

6. **Marker fossils**: These have undergone proven speciation with considerable changes.

E.g. Elephants etc