Evidences of evolution, nature of fossil and geological records as well as role of genetics, human ancestry and life forms

Definition of Evolution

A process of gradual change that occurs in living organisms over long periods/multiple generations, leading to the formation of new species. Such changes can occur in the physical characteristics, behavior, or genetic makeup of an organism due variations.
These changes enable species to adapt to dynamic environments by ensuring survival, reproduction over millions of year and these small modifications accumulate leading to emergence of new species.

- **Gradual change:** Evolution is a slow, continuous process that happens over many generations.
- **Origin of diversity:** It is the process through which the vast variety of present day plants and animals came into existence.
- **Role of variation:** Variations in the genetic material of organisms are crucial for evolution. These variations arise during reproduction through errors in DNA copying and sexual reproduction.
- **Natural selection:** Natural selection is a key mechanism where individuals with traits that are better suited to their environment are more likely to survive and reproduce, passing those advantageous traits to their offspring.
- **New species:** Over long periods, these accumulated changes can result in the formation of new species.

Importance of evolution

- Provides a foundational framework for understanding life's diversity, relationships, adaptations and practical applications in real-life situations including medicine, agriculture, and conservation etc.
- Explains history of life on earth, the interconnectedness of species through common ancestry, and mechanisms that drive biological change over time.

Importance in biology

a) **Unifies biology:** provides a single, unifying theory that connects all biological sciences, from molecular genetics to ecology.
b) **Explains diversity:** explains how incredible diversity of life arose from a common ancestor through a long process of adaptation and change.
c) **Reveals relationships:** provides understanding on how different species are related to each other through shared genetics and a common lineage.
d) **Provides understanding of adaptation:** explains how organisms develop traits that enable to them survive and reproduce in their specific environments in a concept known as adaptation.
e) Basis of modern biological sciences

f) **Basis of practical applications**

- **Medicine:** Enables creation of more effective antibiotics, enzymes, explains health effects of lifestyle changes over evolutionary history and tracks the origin of diseases.
- **Agriculture:** aids in developing new crops that are resistant to pests or diseases and understanding evolutionary relationships between crops and their wild relatives.

- **Conservation:** Evolutionary principles are essential for protecting endangered species by understanding how they adapt to changing environments and how to preserve their genetic diversity.
- **Biotechnology** for development of GMOs

Theories of Organic Evolution

(a) Lamarckian Theory of Evolution/Larmarckism (Inheritance of acquired characteristics).

- Jean Baptiste de Lamarck was one of the earliest scientists to propose a comprehensive theory of organic evolution.
- Naturally, living organisms develop new traits (i.e. increase in size or complexity of body structures) in response to environmental changes.
- Use and Disuse of Organs- Organs/structures that are frequently used become more developed while those that are not used weaken or disappear.
- That traits that are acquired during an organism's lifetime can be passed on to its offspring through inheritance.
- Weaknesses of Larmack's theory: Although inheritance of acquired traits is no longer accepted, his ideas paved the way for future studies on adaptation and the impact of environmental changes on living organisms**.**
- Strength ; environment plays a role in evolution

Examples

1. The long neck and forelimbs of giraffes: Lamarck proposed that giraffes, in their efforts to reach leaves high in the trees, adapted by stretching their necks. This acquired trait of elongated necks was then passed down to subsequent generations, resulting in giraffes gradually developing long necks over time.
2. Aquatic birds stretched their toes and developed webs.
3. Snakes lost their legs. Snakes evolved from lizard-like ancestors, which had two pairs of limbs. Continuous creeping through holes and crevices made the snake's body elongated, and the continuous disuse of limbs, which hinders them while creeping in burrows, resulted in the loss of their limbs

(b) Darwin's Theory of Evolution ("descent with modification.")

In his seminal work On the Origin of Species (1859), Darwin proposed that organisms evolve from simpler ancestral forms through natural selection.

Key aspects of Darwin's Theory

- Variation in Traits: Variations arise in individuals of a population by chance.
- Overproduction of offspring: Most species produce more offspring than those that can survive.
- Struggle for Existence: Due to limited resources, individuals compete for food, shelter, and mates etc.
- Survival of the Fittest: Individuals with favorable/better traits acquire a better chance of survival and reproduction.
- Inheritance of Useful Variations: Beneficial traits are passed over gradually to subsequent generations making them more common/frequent to form a new species.

- In addition, Darwin introduced sexual selection, where traits that help an organism to secure a mate (such as the elaborate plumage of peacocks) become more prevalent over time.

Weaknesses

- Darwin didn't know genetics, and had no satisfactory explanation for the cause, origin, and inheritance of variations.
- Could not identify sources of variation and mechanisms based on mutation
- Only explained survival of the fittest but was unable to explain source of the fittest.
- Unable to explain why only a few individuals develop useful variations in a population while others have harmful variations.
- Criticism of Darwinism was based on sexual selection. Why do only females have the right to be selected for mating?
- Unable to explain existence of vestigial organs.

(c) Modern Synthetic Theory (Neo-Darwinism)

- Neo-Darwinism is a modified form of Darwinism in combination with recent research by Weismann, De Vries, Stebbins, Dobzhansky, Sewall Wright, Mayr, etc.
- Thus, it is a combination of Darwin's ideas with modern genetics.
- Evolution is caused by changes in genetic makeup of populations. Such genetic variations (mutations) arise and are acted upon by natural selection thereby leading to differential reproduction, inheritance and adaptations.

Neo-Darwinism/Mechanism of Organic Evolution

- Formation of new species by Neo-Darwinian is attributed to the following factors namely
  (i) rapid multiplication,
  (ii) Limited food and space ,
  (iii) Struggle for existence
  (iv) Genetic variations
- Neo-Darwinism is explained by the following mechanisms.

(a) **Gene recombination**: New combinations of genes are caused by crossing over during gametogenesis. It is a continuous and common source of variation in a sexually reproducing population.

(b) **Mutation -** Discontinuous source of variations

(c) **Hybridization: I**nvolves crossing of genetically different organisms.

(d) **Gene Migration and Gene Flow**: Occurs when a portion of a population relocates to a different area and integrates with another population thereby altering gene frequencies in both original and new populations. The new population gains new genes/alleles as original population loses them. Repeated occurrence results in gene flow.

(e) Genetic drift: Change in gene frequency that occurs by chance. This is attributed to

- **Natural Selection: V**ariation results in changes in the frequency of genes and alleles in future generations. Repeated reproductive success may result in speciation.

- **Isolation:** Involves separation of populations through various barriers (physical, reproductive, behavioural and ecological e.t.c) that prevent successive interbreeding to form independent isolated populations.

(d) Mutation Theory

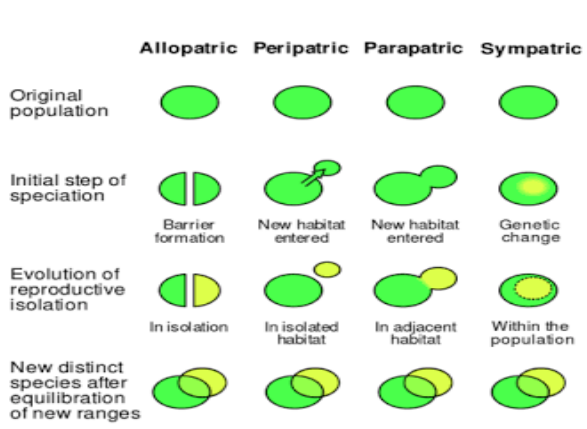
Mutations are primary source of new genetic variations that drive evolution.
Large, sudden changes (mutations) occur and accumulate in a population to form new traits on which natural selection operates and favours beneficial ones to form a new species.

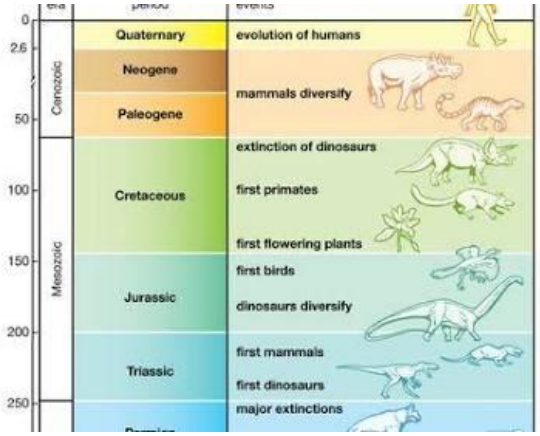
(e) Punctuated Equilibrium

Evolutionary change is not a steady, gradual process.
Instead species remain relatively stable for long periods (stasis) and evolve suddenly in response to environmental shifts.

Types of evolution based on patterns

Patterns of Evolution





(a) Divergent Evolution

Closely relate species/species with a common ancestral origin evolve to occupy different environments and evolve increasingly into two or more distinct species over time, each with different traits. Such populations occupy different environments or ecological niches where they are subjected to different selective pressures.
Results from homologous structures

Example

- Evolution of humans and apes from a common primate ancestor
- Galapogos finches/Darwin's birds on Galapogos Island were a single ancestral species but they evolved into many species with different types of beaks and feet over time to adapt to different modes of feeding/food sources.
- Australian placental mammals showcase this adaptive radiation by diversifying into various forms, each bearing a striking resemblance to a corresponding marsupial counterpart

(b) Convergent Evolution

Distantly related/species with different ancestral origin evolve similar traits to enable them exploit/survive in the same environment (occupy similar ecological ninche) where they are subjected similar environmental challenges or selective pressures.

Results from analogous structures

Examples of analogous structures

- The streamlined body shapes of dolphins (mammals) and sharks (fish) evolved for efficient swimming yet they not share a recent common ancestry.
- Wings of insects (arthropods), birds (Aves) and bats (Mammals) evolved for swimming
- Eye of the octopus and mammals
- Flippers of penguins and dolphins
- Sweet potato (root modification) and potato (stem modification)
- Sting of bee and scorpion

(c) Parallel Evolution

Similar traits in *related* species develop differently from a common ancestral origin but continue to exploit/survive in the same environment (occupy similar ecological ninche) where they are subjected to similar environmental challenges or selective pressures.

Example

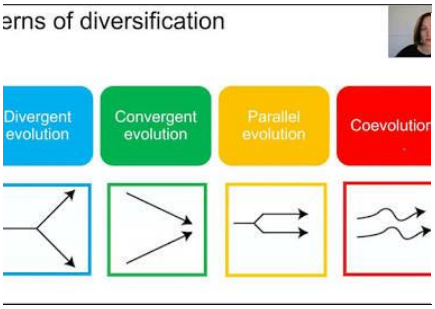
- Independent evolution of similar body types in different related species of marsupial and placental mammals.
- Predators and prey, where the predator evolves a new way to hunt while a prey responds by evolving a new defensive mechanism to enhance its survival.

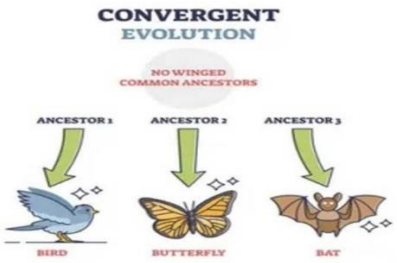
(d) Coevolution

Two or more species share a common ancestry and evolve similar traits independently in response to changes in each other.

Example

- "Arms race" in predator-prey relationships or a mutualistic relationship between pollinators and flowers implying that a change in one species acts as a selective pressure for the other.
- Different groups of mammals evolved ability to see in color after this was lost by their common ancestor.
- Progressive evolution; unicellular to multicellular
- Retrogressive evolution: vestigial structures
- Antibiotic resistance**:**





Mechanisms of Organic Evolution

These are fundamental processes that drive changes in genetic makeup of a population and they include natural selection, gene drift, mutation and gene flow.

(a) Natural Selection: It is a primary mechanism of adaptive evolution. Individuals with advantageous traits that are better suited to their environment are more likely to survive, reproduce and pass over such advantageous/superior traits to their offspring and subsequent generations.

(b) Genetic Drift: Random changes in allele frequencies within a population due to chance events. This has a more significant impact on smaller populations. In small populations, random events (due to chance) can lead to changes in gene/allele frequencies. Over time, such changes can significantly alter the genetic makeup of a population.

(c) Mutation: Random changes in genetic make-up/DNA sequence of an organism. Form original source of all genetic variations in a population by introducing new alleles into the gene pool.While most mutations are neutral or harmful, some can be beneficial and get selected over time to form a new species.

(d) Gene Flow: Transfer of genetic material from one population to another through migration and subsequent breeding. This can introduce new traits into a population and alter allele frequencies of both populations.

Individual Assignment: **Differentiate between hybridization and recombination:**

Speciation

A population becomes isolated (geographically or reproductively, behaviorally, ecologically) over a very long period/over several generations and evolves into a distinct species.

Scales of Evolution

(i) **Microevolution**

Small-scale evolutionary changes that occur within a species or population over a relatively short period, often involving changes in gene frequencies.

(ii) **Macroevolution**

Large-scale evolutionary changes observed over prolonged periods

Examples include emergence of new species (speciation), the evolution of new body plans (e.g., the origin of birds from reptiles), and mass extinctions

Evidence of Organic Evolution

They demonstrate that living organisms descended from common ancestors by changing over time. They include:

- **Paleontology/Fossils**,
- **Comparative anatomy and mophology** (homologous and analogous organs, vestigial organs),
- **Embryology** (similarities in early developmental stages,
- **Biogeography** (geographic distribution of species),
- **Biochemistry/genetics** (shared DNA and proteins).
- **Taxonomical Evidence**
- **Comparative physiology and biochemistry**

(1) Paleontology

- Study of fossils/ preserved remains or impressions of ancient organisms.
- Fossils occur in form of bones, shells, footprints, coprolites (fossilized feces) or whole/entire organisms preserved in ice.

Significance:

- Provide direct evidence of how life may have changed over geological time.
- Demonstrate systematic progression from simpler organisms in older rock layers to more complex ones in newer layers.

Examples of connecting links based on paleontology

- *Archaeopteryx* fossil shows both reptilian and avian features.
- Documented series of fossils showing evolutionary changes of modern horse over time.

Types of fossils

- **Unaltered Fossils:** remains preserved with minimal change, such as insects in amber or woolly mammoths in ice. Hard parts of animals such as bones, shells and teeth are preserved unaltered.
- **Altered/petrified fossils:** Fossilized materials are converted into stones because original protoplasmic substance of each cell is replaced by mineral particles in a process called petrifaction. Petrified fossils have similar external forms, internal structure and sometimes substances of original plants or animals in great detail. Whole organisms are rarely preserved
- **Natural moulds of plants and animals** (i.e. soft bodied animals, tree trunks, stumps, fruits and seeds). Formed in mud and sand which harden into slates or stones. Central portion of the material is not preserved at all but a cavity (mould) is formed due to disintegration of central tissues. Such tissues subsequently filled up with hard minerals and mud, thus forming an incrustation or cast of the original structure.
- **Compression and impression:** Found in sedimentary deposits.

External form of the materials is modified by vertical pressure of overlying sediments in which such material is embedded. In compression, original shape of the materials is changed making it flattened. If the plant part is cylindrical it would be changed to elliptical shape etc.

Geological time-table

A calendar of past history of the earth and which shows that:

- None of ancient organisms were exactly similar to those found today.
- All fossils did not appear at the same time but in different periods.
  - The older forms are relatively simpler and comparable
  - There has been a gradual progress from simpler to complex forms in time.
  - A new species that appeared at one period became predominant in subsequent period and finally disappeared.
  - Mammals among the animals and angiosperms in plants are the latest products of evolution.

Why fossil records/geological time-tables are not reliable evidences of evolution

(i) Incomplete preservation of organic parts. In the process of fossilization hard parts are preserved with little change but the softer parts are incompletely preserved.
(ii) Fragmentary nature of fossilized organic parts.
(iii) Well preserved organisms may be destroyed by physical agents like high pressure, strong heat, volcanoes etc.
(iii) Some organisms in imperfect stages of formation may not have been fossilized.

(2) **Comparative anatomy and morphology**

- Homologous Organs: Structures with similar ancestral origin, have a similar basic structural plan but perform different functions (e.g., the forelimbs of humans, bats, and whales) because they occupy different ecological niches thereby pointing towards divergent evolution.
- Analogous Organs: Structures with different ancestral origin and basic structural plan but they perform similar functions (e.g., wings of birds and insects) because they exploit similar ecological ninches. This shows convergent evolution.
- Vestigial organs: Reduced or non-functional structures that were functional in ancestral life forms (e.g., the human appendix, staminodes in flowers, specialization of stamens into nectaries in certain families of angiosperms.
  - Rudimentary leaflets in apricot (Rosaceae).
  - Reduction of leaflets into glands in apricot.
- Atavism: Reappearance of ancestral traits, like an extra set of ribs or a human with a tail or reduced/enlarged canine.

(3) Comparative Embryology

- Embryological Similarities- Early embryonic stages of different vertebrates have significant resemblances, indicating a common ancestral origin.
- Organisms display ancestral stages during embryonic development. This implies that embryos of advanced species pass through various stages represented by adult organisms of more primitive species
- For instance, Archaeopteryx exhibit both reptilian and avian traits yet both groups are distinct implying that they may have a closer ancestral relationship.
- Pea and bean are dissimilar in adult stage but have similar embryology.

- Monocots and dicots are quite different from each other, but they show similar pattern of embryo development in the beginning. It is believed that one of the two cotyledons of dicot embryo disappeared for ever, giving rise to monocot embryo. In this way, monocots might have solved from dicots.
- Embryos of all multicellular animals develop from single cell (zygote) and all pass through a common series of stages, such as blastula, gastrula, and so on. The closer the relationship of adult structures, the greater the similarity in the courses of embryo development.
- Thus, embryonic development or ontogeny is recapitulation of the ancestral history/phylogeny or in other words, **"ontogeny repeats/recapitulates phylogeny " i.e.** that each of the embryogenic stages corresponds to ancestral adult thereby providing direct evidence to the lines of descent
- Ontogeny is the development of individual while phylogeny is the development of the species or race.

(4) Biogeographical evidence

- Occurs when populations with same ancestral origin occupy areas with different environmental conditions and evolve independently to form different species.
  This demonstrates that organisms are not equally distributed in all parts of the earth. Some are widely distributed on the earth but other species (endemic forms) tend to be restricted to their specific ranges.

  Places with similar climatic conditions in different regions of the world do not always possess the same type of flora and fauna because of evolution. This is because geographical barriers like oceans, rivers, mountains, etc. isolating groups of animals and plants give rise to divergent forms.
  Examples
  - Elephants occur in Africa and India but not in Brazil.
  - Climatic conditions of desert region in south-western United States and western Africa are similar but support different animal and plant species
  - Both South America and African regions are mostly tropical and crossed by equator, have similar habitats yet they support relatively different fauna and flora.
  - In conclusion, existing plant and animal species are descendants of the extinct forms which were more generalized before being exposed and adapted to new environmental conditions.

(5) Biochemical and genetic evidence

- **Molecular similarities:** All living organisms share the same genetic code, have similar amino acids, and basic processes like gene expression (transcription and translation). This illustrates they have a similar ancestral origin.
- **DNA and protein analysis:** Comparison of DNA and protein sequences of different species can reveal their ancestral relatedness.
  Assignment: Read and make notes on genetics and cytology

(6) Taxonomical Evidence

Description, naming, classification and phylogeny of plant and animals supports organic evolution on the following bases.

(i) Existence of border line or intermediate and transitional taxonomic groups, among taxa.

(ii) Different individuals belonging to particular phyla have common ancestry but possess common fundamental characters.

(iii) More complex plants and animals may be traced back to simple beginnings.

(7) Comparative Physiology and Biochemistry

Basic physiological and biochemical differences and similarities in individuals of particular plant or animal groups can also be used to explain ancestral relationships.

(i) The Protoplasm:

The basic substance of living body contains nearly the same elements compounded from similar proportions of proteins, carbohydrates, fats, water am other substances. Chromosomes consist of basic proteins called nucleic acids which are relatively similar in all organisms.

(ii) Enzymes and Hormones:

Similar groups of plants or animals have similar enzymes hormones. For instance (i) some digestive enzymes of animals and (ii), all green plants belonging to diverse groups have similar photosynthetic enzymes implying that they have a common ancestry.

(iii) Metabolites:

The presence of characteristic chemical substances, such as (i) aromatic volatile oil in plant family Rutaceae and Labiatae as well as (ii) resins in coniferous plants suggests close relatedness.

Excretory product analysis:

- Analysis of the urinary wastes of animals provides evolutionary relationship.
- Nitrogenous wastes (in the form of uric acid, allantoin, urea and ammonia) excreted by man and other animals. Formation of such wastes depend on activity of certain enzymes selected in the course of evolution.
- For instance, there is a successive loss of enzymes in evolution of vertebrates like in mammals where uric acid is not degraded unlike in birds.
- In the early stages of chick embryo development, ammonia is the first one to be excreted, then urea and finally uric acid. Thus, enzyme uricase is present in early stages of chick embryo to catalyse degradation of uric acid but disappears later.

(iv) Hematological Characters: Closely related genera of vertebrates have similar crystals obtained from Hemoglobin than those that are distantly related

(v) Comparative Serology: Based on serum precipitation tests of **"antigen-antibody reactions". For** example, serum precipitation tests of mammals show a closer chemical relationship between man and ape than between man and dog. Sera of mammals are more closely related when compared to those of other vertebrates.

(vi) Blood Groups: The blood of human is classified into four groups 'A', 'B', 'AB' and 'O' based on antigen-antibody reaction. Bloods of horse and ass have similar properties suggesting a closer ancestral relationship between them.

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The Role of Genetics

- **Blueprint for Life**
  Genes are made of DNA segments that determine formation of specific amino acids/proteins used to regulate physiological activities in an organism. The sequence of nitrogenous bases in the DNA are used to determine structural and functional activities of an organism.
- **Heredity and Variation**
  Genetics explains why offsprings resemble their parents and why there is variation among individuals thereby providing raw materials for natural selection and evolution. This is caused by mutations and shuffling of genes during sexual reproduction.
- **Health and Disease**
  Nearly every human trait and disease has a genetic component. Therefore, understanding genetic makeup of an individual can help in predicting risks of certain conditions thereby enabling personalized medicine, early diagnosis, and targeted treatments or preventative lifestyle choices.
- **Interaction with Environment**
  Gene expression and its effect on traits (phenotype) is influenced by interactions with the environment and behavior (e.g., diet, sun exposure, exercise
- **Forensics and Identity**: DNA analysis is used to identify paternity and testing because each individual has unique genetic markers.

Explain Applications of Genetics in the Following Areas

(a) Medicine.

- Diagnosis of genetic diseases.
- Personalization of medical treatments.
- Gene therapies
- Vaccine development.
- Risk prediction.

(b) Agriculture through plant and animal breeding to produce desirable characteristics that contribute to improved food security and sustainable environment.

(c) Forensic Science

(d) Biotechnology

(e) Evolution studies

(f) Conservation biology

(g) Disputed parentage

(h) Improvement of industrial microorganisms

Role of Genetics in Human Ancestry

Genetics provides powerful tools of tracing evolutionary history and relationships among species. For instance:

a) **Common Ancestry of all Life**: All organisms on earth are have a common origin, similar genetic materials (DNA) and basic genetic code

b) **Relatedness to other Species**: scientists can determine the degree of relatedness between organisms by comparing their genomes. Humans share a high percentage of genetic similarity with higher apes thereby confirming a shared common ancestry that occurred between 6 and 8 million years ago.

c) **Tracing Human Migration**: Genetic data, particularly from mitochondrial DNA (inherited maternally) and Y-chromosome (inherited paternally) can be used to map out ancient human migration routes out of Africa and understand historical connections between different populations.
d) **Rethinking Race**: Approximately 85% of human genetic variation exists *within* populations, while15% exists *between* populations..
e) **Neanderthal DNA**: Analysis of ancient DNA has revealed that modern humans outside of Africa carry traces of approximately 1-4% Neanderthal DNA in their genomes. This is likely to have been obtained from interbreeding between *Homo sapiens* and Neanderthals in Eurasia that occurred thousands of years ago.

Implications of Evolutionary Theory on the Concept of Human Nature, Morality, and Ethics

- Evolutionary theory affects human nature, morality, and ethics by providing a scientific explanation for the origin of human social behaviors and capacity for moral judgment of man.
- Certain *capacities* of morality result from evolution while specific *moral codes* are derived from human culture.

(a) Evolutionary Theory and Human Nature

Refers to general psychological characteristics, feelings, and behavioral traits shared a humankind (i.e. human race).
Evolutionary theory considers human nature as

a. Being a product of natural selection
b. Explanatory source of shared traits like language, morality (empathy, reciprocity), and mating behaviors (gift-giving, mate selection).

c. It provides:

- Adaptations for survival and reproduction,
- An account for cultural variations as they have also evolved in responses to diverse environments and cultural influences thereby illustrating that humans are universally similar and uniquely diverse.

Areas of Human Nature Explained by Evolution

- Social Behavior as foundations for morality, present in primates and humans.
- Mating & Family: Mate preferences, pair bonding, and resource display (gift-giving) are evolutionarily rooted in securing reproductive success.
- Physical Traits: Bipedalism is efficient but it also creates new health problems (back pain, childbirth issues) because of recent evolutionary changes.
- Psychology: Understanding of evolutionary pressures helps explain personality complexity, risk-taking, and even public health challenges like antibiotic resistance.
- Cooperation and Sociality: Humans evolved in small and interdependent groups where cooperation, empathy, and social cohesion were crucial for survival. Traits like loyalty, a sense of fairness, and a capacity for trust became embedded in human psychology because groups with such traits outcompeted others.

- Altruism (behavior that benefits others at a personal cost) including kin selection (favoring relatives to pass on shared genes) and reciprocal altruism (helping others with the expectation of future return). These mechanisms explain why prosocial behaviors are widespread in human societies.
- Conflict and Fear: Alongside cooperation, evolutionary theory also helps explain darker aspects of human nature, such as in-group favoritism, fear of strangers, and aggression, as historical adaptations to competition for resources or threats from rival groups.

Core Implications of Evolutionary Theory on Human Nature

I. **Humans are not separate from nature:** Human beings belong to kingdom Animal where share basic characteristics with other animals thereby illustrating a common ancestry.
II. **Behaviour** is shaped by both genes and environment
III. **Universal Traits:** Evolution explains similarities like language, complex emotions (fear, jealousy), cooperation, long-term bonding, and morality as adaptations that promote group survival and reproduction in ancestral environments.
IV. **Adaptation & Variation:** Different environments created selective pressures, leading to genetic and cultural adaptations (e.g., skin color, bipedalism, and diverse customs) that explain human diversity within a shared evolutionary framework.
V. **Biology Meets Culture:** Human nature also involves interactions between innate predispositions and cultural learning.
VI. **Explanation of Daily Behaviors:** Evolutionary psychology links modern activities to ancient survival strategies thereby revealing underlying biological drivers.
VII. **Human nature is adaptable and flexible/dynamics:** human nature is a flexible set of capacities shaped by evolutionary history thereby allowing significant behavioral changes, adaptations and cultural innovation.
VIII. **Inequality is not biologically justified and that human nature is a product of natural processes rather than intentional design.**

Conclusion

- Evolution provides a scientific framework for understand our current status, and linkages with biology, psychology, and anthropology which explains both shared human essence and vast cultural differences

(b) Evolutionary Theory versus Morality and Ethics

Evolution of morality refers to emergence of human moral behavior over time.
Morality can be defined as a system of ideas about right and wrong conduct. Morality is typically associated with human behavior rather than animal behavior.

Thus, evolutionary theory provides a powerful framework for understanding the origins of our moral psychology and social instincts. However, it allows our ethical systems to be determined by human reason and cultural development.

Contributions of Evolutionary Theory to Morality and Ethics

- **Descriptive ethics:** explains *why* we have moral beliefs instead of **normative ethics** which are expected to describe *what* we *ought* to do.
- **The Moral Sense:** capacity for moral judgment is the ability to assess actions as right or wrong. On the other hand emotional feelings like guilt or resentment evolved from advanced intelligence and social living to regulate behavior within groups.
- **Cultural Influence:** Whereas morality is an evolved trait, specific *content* of moral and ethical rules (moral codes) is largely derived from cultural evolution which accounts for a wide diversity of moral norms across different societies and time periods.
- **The "Naturalistic Fallacy" or "is-ought" Problem:** According to this philosophical fallacy, moral "oughts" (prescriptions) cannot be derived logically from scientific perspective "is" (descriptions of nature). Just because a behavior (e.g., aggression) evolved naturally does not mean it is morally right. Thus, Darwin's theory of natural selection of the strong dominating over the weak is widely rejected by modern ethicists on these grounds.
- **Metaethics:** that objective moral facts are not independent of human experience. However, some philosophers believe that:
  - Our moral judgments are "illusions" generated by our genes to encourage fitness-enhancing behaviors and that, they not reliable tools of discovering objective moral truths.
  - Human reasoning can go beyond evolved instincts to develop universal ethical principles.

Individual Assignment: Construct a model of origin of life (1-page)