

(Please do not write anything except the question number in this space)
कृपया इस स्थान में प्रश्न संख्या के अतिरिक्त कुछ न लिखें।

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उम्मीदवारों को इस हाशिए में नहीं लिखना चाहिए।
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Q1(b)

Isolation or reproductive isolation refers to physical or social barriers to breeding between 2 or more population

Isolation $\xrightarrow[\text{to}]{\text{leads}}$ Speciation

Speciation is the formation of new species -

Mechanism of speciation

① Genetic drift

1. This happens when a small part of larger population migrates to an abandoned place and breeds among self.
2. Over long time, due to effects of natural selection on small populations in this sub population, it can no longer interbreed with original population, hence formation of new species

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② Bottleneck effect

1. When some natural calamity isolates a sub group of population
2. Barriers to mating → mate among self
3. Small mutations get accumulated and acted on by natural selection
4. Leads to formation of sub-species or new species.

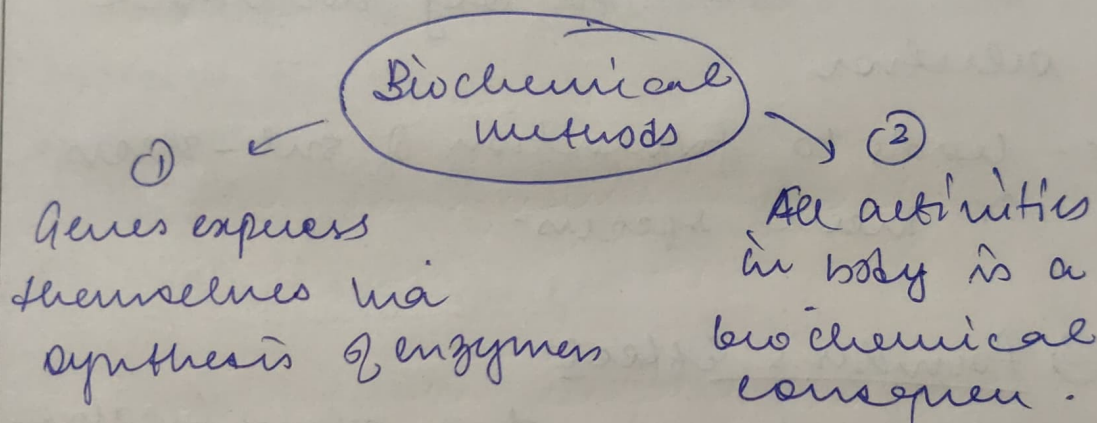
③ Founder's Effect

when barrier to mating because of migration and practice of endogamy.

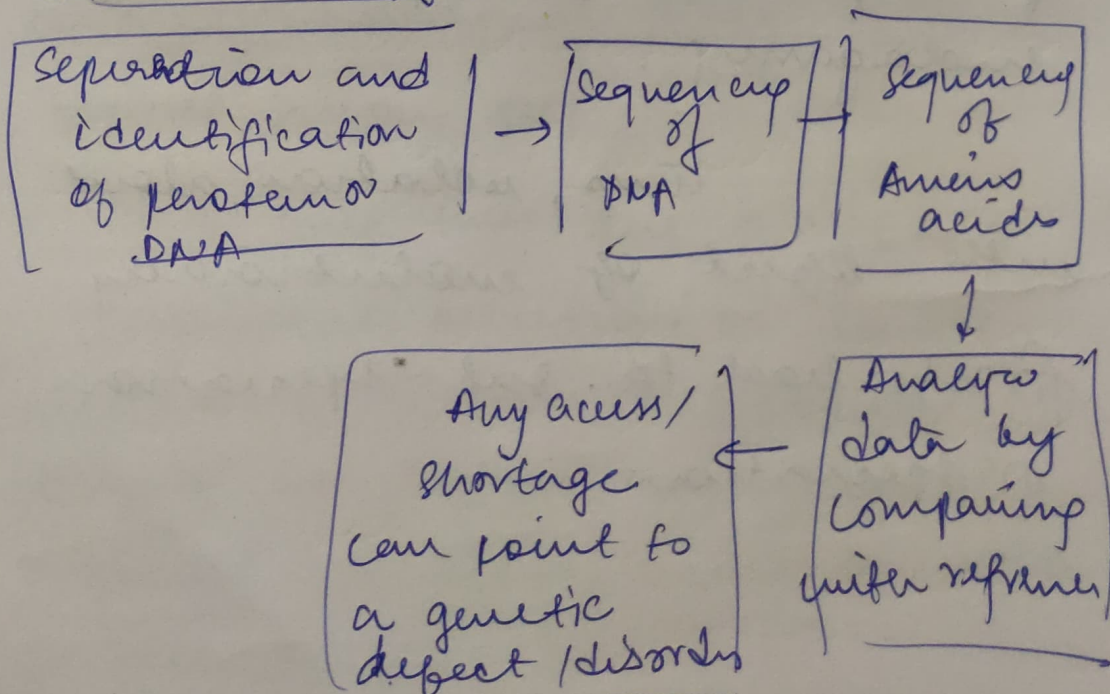
thus, isolation, along with effect of evolutionary forces lead to sub-speciation or speciation

Q1(c)

Biochemical methods involve study of endocrine system and interplay of protein, enzymes and other chemicals in the human body — for man-family study.



Methodology



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• Techniques of Protein Synthesis

- ① Gel Electrophoresis : separation on basis of charge of protein
- ② Gel filtration : separation basis size and weight
- ③ Affinity chromatography using ligands

Significance

1. Detection of ~~cause~~ of inherited Genetic disorders.
2. Detection can be done in early pregnancy stage on: by using amniotic fluid
3. Genetic tool to identify inter and intra population variations
ex: More melanin in tropical population.

Thus, biochemical study disorders, helps identify ~~not~~ only genetic ~~but~~ ~~not~~ environment effects, but an effective methodology to uncover metabolic pathways and functions

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Q1(c)

Mitochondrial DNA is that DNA of the ovum responsible for energy production.

Mitochondria in an cell organelle and has own DNA

Functions of Mitochondria or Mitochondrial DNA :-

- 1) Power house of cell
- 2) Provide pathways to enable production of ATPs.
- 3) Supports the embryo on fertilisation of the ovum.

It is inherited from the mother.

Contemporary Relevance

1. Defects in mitochondrial DNA leads to some health disorders
2. These disorders get inherited by the child.
3. To avoid this inheritance,

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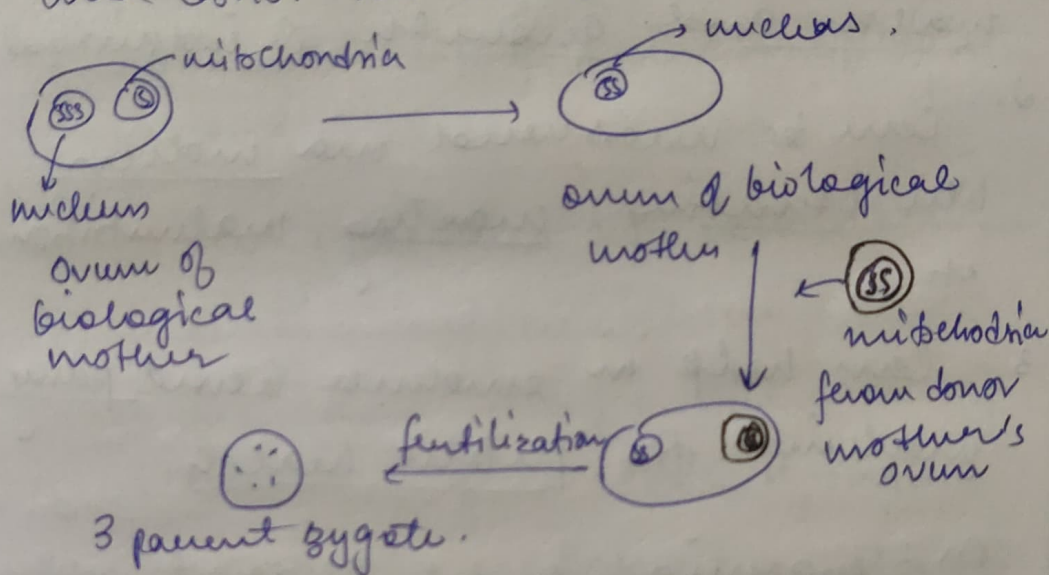
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Recent advancement in health care
in form of 3 parent baby

Features of 3 parent baby

1. Has genetic material of 3 people
i.e., father (from sperm), mother
biological (ovum's nuclear DNA)
and donor mother (mitochondrial DNA)



A very effective advancement to
stop inheritance of serious health
disorders.

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Q1(e)

Nutritional Anthropology refers to the study of nutrition intake of the population or individuals across space and time.

[Relevance]

1. Nutritional intake, pattern and levels have direct impact on health and growth of individual.
2. Can be measured via indices like stunting, wasting, malnutrition, etc.
3. Can help in evidence based policy making for public health

ex: Anaemia Mukt-Bharat,
Special focus on girls and females
(as per NFHS 5 - 57% females anaemic)
use of iron tablets, fortified food

4. Can help determine what nutrition lack and leading to what health condition ex: calcium levels



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to weak bones, iron → anemia, etc.

5. important to ensure wholesome growth of children and adolescent, as long term impact on economic productivity of country
6. Applications in sports to enhance performance by uptake of right nutrients

Schemes like Poshan abhiyan and mid-day meals in schools have the same target of ensuring a nutritious growth of youth. Nutritional anthrop has played significant role in policy formulation and identification of sub issues

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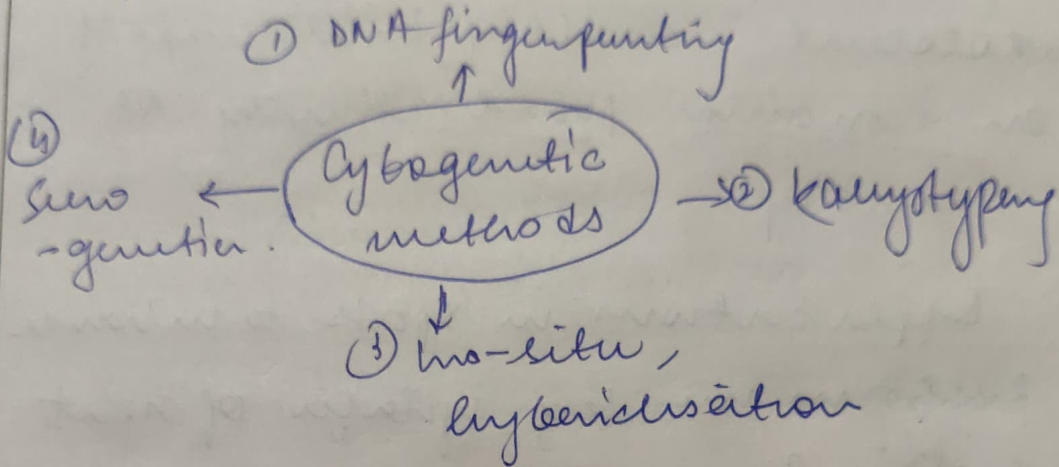
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Q2.

a) Cytogenetic methods involve the study of genetic material by various techniques -



Basic Methodology

1. Extraction of actively dividing cells + culture cells -
- 2. Fixing the cells at metaphase plate phase
- 3. Adding hypotonic solution to allow swelling
- ↓
4. Separation and extraction of genetic material
- ← 5. Blotting with suitable solution for banding
- ← 6. Taking microphotograph for further analysis

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Cyogenetic methods and advancement in forensic anthropology

1. Genetic material used in cyogenetic methods help in identification of individuals
2. In forensics, the various substances collected from crime or investigation site (like fingerprints, ~~blood~~, hair, serum, fluids, flesh from nails etc) serve as raw material for cyogenetic methods.
3. For example, accusations can be confirmed by matching DNA fingerprint of evidence from site. ~~and~~ - if similarity in band patterns. (Karyotyping)
4. Storing ^{such} data of repeated offenders and matching evidence can help detect the criminals faster.
5. Unidentified bodies can be

recognized by matching genetic material with parents or siblings

Cyogenetics and population studies

1. It is well established the different populations have some degree of distinctive genetic material
ex: Longer 'Y' chromosome found in Japanese men. as compared to Negroids.
2. Cyogenetic methods help identify these underlying similarities or differences in population by DNA sequencing ex: Human Genome Project (HGP)
3. The findings can be used in health research and policy formulation
ex: Higher presence of Hb^S haemoglobin in tribal populations in India - prone to sickle cell anaemia.

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This information used to form
Anaemia related blood disease.

4. Helps understand differences and
similarities with relation to
environment on: Lactose intolerance
in Scandinavian countries, more
absorptions of vitamin D.

Limitations

1. The methods are very technical,
require special skills and
resources
2. Scope for misinterpretation and
discrepancy as 96-98% of all
human DNA is same.
3. Can't isolate effect of environment
of development of certain traits
embedded in genes.

Thus, cytogenetic methods
are essential tool for man-population
study, can be more holistic if
clubbed with other methods of
population study.

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Q2(b)

Polymorphism refers to presence of more than 2 form (allele) of a single gene in a population, such that the gene frequency is $\geq 1\%$, else it is just a mutation.

Genetic Polymorphism and Adaptive Advantage

Various type of evolutionary forces or natural selection act on certain polymorphs that lead to adaptive advantages.

1. Balanced polymorphism: Selection of mean or average characteristic or traits, elimination/reduction of extreme traits.

ex: Sexual dimorphism in humans, very less inter sex are found, as sexual dimorphism best for sustaining population.

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2. Sometimes, heterozygotes of leucism and dominant allele have selective advantage in certain environment

ex: Sickle cell anaemia: $Hb^A Hb^S$
heterozygotes are less prone to malaria. Found in tropical populations more as live in jungle - protected from mosquitoes.

3. Directional selection leads to selection of extreme variations of a trait. ex: Study of black and white moth population in London - initially more white, as black were more visible in sky so caught by prey, as industrial fog increased, black ones got masked so population increased, but white ones exposed so decrease in population

4. Genetic polymorphism followed by genetic drift leads to speciation. This induced competition for

muscles as ecological niches change — thus better survival of more specie populations.
ex: various molluscs living in water and just above water.

5. Neanderthals were more adapted to cold climate but as environment changed — perished while other lines survived.

6. Thus, polymorphism acts as an effective buffer to environment change by increasing chances of adaptation to new environment and prevents extinction.

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Q2
(C)

Gene Editing refers to insertion or deletion of genetic material of human or other organisms to fix genetic defects.

Basic Principles

1. Gene express themselves via secretion of proteins or enzymes
2. If a genetic defect is there, it can be because of below 3 cases :-

Q.1 : Gene is absent $\rightarrow$ so that protein not secreted at all

Q.2 : Gene is present but not activated

Q.3 : Gene is present but defective i.e., not functioning properly.

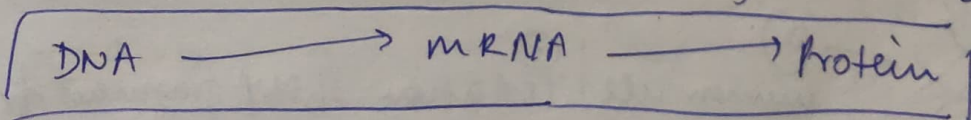


Fig : Central Dogma of Genetics.

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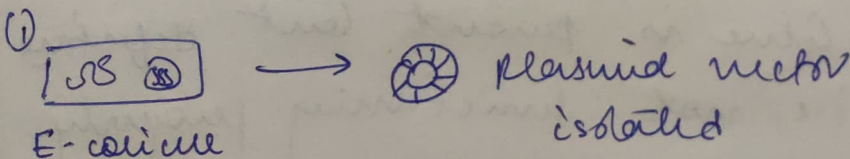
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Gene Editing to treat genetic disorders

1. In case a gene is absent altogether — gene editing done to introduce the gene. A reference chromosome taken to determine absence from location.
2. For an inactivated gene, the gene editing done to activate the gene so that protein formation takes place.
3. For a defective gene, gene is replaced.

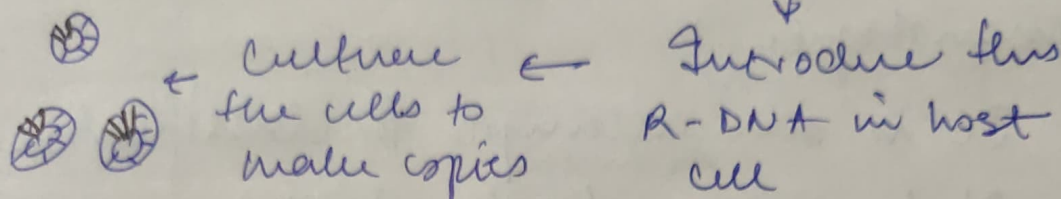
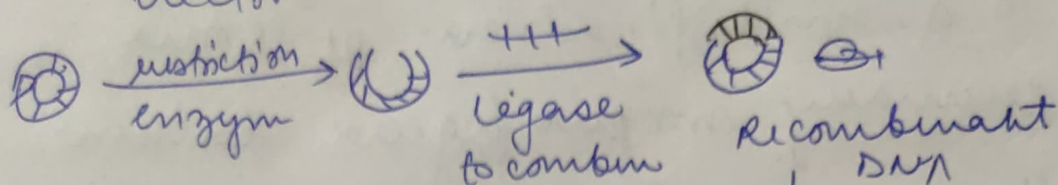
Methodology

Fig: Gene editing for insulin production



~~XXXX~~ ← ③ human cell | ② Isolation of DNA fragment for
Gene of interest (insulin) (++++)

③ Incorporate DNA fragment in suitable vector



↳ Downstream processing.

Applications

1. Vaccine formation
2. Gene therapy to correct defects
in: Cystic fibrosis, ADA deficiency
3. Diagnosis of disorders.
4. Help in gene mapping also —
finding what gene location
on chromosome.

Concern exist for
judicious use not use for bio-
ethicals. Technology like CRISPER
is a big advancement in the
step to create genetic defects.

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Q4
(a)

Anthropometric somatotype refers to quantification of some primary morphological feature that determine the human phenotype.

It is an attempt for classification of human body types.

Sheldon's Method

1. Studied college going males of age 16-20 years
2. Took photographs - back and rear to take anthropometric measurements.
3. Took 17 measurements like length of limbs, thorax, facial index, etc
4. Classified broadly into 3 types
 - A) Endomorph
 - B) Mesomorph
 - C) Ectomorph.

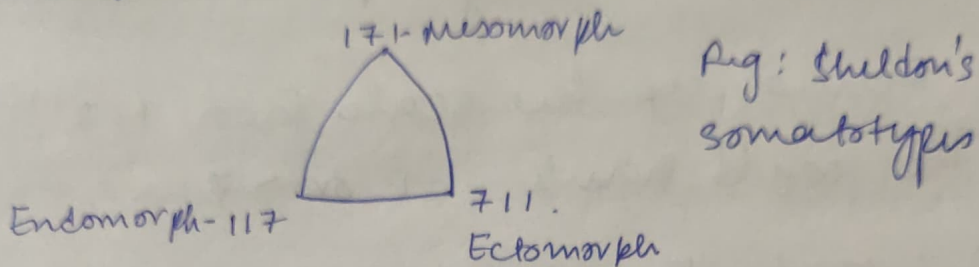
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5. ~~Box~~ Scored each individuals for the 3 type on on closed scale of 1-2.



Properties

1. ^{meso}~~Endomorph~~ : muscular, thorax dominant, long limbs, assertive and dominant nature, prone to bipolar
2. Endomorph : Dominant of digestive system, fat, tapering ends, prone to schizophrenia.
3. Ectomorph : long, slender, linear body, prone to depression.

Heath and Carter's, improved upon the sheldon's model to have more objectivity.

- ① Expanded sample to include female and children.

- ② Combined anthropometric methods of measurement and Sheldon's pictographic measurements
- ③ Opened up the scale from 1-7, i.e., could rank <1 or >7 .
- ④ Plotted the score on a graph (147) to visualize and group the intermediates and extremes.
- ⑤ Instead of the 14 measurements, measured these 10 :-
 - I. Height
 - II. Weight
 - III. Skin folds
 - triceps
 - sub-scapular
 - supra spinal
 - IV. Bone breadth
 - medial calf
(humerus & femur)
 - V. Limb girth (arm & calf)

This way, helped study sexual and temporal variation, though limitations of age group diversity remained.

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Relevance of Somatotyping

1. Application in physiology :
helps determine inheritance in
body type and susceptibility
to diseases ex: as given by Pennell
2. Application in psychology by
deriving relations between
behaviours and body type
3. Applications in sports anthropology
- Identifying which body type
good for what sport.
ex: Mesomorphs - weightlifting
Ectomorphs - athletics.

Hollander and Carter is outcome
various limitations of Sheldon's
method. Sheldon's was a major
work upon which other anthropo-
logists elaborated and developed
Somatotyping as a school.

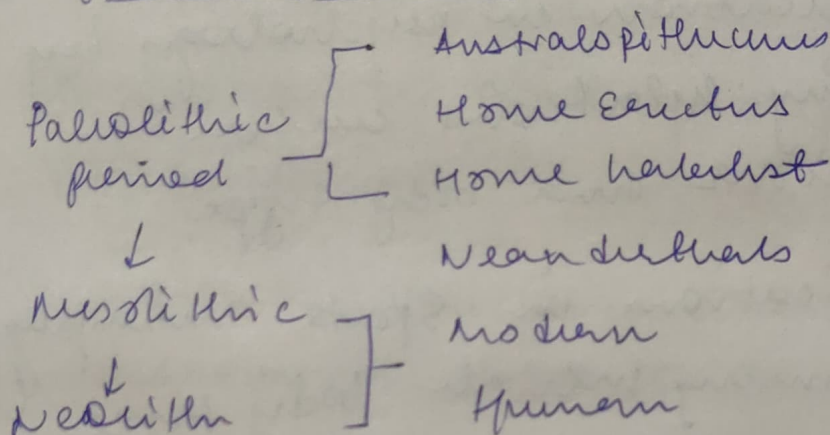
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04(b)

The human evolution to current form starts lakhs of years ago, characterised by various physiological, morphological, developmental and behavioural changes.

Fig: Human Evolution



① Neurophysiological changes :

1. Changes in cranial capacity :
~ 300 cc in australopithecus, gradually growing to ~ 1300 cc
2. Changes in crain-facial features like prognathism to no prognathism, U shaped dental arcade to

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Parabolic dental arcade, development of prominent occipital region and sloping forehead. receded.

3. lost Cranial features

Initially hind limbs smaller than forelimbs, no opposable thumb and tailed body - no bipeds with longer hind limbs, precision grip and no tail

② Developmental changes

1. larger brain capacity lead to complex brain.
2. Discovery of fire further developed complex thinking processes
3. Acquisition of tools from rudimentary to small sized crably tools, pottery
4. Development of medium of communication from gestures, sounds to language
5. Developed agriculture from initial hunter gatherers.

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③ Physiological and behavioural

1. development of religion, culture -
2. evolution of family, marriage and social institutions
3. Physiological changes for immunity from diseases and infection, better digestion
4. Segregation of vermiform appendix, no more digestion of grass, etc. as adapted to cooked food.

All these changes have collectively enhanced the adaptability and survival of humans as the most complex and civilized species on the planet. The evolutionary process is continuous even today, making us adaptable to human induced changes in the world itself.

4
(C)

Chance factors producing rapid changes in gene frequencies of a small isolated population, independent of mutation, recombination or natural selection refers to Genetic Drift.

Features

1. Also known as Small Wright effect - first explained by him.
2. Isolation to mating can be because of physical and geographical barriers.
3. When certain rapid changes in gene frequencies occur, the impact is enhanced in smaller populations.
4. Leads to loss of certain genes also in small population.

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Various Mechanisms of Drift

① Founder's effect: migration of a section of population leading to isolation.

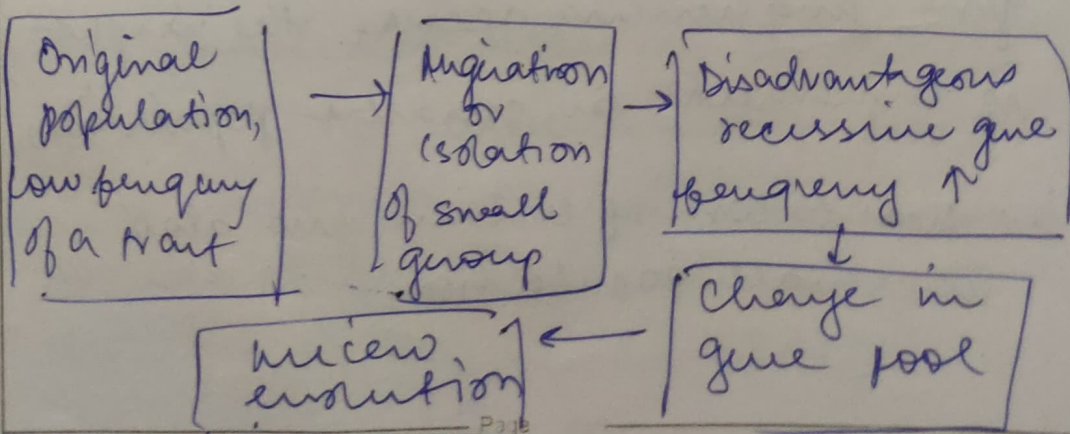
ex: Dutch Germans to Pennsylvania.
Increased incidence of B-finger dwarfism.

② Bottleneck effect: large population wiped out due to natural calamity, few remain with limited genetic pool.

ex: Spread of ITD genes in US

ex: Toba Catastrophic theory of humans - few 30,000 remained ~75,000 years ago.

Role of Genetic Drift in Evolution



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Consequence

1. Formation of different gene combination.
Evolutionary forces act on these to change gene frequency.
2. Success of disadvantageous genes otherwise expected in original population due to increased adaptability.

Supports gradualistic theory of human evolution. Forces of evolution combinedly contribute to micro evolution and subspeciation.

All factors not in human control and are mostly unintentional.