EVOLUTION

Evolution

- **Evolution is the successive generation of different species over the years under the influence of changing environment.**
- **Successive populations inherit the characterisics and pass on the traits to the newer generations over the years.**
- **In fact the genes are passed on through the reproduction.**
- **Environmental changes may bring about changes in genes i.e., genetic mutation.**

Natural Selection

- **Natural selection is the ability of the organism or species to survive and reproduce under the given environment or circumstances.**
- **Survival of the fittest.**
- **The organisms which were stronger, intelligent and smarter or more intelligent did not survive, but those which adapted or changed according to the environment mostly survived**

Those organisms survived which moulded themselves according to the change.

Three types of Ribonucleic acid (RNA)

- **The three major types of RNA are:**

- **mRNA (messenger RNA): it has the template (bases) for protein synthesis during translation**
- **tRNA (transfer RNA): it brings amino acids and reads the genetic code during translation**
- **rRNA (ribosomal RNA): it plays a structural and catalytic role during translation**

- **DNA is composed of four building blocks called nucleotides i.e., ribose sugars attached to N- and Phosphate bases :**
- **adenine (A),**
- **Thymine (T),**
- **Guanine (G), and**
- **Cytosine (C).**
- **And Uracil in some RNAs.**

Genetic Codons

- Each gene's code uses the four nucleotide bases of DNA: adenine (A), cytosine (C), guanine (G) and thymine (T) — in various ways to spell out three-letter “codons” that specify which amino acid is needed at each position within a protein.
- In humans, each cell normally contains 23 pairs of chromosomes, for a total of 46. Twenty-two of these pairs, called autosomes, look the same in both males and females. The 23rd pair, the sex chromosomes, differ between males and females.

- **Evolution happens when evolutionary processes such as natural selection (including sexual selection) and genetic drift (genetic variation) takes place resulting in certain characteristics becoming more common or more rare within a population or disappear.**
- **Evolutionary processes change resulting in changes in the different traits or characteristics in the population including heritable changes in the successive generations.**

Genes and Heredity

- Typically, people have two copies of each gene, one inherited from each parent. Most genes are the same in all people, but a small number of genes (less than 1 percent of the total) are slightly different between people. Forms of the same gene with small differences in their sequence of DNA bases are called alleles.

What environmental factors affect heredity?

- **Factors in your environment can range from chemicals in air or water pollution, mold, pesticides, diet choices, or grooming products. Subtle differences in one person's genes can cause them to respond differently to the same environmental exposure as another person.**

- **This process of evolution has led to biodiversity at every level of biological organisation, including the levels of species, individual organisms, and molecules.**
- **Hilly areas – Height of people**
- **Cold Countries – Skin**
- **Hot Countries -**
- **India – Average Temperature around 27 Deg. C.**

- **Evolution by natural selection has been proved by observing facts about living organisms:**
- **(1) More offsprings are often produced than can possibly survive , e.g., seeds.**
- **(2) Traits vary among individuals with respect to their morphology, physiology, and behaviour (phenotypic variation).**
- **(3) Different traits confer different rates of survival and reproduction (differential fitness); and**
- **(4) Traits can be passed from generation to generation (heritability of fitness).**

- In successive generations, members of a population are therefore more likely to be replaced by the offspring of parents with favourable characteristics.
- All life on Earth shares a last universal common ancestor (LUCA) which lived approximately 3.5–3.8 billion years ago.
- The fossil record includes a progression from early biogenic graphite to microbial mat fossils to fossilised multicellular organisms.

Human Genome Sequencing

- **What is human genome sequencing used for?**

- **Researchers finished sequencing the roughly 3 billion bases (or "letters") of DNA that make up a human genome. Having a complete, gap-free sequence of our DNA is critical for understanding human genomic variation and the genetic contributions to certain diseases – Great contribution from the Information Technology.**

Effect of environment on evolution

- Changing environmental conditions influence which organisms survive and reproduce, which, in turn, can lead to evolutionary changes in populations. Descent with modification.
- Evolutionary change may change both the abiotic and biotic components of the environment.

Environment and Evolution

- **There are many ideas about the role of the environment in human evolution. Some views assume that certain adaptations, such as upright walking or tool-making, were associated with drier habitat and the spread of grasslands, an idea often known as the savanna hypothesis.**
- **savanna, vegetation type that grows under hot, seasonally dry climatic conditions and is characterized by an open tree canopy (i.e., scattered trees) above a continuous tall grass understory.**

Savanna (the vegetation layer between the forest canopy and the ground).

- Existing biodiversity levels have been brought about by repeated generations of new species (speciation), changes within species (anagenesis), and loss of species (extinction) throughout the evolutionary history of life on Earth.
- Morphological and biochemical traits are more similar among species that share a more recent common ancestor, and these traits can be used to reconstruct phylogenetic trees.

- **Evolutionary scientists have been studying the science of evolution by forming and testing hypotheses as well as propounding theories based on evidence from the field or laboratory and on data generated by the methods of mathematical and theoretical/ computational biology.**
- **Their discoveries have led to the development of biology but numerous other scientific and industrial fields, including agriculture, medicine, and computer science.**

- **The Time Theory of the Universe: Formula of Everything - Time-speed is faster than the speed of light – October 21, 2021 By Olusegun Sotade (Author).**
- **Time, a determinant of weather-invoking occurrence.**
- **Time, a determinant of weather- invoking occurrence as heat or cold for transformation of matter into solid, liquid or gas.**

Heredity

- Evolution in organisms occurs through changes in heritable traits—the inherited characteristics of an organism. In humans, for example, eye or hair colour is an inherited characteristic and an individual might inherit the brown-eye or blue eye trait from one of their parents.
- Inherited traits are controlled by genes and the complete set of genes within an organism's genome (genetic material) is called its genotype.

- **Heritable traits are passed from one generation to the next via DNA, a molecule that encodes genetic information.**
- **Developmental biologists suggest that complex interactions in genetic networks and communication among cells can lead to heritable variations that may underlay some of the mechanics in developmental plasticity (adaptability) and canalisation (constant forms) under different environmental challenges. Heritability may also occur at even larger scales.**
- **Systems Biotechnology – Interactomics, Genomics, Metabolomics, Reverse Genomics, Transcriptomics, Proteomics etc.**
- **Computational mathematical modeling of biological systems.**

Genes and Heredity

- Suggested readings ;

- https://www.ncbi.nlm.nih.gov/books/NBK9944/#:~:text=All%20organisms%20inherit%20the%20genetic,cell%20at%20each%20cell%20division

- https://kidshealth.org/en/teens/genes-genetic-disorders.html

Inheritance not mainly through genes but through practice or niche

- For example, ecological inheritance through the process of niche construction is defined by the regular and repeated activities of organisms in their environment. This generates a legacy of effects that modify and feed back into the selection regime of subsequent generations i.e., effects exist long after the species has ceased to exist even. Example : effect of agriculture on soil structure.
- Descendants inherit genes plus environmental characteristics generated by the ecological actions of ancestors.

Heritability in evolution that are not under the direct control of genes

- **Continued …….Other examples of heritability in evolution that are not under the direct control of genes include the inheritance of cultural traits and symbiogenesis.**
- **Company of a man and his surrounding cultural conditions or atmosphere.**
- **Symbiogenesis - Evolving of the traits by living together – Interactive adaption.**

What is the environmental evolution theory?

- **Ecological-evolutionary theory (EET) is a sociological theory of sociocultural evolution that attempts to explain the origin and changes of society and culture.**
- **Key elements focus on the importance of natural environment and technological change.**
  Eras in Human History | Overview, Timeline & Significance
- **Stone Age: 3.3 million to 5,000 years ago · Bronze Age: 5,000 to 1,400 years ago (1,200 BC) · Iron Age: 1,200 BC to 500 BC · Classical Era: 500 BC to 500 AD ..**

Which is the oldest civilization in the world?

- Ancient Sumerians of Mesopotamia
- The ancient Sumerians of Mesopotamia (now modern Iraq) were the oldest civilization in the world, beginning about 4000 BCE (Before the Common Era).
- Are Indus valley people Aryans?
- It is perfectly possible that indus valley people may have been displaced or went extinct due to aryan migration, but it has never been proven to be the case, we similarly cannot prove that indus valley civilization people were aryan people.

Was the Indus Valley before Mesopotamia?

- **Indus era 8,000 years old, not 5,500; ended because of weaker monsoon?**
- **Scientists from IIT-Kharagpur and Archaeological Survey of India (ASI) have uncovered evidence that the Indus Valley Civilization is at least 8,000 years old, and not 5,500 years old, taking root well before the Egyptian (7000 BC to 3000 BC) and Mesopotamian (6500 BC to 3100 BC) civilizations.**
- **How civilizations perished ?**
- **DNA of old civilization people – very old skeletons -– complex studies -**

- **Archaeological evidence gives researchers some sense of the daily lives of the Harappan people, but scientists have struggled to piece together evidence from ancient DNA in the Indus Valley Civilization due to the deterioration of genetic material in the hot and humid region—until now.**
  Some progress has been made though.

What is the DNA of the Indus Valley Civilization?

- **The DNA belongs to a woman who was buried four to five millennia ago in Rakhigarhi, now part of Haryana in India. Her genes point to an ancestry of ancient Iranians and Southeast Asian hunter-gatherers.**
- **What is the DNA of ancient Indians?**
- **Most Indians are primarily a mixture of three ancestral populations: hunter-gatherers who lived on the land for tens of thousands of years, farmers with Iranian ancestry who arrived sometime between 4700 and 3000 B.C.E., and herders from the central Eurasian steppe region who swept into the region sometime after 3000 BCE. Thus, the Indus Valley people cannot be classified into a single racial or ethnic group, reflecting the region's long history of migrations and interactions.**

What type of genetics are Indian?

- **Most Indian groups descend from a mixture of two genetically divergent populations: Ancestral North Indians (ANI) related to Central Asians, Middle Easterners, Caucasians (White) and Europeans;**
- **and Ancestral South Indians (ASI) not closely be related to groups outside the subcontinent.**
- **Aryans and Dravidians ?**

Assignent just for reading only & No submission

- Older civilization of India
- Discovery of their evolution after 1858.
- Language
- Weapons and tools
- Animals
- Food
- Rituals
- Height
- Skeletons etc. etc.
- Dancing woman and a Man sculptors
- How was it destroyed?
- What are the differences between Rig Vedic and Indus Valley Civilization?
- Socrates -“Education is the kindling of a flame, not the filling of a vessel.”

What are the factors affecting evolution?

- **Mechanisms of evolution correspond to violations of different Hardy-Weinberg assumptions.**
- **They are: mutation, non-random mating, gene flow, finite population size (genetic drift), and natural selection.**

What is the environmental evolution theory?

- **Ecological-evolutionary theory (EET) is a sociological theory of sociocultural evolution that attempts to explain the origin and changes of society and culture.**
- **Key elements focus on the importance of natural environment and technological change.**
- **Necessity is the mother of invention.**
- **Survival, Sustainability , Existence, Securiy,**
- **Development and Comfortable living and fighting the environmental and other challenges, forging ahead, learning to tackle the threats to ;living etc. etc.**

Variation

- **Evolution can occur if there is genetic variation within a population. Variation comes from mutations in the genome, reshuffling of genes through sexual reproduction and migration between populations (gene flow). Despite the constant introduction of new variation through mutation and gene flow, most of the genome of a species is identical in all individuals of that species.**

- **However, even relatively small differences in genotype can lead to dramatic differences in phenotype: for example, chimpanzees and humans differ in only about 5% of their genomes.**
- **An individual organism's phenotype results from both its genotype and the influence of the environment it has lived in. A substantial part of the phenotypic variation in a population is caused by genotypic variation.**

- **The modern evolutionary synthesis defines evolution as the change over time in this genetic variation.**
- **Variation disappears when a new allele reaches the point of fixation—when it either disappears from the population or replaces the ancestral allele entirely.**

Genetic mutations

- **Genetic mutations are changes to your DNA sequence that happen during cell division when your cells make copies of themselves. Your DNA tells your body how to form and function. Genetic mutations could lead to genetic conditions like cancer, or they could help humans better adapt to their environment over time.**

Mutation

- **Mutations are changes in the DNA sequence of a cell's genome and are the ultimate source of genetic variation in all organisms.**
- **When mutations occur, they may alter the product of a gene, or prevent the gene from functioning, or have no effect.**
- **New genes can be generated from an ancestral gene when a duplicate copy mutates and acquires a new function. This process is easier once a gene has been duplicated because it increases the redundancy of the system; one gene in the pair can acquire a new function while the other copy continues to perform its original function**

- Other types of mutations can even generate entirely new genes from previously noncoding DNA, a phenomenon termed de novo gene birth.
- One example of mutation is wild boar piglets. They are camouflage colored and show a characteristic pattern of dark and light longitudinal stripes. However, mutations in melanocortin 1 receptor (MC1R) disrupt the pattern. The majority of pig breeds carry MC1R mutations disrupting wild-type color and different mutations causing dominant black color of the pigs.

Video on genetic mutations

- https://www.britannica.com/video/change-video-DNA-nucleotide-sequence-amino-acid/-209383

Sex and recombination

- The offspring of sexual organisms contain random mixtures of their parents' chromosomes that are produced through independent assortment. In a related process called homologous recombination, sexual organisms exchange DNA between two matching chromosomes.
- Recombination and reassortment do not alter allele frequencies, but instead change which alleles are associated with each other, producing offspring with new combinations of alleles. Sex usually increases genetic variation and may increase the rate of evolution.

Mutagens

- Anything that causes a mutation (a change in the DNA of a cell). DNA changes caused by mutagens may harm cells and cause certain diseases, such as cancer. Examples of mutagens include radioactive substances, x-rays, ultraviolet radiation, and certain chemicals.
- Examples of chemical mutagens that are base analogs include 5-Bromouracil and 2-Aminopurine, ethyl methanesulfonate or N-ethyl-N-nitrosourea wetc.

Gene flow

- **Gene flow is the exchange of genes between populations and between species. It can therefore be a source of variation that is new to a population or to a species. Gene flow can be caused by the movement of individuals between separate populations/ countries / regions of organisms, as might be caused by the movement of mice between inland and coastal populations, or the movement of pollen between heavy-metal-tolerant and heavy-metal-sensitive populations of grasses.**

- **Gene transfer between species includes the formation of hybrid organisms and horizontal gene transfer. Horizontal gene transfer is the transfer of genetic material from one organism to another organism that is not its offspring; this is most common among bacteria. In medicine, this contributes to the spread of antibiotic resistance, as when one bacteria acquires resistance genes it can rapidly transfer them to other species**

- **Horizontal transfer of genes from bacteria to eukaryotes such as the yeast *Saccharomyces cerevisiae* and the adzuki bean weevil (Bhaneara in Hindi) *Callosobruchus chinensis* has occurred. An example of larger-scale transfers are the eukaryotic *bdelloid rotifers (Microscopic Omnivers – Wheel animals)* , which have received a range of genes from bacteria, fungi and plants. Viruses can also carry DNA between organisms, allowing transfer of genes even across biological domains.**

What is an example of horizontal gene transfer?

- Horizontal gene transfer (HGT) occurs in various ways in multi-cellular organisms. For example, in plants, HGT can operate via natural factors, such as host-parasite connection. The parasite acts as a vector transferring mitochondrial genes among two diverse plant species.
- Horizontal gene transfer also plays a role in the spread of virulence factors, such as exotoxins and exoenzymes, amongst bacteria. A prime example concerning the spread of exotoxins is the adaptive evolution of Shiga toxins in E. coli through horizontal gene transfer via transduction with Shigella species of bacteria.

How are viruses used in gene transfer?

- For gene therapy to work, scientists need ways to deliver genes into specific cells. Vectors use the shell of the virus, called the capsid, to deliver a healthy copy of a gene into a cell. But merely delivering a gene into a cell doesn't make it function properly; the gene needs to survive in the cell and be turned on.
- Transduction is the process by which a virus transfers genetic material from one bacterium to another. Viruses called bacteriophages are able to infect bacterial cells and use them as hosts to make more viruses.

Change of sex in fish

- **Researchers have identified more than 500 fish species that regularly change sex as adults. Clown fish begin life as males, then change into females, and kobudai do the opposite. Some species, including gobies, can change sex back and forth. The transformation may be triggered by age, size, or social status.**

Evolutionary processes

- From a neo-Darwinian perspective, evolution occurs when there are changes in the frequencies of alleles within a population of interbreeding organisms.
- For example, the allele for black colour in a population of moths becoming more common. Mechanisms that can lead to changes in allele frequencies include natural selection, genetic drift, gene flow and mutation bias.

Natural selection

- Evolution by natural selection is the process by which traits that enhance survival and reproduction become more common in successive generations of a population. It embodies three or four principles.
- There are four principles at work in evolution—variation, inheritance, selection and time. These are considered the components of the evolutionary mechanism of natural selection.
- Variation exists within populations of organisms with respect to morphology, physiology and behaviour (phenotypic variation).

- **Different traits confer different rates of survival and reproduction (differential fitness).**
- **These traits can be passed from generation to generation (heritability of fitness).**
- **More offsprings are produced than can possibly survive, and these conditions produce competition between organisms for survival and reproduction. Consequently, organisms with traits that give them an advantage over their competitors are more likely to pass on their traits to the next generation than those with traits that do not confer an advantage.**

- However, fitness is not the same as the total number of offspring: instead fitness is indicated by the proportion of subsequent generations that carry an organism's genes
- For example, if an organism could survive well and reproduce rapidly, but its offspring were all too small and weak to survive, this organism would make little genetic contribution to future generations and would thus have low fitness.

- However, even if the direction of selection does reverse in this way, traits that were lost in the past may not re-evolve in an identical form (see Dollo's law).
- However, a re-activation of dormant genes, as long as they have not been eliminated from the genome and were only suppressed perhaps for hundreds of generations, can lead to the re-occurrence of traits thought to be lost like hindlegs in dolphins, teeth in chickens, wings in wingless stick insects, tails and additional nipples in humans etc. "Throwbacks" such as these are known as atavisms.

- **Natural selection most generally makes nature the measure against which individuals and individual traits, are more or less likely to survive. "Nature" in this sense refers to an ecosystem, that is, a system in which organisms interact with every other element, physical as well as biological, in their local environment.**
- **Wildlife may seek out agreeable habitats. This means that invasive species suited to changes in extreme climate may get a foothold in an ecosystem where at-risk native species are unable to hold their place.**
- **Ants growing wings during rainy season?**
- **Mosquito biting human?**

Adapting to a Changing Climate

- **The following Animals Are Already Adapting to a Changing Climate**
- **Sierra squirrels are sticking to favored environments.**
- **California's sea lions have switched up their diet.**
- **Sticklebacks have changed their looks.**
- **West Coast birds have changed their nesting times.**
- **Will these adaptations be enough?**

Genetic Hitchhiking

- **Natural selection can drive a selective sweep that will also cause the other alleles in the haplotype to become more common in the population; this effect is called genetic hitchhiking or genetic drift.**
- **Haplotypes - Variant genes present together in a single chromosome.**

Video on Genetic hitch - hiking

- https://www.youtube.com/watch?v=DTOxueVjtrs

Sexual selection

- **A special case of natural selection is sexual selection, which is selection for any trait that increases mating success by increasing the attractiveness of an organism to potential mates.**
- **Traits that evolved through sexual selection are particularly prominent among males of several animal species.**

- **Although sexually favoured, traits such as cumbersome antlers, mating calls, large body size and bright colours often attract predation. This may result in higher reproductive success in males that show these hard-to-fake, sexually selected traits.**

Genetic drift- Genetic shift or RANDOM CHANGE

- **Genetic drift is the random fluctuation of allele frequencies within a population from one generation to the next. Depending upon whether selective forces are strong, absent or relatively weak, allele frequencies are equally likely to drift upward or downward.**
- **Genetic drift may therefore eliminate some alleles from a population due to even a chance alone and even when the selective forces are absent – evolution of new species even.**

Start of a new or smaller/ isolated/ new population from a larger population

Genetic drift can cause two separate populations that begin with the same genetic structure to drift apart into two divergent populations with different sets of alleles.

Gene flow

- **Gene flow involves the exchange of genes between populations and between species. The presence or absence of gene flow fundamentally changes the course of evolution.**
- **When the difference between populations develops, gene flow between populations can introduce traits or alleles which are different in the local population and this may lead to organisms within these populations evolving genetically distant populations, eventually resulting in the appearance of new species.**

Applications

- **Concepts and models used in evolutionary biology, such as natural selection, have many applications.**

- **Artificial selection is the intentional selection of traits in a population of organisms. This has been used for thousands of years in the domestication of plants and animals.**

- **More recently, such selection has become a vital part of genetic engineering, Developing proteins with valuable properties have evolved by repeated rounds of mutation and selection (for example modified enzymes and new antibodies, prevention) in a process called directed evolution.**
- **Our research on biodesulfurisation and biodegradation – Environmental Biotechnology.**

Optical genes

- Understanding the changes that have occurred during an organism's evolution can reveal the genes needed to construct parts of the body, genes which may be involved in human genetic disorders.
- For example, the Mexican tetra is an albino cavefish that lost its eyesight during evolution. Breeding together different populations of this blind fish produced some offspring with functional eyes, since different mutations had occurred in the isolated populations that had evolved in different caves. This helped identify genes required for vision and pigmentation.

- **Evolutionary theory has many applications in medicine. Many human diseases are not static phenomena, but capable of evolution. Viruses, bacteria, fungi and cancers evolve to be or become resistant to host immune defences, as well as to pharmaceutical drugs. These same problems occur in agriculture with pesticide and herbicide resistance.**
- **One potential resistance-breaking compound is darobactin, a naturally occurring antibiotic first discovered in a bacterium by researchers in the US in 2019.**
- **The autonomous luminescence in a multicellular eukaryotic organism by incorporating a discovered bioluminescent fungal system into tobacco plants has been demonstrated.**

- **It is possible that we are facing the end of the effective life of most of available antibiotics and predicting the evolution and evolvability of our pathogens and devising strategies to slow or circumvent it is requiring deeper knowledge of the complex forces driving evolution at the molecular level- understanding the biochemical mechanisms including pumping systems or genetics.**
- **Quorum sensing / quorum quenching research**
- **Natural Products – Flavonoids, Curcumin, Nanoniotechnology etc.**

- In computer science, simulations of evolution using evolutionary algorithms and artificial life started in the 1960s and were extended with simulation of artificial selection. Artificial evolution became a widely recognised optimisation method as a result of the work of Ingo Rechenberg in the 1960s. He used evolution strategies to solve complex engineering problems. Genetic algorithms in particular became popular through the writing of John Henry Holland.

What is evolutionary computation/evolutionary AI?

- **Evolutionary computation (EC) is inspired by natural evolution. In contrast to most techniques in engineering and design, where humans come up with the best solution possible, debug it and deploy it, evolutionary AI provides a way of coming up with new, creative solutions automatically—often solutions that are too complex or unusual for humans to discover.**

What is the evolution function in AI?

- **Human-AI interactions may mimic ecological relationships, influencing evolution. Evolutionary shifts could include changes in brain size, attention spans, and personality. The study emphasizes cultural impacts may outweigh genetic effects in the near term.**
- **An evolutionary algorithm is an evolutionary AI-based computer application that solves problems by employing processes that mimic the behaviors of living things. As such, it uses mechanisms that are typically associated with biological evolution, such as reproduction, mutation and recombination.**

- Simulations of evolution using evolutionary algorithms and artificial life started.
- Practical applications also include automatic evolution of computer programmes. Evolutionary algorithms are now used to solve multi-dimensional problems more efficiently than software produced by human designers and also to optimise the design of systems.
- Sequencing of complete genome.
- Artificial intelligence in genetic manipulations ?

Suggested Reading :

- Evolutionary Computation : -
- https://www.cognizant.com/us/en/glossary/evolutionary-computation#:~:text=Evolutionary%20computation%2Fevolutionary%20AI,-What%20is%20evolutionary&text=Given%20such%20definitions%2C%20any%20engineering,circuits%20or%20even%20football%20schedules.

Reference : Cureus. 2024 Jan 10;16(1):e52035. doi: 10.7759/cureus.52035
Artificial Intelligence in Genetics
Rohit S Vilhekar 1, ✉, Alka Rawekar 2
Editors: Alexander Muacevic, John R
Adlerhttps://pmc.ncbi.nlm.nih.gov/articles/PMC10856672/

- **AI is a powerful tool for creating new hypotheses and helping with experimental techniques. From the previous data of a gene model, it can help in the detection of heredity and gene-related disorders. AI developments offer an excellent possibility for rational drug discovery and design, eventually impacting humanity.**
- **AI has significantly aided in the treatment of various biomedical conditions, including genetic disorders. In both basic and applied gene research, deep learning - a highly versatile branch of AI that enables autonomous feature extraction - is increasingly exploited.**

- **In 2017, fetal researchers at the Children's Hospital of Philadelphia published a study showing they had grown premature lamb fetuses for four weeks in an extra-uterine life support system. A 14-day rule prevents human embryos from being kept in artificial wombs longer than 14 days; this rule has been codified into law in twelve countries.**
- **An artificial womb is not designed to replace a pregnant person; it could not be used from conception until birth. Rather, it could be used to help a small number of infants born before 28 weeks of pregnancy, which is considered extreme prematurity. Less than 1% of babies are born this early.**

Natural outcomes

- **Evolution influences every aspect of the form and behaviour of organisms. Most prominent are the specific behavioural and physical adaptations that are the outcome of natural selection.**
- **These adaptations increase fitness by aiding activities - such as**

finding food, avoiding predators or attracting mates.

Over expression of genes.

More Applications

- 1. Culture enrichment
- 2.Genetically modified crops – Golden rice- Vitamin A .
- 3. Wastewater treatment.
- 4.Air pollution control- Bioremediation of air pollutants by exploiting the potentials of plant leaves and leaf-associated microbes.
- 5.Over expression of genes –Excessive expression of a gene (as that caused by increasing the frequency of transcription). The expression of genes in an organism can be influenced by the environment, including the external world in which the organism is located or develops, as well as the organism's internal world, which includes such factors as its hormones and metabolism.
- 6.Green revolution
- 7.Biodesulfurisation of coal and petroleum.
- 8.Biosynthesis of hydrolase enzymes by fungi.
- 9.Single cell proteins

- **10.Genetically modified animals- For instance, mice, goats, and cows have all been engineered to create medically valuable proteins in their milk; moreover, hormones that were once isolated only in small amounts from human cadavers can now be mass-produced by genetically engineered cells.**
- **11. Bioremediation of soil.**
- **12. Production of methanol from biogas.**
- **13.Optical genes and animal husbandry.**
- **14. Pets including pythons, tigers, eagle, dogs, cats etc.**
- **15. Different colors of roses.**
- **16. Biodemineralization of coal and ore beneficiation.**

- **17. Enhancement of photosynthesis.**
- **18. Pest resistance in plants**
- **19. Strain improvement – UV irradiation.**
- **20. Metal tolerance in plants.**
- **21. Genetic mining – H2 production.**
- **22.Gene editing – disease causing bacteria.**
- **22. Genetic switches**
- **23.Cloning – Animals, Cross pollination**
- **24. Biodelignification/bioleaching – nPaper production.**
- **25. Crossing breediung – Mules.**

What fish symbolizes rebirth?

- **The hydrozoan Turritopsis dohrnii, an animal about 4.5 millimetres wide and tall (likely making it smaller than the nail on your little finger), can actually reverse its life cycle. It has been dubbed the immortal jellyfish.**
- **Fish have the ability to regenerate, which means that if a fish loses a body part, it can grow it back. However, this process can take up to 2 years. Over 200 species of fish are known to have regenerative abilities. For example, a wrasse fish can completely regrow its tail in the span of 8-9 months.**
- **The key to Hydractinia's regenerative talent is the fact that it retains its embryonic stem cells for life. This means that any wound healing process doesn't just produce a scab and a scar but a whole new body part as it would in an embryo, even a head.**

Revival of a fish

https://www.google.com/search?q=immortal+jelly+fish&sca_esv=e5b76c5ec865bd30&rlz=1C1YTUH_enIN1045IN1045&sxsrf=AHTn8zpyFTycDGhmhBcCIyJgG1b69BD0cA%3A1738484540420&ei=PCufZ4GtGY6Z4-EP5-Wp6AM&ved=0ahUKEwiBu-rLx6SLAxWOzDgGHedyCj0Q4dUDCBA&uact=5&oq=immortal+jelly+fish&gs_lp=Egxnd3Mtd2l6LXNlcnAiE2ltbW9ydGFsIGplbGx5IGZpc2gyBxAuGIAEGAoyBxAAGIAEGAoyBxAAGIAEGAoyBxAAGIAEGAoyBxAAGIAEGAoyBxAAGIAEGAoyCBAAGAgYChgeMggQABgIGAoYHjIGEAAYCBgeSPp-UABY5XlwAXgAkAEAmAHwAaABiRyqAQYwLjIxLjG4AQPIAQD4AQGYAhegAvQcqAIKwgIHECMYJxjqAsICBBAjGCfCAgsQLhiABBiRAhiKBcICCxAAGIAEGJECGIoFwgILEAAYgAQYsQMYgwHCAg4QABiABBixAxiDARiKBcICDhAuGIAEGLEDGNEDGMcBwgIFEAAYgATCAggQABiABBixA8ICChAAGIAEGEMYigXCAg0QABiABBixAxhDGIoFwgIOEC4YgAQYkQIYsQMYigXCAhAQABiABBixAxhDGMkDGIoFwgINEC4YgAQYsQMYQxiKBcICCxAAGIAEGJIDGIoFwgIKEC4YgAQYQxiKBcICDhAuGIAEGMcBGI4FGK8BwgIQEC4YgAQYsQMYQxiDARiKBcICDhAAGIAEGJECGLEDGIoFwgIREC4YgAQYxwEYyQMYjgUYrwHCAggQLhiABBjlBMICFBAuGIAEGJIDGMcBGMkDGI4FGK8BwgIFEC4YgATCAgoQLhiABBixAxgKwgIKEC4YgAQYsQMYDcICBxAAGIAEGA2YAwjxBSujugWNhbeKkgcGMS4yMS4xoAfT3wI&sclient=gws-wiz-serp#fpstate=ive&vld=cid:74c3bc32,vid:jZPtwrI_G1Y,st:0

How are viruses used in gene transfer?

- For gene therapy to work, scientists need ways to deliver genes into specific cells. Vectors use the shell of the virus, called the capsid, to deliver a healthy copy of a gene into a cell. But merely delivering a gene into a cell doesn't make it function properly; the gene needs to survive in the cell and be turned on.
- Transduction is the process by which a virus transfers genetic material from one bacterium to another. Viruses called bacteriophages are able to infect bacterial cells and use them as hosts to make more viruses.
- Covid 19.

Genetic Engineering - Can genes be turned on and off in cells?

- **Each cell expresses, or turns on, only a fraction of its genes at any given time. The rest of the genes are repressed, or turned off. The process of turning genes on and off is known as gene regulation. Gene regulation is an important part of normal development. Genes are turned on and off in different patterns during development to make a brain cell look and act different from a liver cell or a muscle cell, for example.**
- **Gene regulation also allows cells to react quickly to changes in their environments. Although we know that the regulation of genes is critical for life, this complex process is not yet fully understood.**

- **Gene regulation can occur at any point during gene expression, but most commonly occurs at the level of transcription (when the information in a gene's DNA is passed to mRNA). Signals from the environment or from other cells activate proteins called transcription factors. These proteins bind to regulatory regions of a gene and increase or decrease the level of transcription. By controlling the level of transcription, this process can determine when and how much protein product is made by a gene.**

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- **Gene silencing is a relatively new treatment technique that makes use of the body's natural processes to control disease by suppressing or 'silencing' specific genes that are associated with certain diseases.**
- **Introducing an ‘anti-code’ designed to block problematic mRNA triggers the RNAi process, making it possible to ‘silence’ (temporarily switch off) specific disease-associated genes.**

What is the gene editing process?

- **Genome editing (also called gene editing) is a group of technologies that give scientists the ability to change an organism's DNA. These technologies allow genetic material to be added, removed, or altered at particular locations in the genome. Several approaches to genome editing have been developed.**
- **CRISPR/ Cas9 is a highly effective gene-editing tool that is widely used in the scientific community. The CRISPR/Cas9 system evolved naturally in bacteria and archaea as a defense mechanism against bacterio phage infection and plasmid (circular DNA) transfer.**

- **Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR/ Cas9) for removing, adding or altering sections of the DNA sequence.**
- **An enzyme called Cas9. This acts as a pair of 'molecular scissors' that can cut the two strands of DNA at a specific location in the genome and a piece of RNA called guide RNA (gRNA) 'guides' Cas9 to the right part of the genome.**
- **CRISPR has been used to experiment with gene-edited mosquitos to reduce the spread of malaria, for engineering agriculture to withstand climate change, and in human clinical trials to treat a range of diseases, from cancer to transthyretin amyloidosis , a rare protein disorder that devastates nerves and organs.**

Our DNA changes as we age.

- **Some of these changes are epigenetic—they modify DNA without altering the genetic sequence itself. Epigenetic changes affect how genes are turned on and off, or expressed, and thus help regulate how cells in different parts of the body use the same genetic code.**
- **Each time a cell divides, the telomeres become slightly shorter. Eventually, they become so short that the cell can no longer divide successfully, and the cell dies.**
- **Without telomeres, chromosome ends could fuse together and corrupt the cell's genetic blueprint, possibly causing malfunction, cancer, or cell death.**

Epigenetics

- Various environmental factors and lifestyle choices can also affect gene activity and expression. This is known as epigenetics.
- Epigenetics refers to the study of how cells control gene activity without changing the DNA sequence. Epigenetic changes describe reversible chemical modifications that can activate and deactivate parts of the genome and alter the expression of these genes.
- As such, epigenetics describes how a person's environment and behaviors can affect how their genes work. These changes can increase a person's risk of genetic damage or disease.
- Epigenetics affects gene expression by turning genes on and off. This can refer to genes making proteins where or when they normally would not, or not making proteins where and when they normally would. It can also influence how much or how little of a protein they would normally produce.

- One way this can occur is through DNA methylation. This involves the addition of a chemical, known as a methyl (-CH3) group, to DNA. Conversely, the removal of a methyl group is known as demethylation. Usually, methylation turns genes off, which reduces protein production, while demethylation turns them on, increasing the amount of protein a cell makes.

- **Research suggests that lifestyle practices like yoga and meditation can potentially influence epigenetic processes, modulating gene expression and impacting our health. Stress Response and Telomeres (A telomere is a region of repetitive DNA sequences at the end of a chromosome.).**
- **:Yoga practices have been shown to reduce stress levels and improve the body's stress response.**
- **A muscle cell has a structure that aids in your body's ability to move. Epigenetics allows the muscle cell to turn on genes to make proteins important for its job and turn off genes important for a nerve cell's job.**

- Exercise induces profound alterations in epigenetics in multiple tissues. Exercise induces alterations in histone modification, DNA/RNA methylation, and non-coding RNA expression in multiple tissues, which underlies its beneficial effects on health promotion and disease prevention.
- Hence, physical activity has been found to induce changes in DNA methylation patterns as well as expression of corresponding genes in skeletal muscle, both in response to a single exercise bout and after prolonged exercise training.
- Yog Guru Ramdev or other yoga programs?
- The human body was made to be in constant movement. Walking is therefore the nature of man as a biological being.
- It is believed that Walking is good for health.

Gene Editing- Genetic Engineering

- RNA-guided endonucleases:clustered regularly interspaced short palindromic repeats associated Cas9 (CRISPR/Cas9) are a new tool, further increasing the range of methods available. In particular CRISPR/Cas9 engineered endonucleases allows the use of multiple guide RNAs for simultaneous Knockouts (KO) in one step by cytoplasmic direct injection (CDI) on mammalian zygotes

CRISPR/Cas9 Technique

- **This technique involves adapting a naturally occurring genome editing system that bacteria use as an immune defense. It allows researchers to do the following:**

- **Use a cell's own DNA repair machinery to add or delete pieces of genetic material**
- **Make changes to the DNA by replacing existing segments with an altered DNA sequence**

CRISPR/Cas9 has been the primary choice for plant genome editing and Agrobacterium-mediated transformation is the most common method for delivery of the CRISPR/Cas9 DNA components to plants.

- **Genome editing is a specific method of gene therapy. Instead of introducing new genetic material into cells, genome editing involves using molecular tools to modify the existing DNA in a cell. This can help make changes in physical traits such as reducing disease risk.**

- **Scientists can also use genome editing to investigate different conditions that affect humans. They do this by editing the genomes of animals that have similar genes to humans, such as mice and zebrafish. By editing their genome, researchers can observe how these changes affect the animals' health. E.g., (the body of the zebrafish is almost entirely transparent).**

What are the two types of gene regulation?

- **Specifically, gene expression is controlled on two levels. First, transcription is controlled by limiting the amount of mRNA that is produced from a particular gene. The second level of control is through post-transcriptional events that regulate the translation of mRNA into proteins.**
- **Gene regulation also allows cells to react quickly to changes in their environments. Although we know that the regulation of genes is critical for life, this complex process is not yet fully understood.**

Recombinant Gene technology

- **Recombinant DNA technology involves using enzymes and various laboratory techniques to manipulate and isolate DNA segments of interest. This method can be used to combine (or splice) DNA from different species or to create genes with new functions.**
- **Recombinant DNA technology comprises altering genetic material outside an organism to obtain enhanced and desired characteristics in living organisms or as their products. This technology involves the insertion of DNA fragments from a variety of sources, having a desirable gene sequence via appropriate vector.**

Switching on the genes

- **The process of turning genes on and off is known as gene regulation. Gene regulation is an important part of normal development. Genes are turned on and off in different patterns during development to make a brain cell look and act different from a liver cell or a muscle cell, for example.**

How do gene switches work?

- **The gene switch determines when and where the gene is turned on. The regulatory molecule binds to the switch. If the regulatory molecule is not present in the cell, the gene is not activated.**
- **What chemicals can alter your DNA?**
- **In-vitro, animal, and human investigations have identified several classes of environmental chemicals that modify epigenetic marks, including metals (cadmium, arsenic, nickel, chromium, methylmercury), peroxisome proliferators (trichloroethylene, dichloroacetic acid, trichloroacetic acid), air pollutants (particulate matter.**
- **Tobacco smoke reduces DNA repair in lungs.**

- **Many transhumanists see genome editing as a potential tool for human enhancement. Australian biologist and Professor of Genetics David Andrew Sinclair notes that "the new technologies with genome editing will allow it to be used on individual) to have healthier children" – designer babies. According to a September 2016 report by the Nuffield Council on Bioethics in the future it may be possible to enhance people with genes from other organisms or wholly synthetic genes to for example improve night vision and sense of smell. George Church has compiled a list of potential genetic modifications for possibly advantageous traits such as less need for sleep, cognition-related changes that protect against Alzheimer's disease, disease resistances and enhanced learning abilities along with some of the associated studies and potential negative effects.**

What drugs damage DNA?

- **Reports have shown that psychoactive drugs such as cocaine, morphine, tramadol, alcohol, tobacco, khat, cannabis, etc can interact with the DNA and cause significant damage. In vitro and in vivo studies have been carried out to show the genotoxicity and mutagenicity of these drugs.**

- **The American National Academy of Sciences and National Academy of Medicine issued a report in February 2017 giving qualified support to human genome editing. They recommended that clinical trials for genome editing might one day be permitted once answers have been found to safety and efficiency problems "but only for serious conditions under stringent oversight."**

- **The production of genetically engineered plants became possible after Bob Fraley and others succeeded to use Agrobacterium tumefaciens to transform plant cells with recombinant DNA in the early 1980s (Vasil, 2008). Since this breakthrough in plant biotechnology, GM crops are now routinely developed and grown in many parts of the globe.**

- **Genetic engineering is the targeted addition of a foreign gene or genes into the genome of an organism. The genes may be isolated from one organism and transferred to another or may be genes of one species that are modified and reinserted into the same species. The new genes, commonly referred to as transgenes, are inserted into a plant by a process called transformation. The inserted gene holds information that will give the organism a trait.**

Microevolution and Macroevolution

- Organisms can also respond to selection by cooperating with each other, usually by aiding their relatives or engaging in mutually beneficial symbiosis.
- In the longer term, evolution produces new species through splitting ancestral populations of organisms into new groups that cannot or will not interbreed due to some reasons (leading to speciation).These outcomes of evolution are distinguished based on time scale as macroevolution versus microevolution.

- Macroevolution refers to evolution that occurs at or above the level of species, in particular speciation and extinction,e.g.,
- Evolution of bat wings and loss of limbs in snakes and lizards.
- Microevolution is defined as changes in the frequency of a gene in a population. These are subtle changes that can occur in very short periods of time, and may not be visible to a casual observer, for example, between one generation and the next, the frequency of a gene for brown coloration in a population of beetles increases.

e.g., - Bacterial strains that have acquired antibiotic resistance. Pesticide resistance, herbicide resistance, and antibiotic resistance are all examples of microevolution by natural selection.

- In this sense, microevolution and macroevolution might involve selection at different levels—with microevolution acting on genes and organisms, versus macroevolutionary processes such as species selection acting on entire species and affecting their rates of speciation and extinction homo sapiens from apes i.e., Homo habilis, Homo rudolfensis and Homo erectus.

Adaptation

- **Adaptation is the process that makes organisms better suited to their habitat.**
- **Adaptation is the evolutionary process whereby an organism becomes better able to live in its habitat or habitats.**
- **Adaptedness is the state of being adapted: the degree to which an organism is able to live and reproduce in a given set of habitats.**
- **An adaptive trait is an aspect of the developmental pattern of the organism which enables or enhances the probability of that organism surviving and reproducing**. Sutainment of life in that environment /stting.

- **Adaptation may cause either the gain of a new feature, or the loss of an ancestral feature. An example that shows both types of change is bacterial adaptation to antibiotic selection, with genetic changes causing antibiotic resistance by both modifying the target of the drug, or increasing the activity of transporters that pump the drug out of the cell.**

- **Adaptation occurs through the gradual modification of existing structures.**
- **The bones within bat wings, for example, are very similar to those in mice feet and primate hands (mammals) , due to the descent of all these structures from a common mammalian ancestor.**
- **During evolution, some structures may lose their original function and become vestigial (loss of function) structures.**

- **Such structures may have little or no function in a current species, yet had a clear function in ancestral species, or other closely related species. Examples include pseudogenes, the non-functional remains of eyes in blind cave-dwelling fish, wings in flightless birds, (hen) the presence of hip bones in whales and snakes, and sexual traits in organisms that reproduce via asexual reproduction.**

Exaptation – Functional change of organs

- Examples of vestigial structures in humans include wisdom teeth.
- However, many traits that appear to be simple adaptations are in fact structures originally adapted for one function, but which coincidentally became somewhat useful for some other function in the process.
- One example is the African lizard Holaspis guentheri, which developed an extremely flat head for hiding in crevices, as can be seen by looking at its near relatives. However, in this species, the head has become so flattened that it assists in gliding from tree to tree—an exaptation.

Exaptations

- **An area of current investigation in evolutionary developmental biology is the developmental basis of adaptations and exaptations. This research addresses the origin and evolution of embryonic development and how modifications of development and developmental processes produce novel features.**

Re -expression of conserved genes

- It is also possible for structures that have been lost in evolution to reappear due to changes in developmental genes, such as a mutation in chickens causing embryos to grow teeth similar to those of crocodiles. It is now becoming clear that most alterations in the form of organisms are due to changes in a small set of conserved genes.- Exaptation.

Can a short father have a tall son?

- Height is often considered a straightforward inheritance from parents, but sometimes, shorter parents end up with unexpectedly tall children. This phenomenon may seem surprising at first, but it offers a fascinating glimpse into the complexities of genetics and ancestral traits.

Coevolution - Predator and its Prey - Upmanship/ Outsmarting

- **Interactions between organisms can produce both conflict and cooperation. When the interaction is between pairs of species, such as a pathogen and a host, or a predator and its prey, these species can develop matched sets of adaptations (Smarter upmanship and counter upmanship).**
- **Here, the evolution of one species causes adaptations in a second species. These changes in the second species then, in turn, cause new adaptations in the first species. This cycle of selection and response is called coevolution.**

Example of coevolution- Predator-Prey evolve defences and counter effects

- An example is the production of tetrodotoxin in the rough-skinned newt and the evolution of tetrodotoxin resistance in its predator, the common garter snake. In this predator-prey pair, an evolutionary arms race has produced high levels of toxin in the newt and correspondingly high levels of toxin resistance in the snake.

Cooperation

- **Not all co-evolved interactions between species involve conflict. Many cases of mutually beneficial interactions have evolved. For instance, an extreme cooperation exists between plants and the mycorrhizal fungi that grow on their roots and aid the plant in absorbing nutrients from the soil.**
- **N- fixation and Sugars.**

Cooperation

- **Coalitions between organisms of the same species have also evolved. An extreme case is the eusociality found in social insects, such as bees, termites and ants, where these insects cooperate in feeding and guarding the small number of organisms in a colony that are able to reproduce (queen bees).**
- **Hen, cat and dog living together.**
- **Hare and dogs.**

occurs when reproductively isolated and diverge.

- Scientists think that geographic isolation is a common way for the process of speciation to begin: rivers change course, mountains rise, continents drift, organisms migrate, and what was once a continuous population is divided into two or more smaller populations.
- Gene flow may slow this process by spreading the new genetic variants also to the other populations. Depending on how far two species have diverged since their most recent common ancestor, it may sometimes still be possible for them to produce offspring However, as with horses and donkeys mating to produce mules. Such hybrids are generally infertile. In this case, closely related species may regularly interbreed.
- Speciation produces diversity of life on earth by splitting evolutionary lineages through the evolution of reproductive isolation between populations of a species.

Metal resistant plants becoming poorly resistant

- **One example is the grass *Anthoxanthum odoratum,* which can undergo parapatric speciation in response to localised metal pollution from mines. Here, plants evolve and develop resistance to high levels of metals in the soil. Selection against interbreeding with the metal-sensitive parental population produced a gradual change in the flowering time of the metal-resistant plants and plants eventually survive poorly on nonmetallic soils.**

SYMBIOSIS

Symbiosis- the relationship between certain species of ants and acacia trees – saving these from herbivores.

- **Interaction between two different organisms living in close physical association, typically to the advantage of both.**
- **A mutually beneficial relationship between different people or groups.**
- **Symbiosis is the interaction between two dissimilar organisms living in close physical association.**
- **N-FIXATION IN ROOTS.**

Earliest Human appearance on Earth

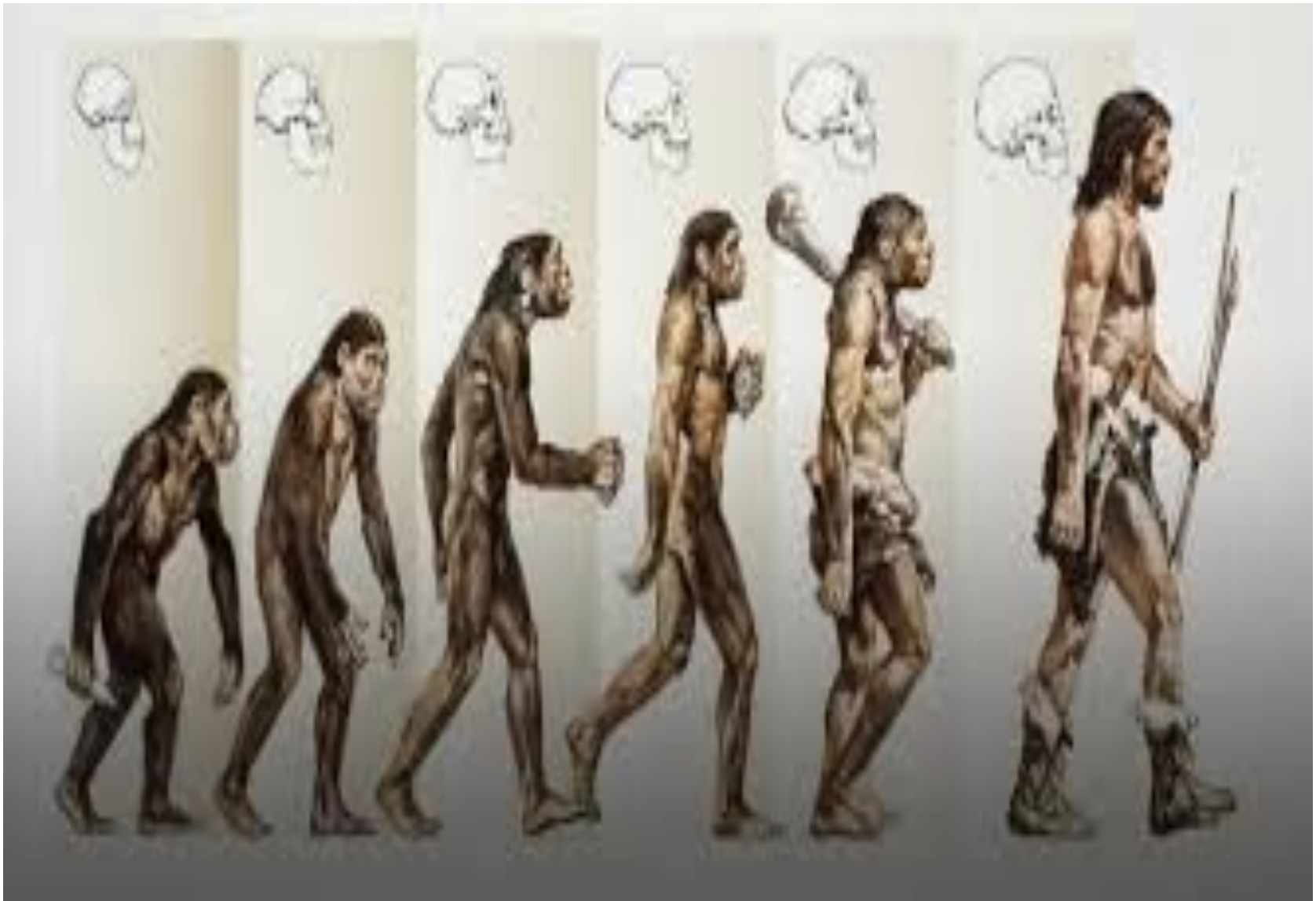
- **Hominins first appeared by around 6 million years ago, in the Miocene epoch, which ended about 5.3 million years ago. Our evolutionary path takes us through the Pliocene, the Pleistocene, and finally into the Holocene, starting about 12,000 years ago. The Anthropocene would follow the Holocene - Examples of Macroevolution.**

When did actual humans first appear?

- **Fossils and DNA suggest people looking like us, anatomically modern Homo sapiens, evolved around 300,000 years ago. Surprisingly, archaeology – tools, artefacts, cave art – suggest that complex technology and cultures, "behavioural modernity", evolved more recently: 50,000-65,000 years ago.**

Who was the first human on earth

- **Scientists still don't know exactly when or how the first humans evolved, but they have identified a few of the oldest ones. One of the earliest known humans is Homo habilis, or “handy man,” who lived about 2.4 million to 1.4 million years ago in Eastern and Southern Africa.**



Earliest man on earth - Video

- https://www.pbs.org/video/first-peoples-omo-1-worlds-first-modern-human/

- https://www.google.com/search?q=early+men+on+earth+video+&sca_esv=c971498ae52dc37f&sxsrf=AHTn8zpJlN6UQeqyVWnng9tu8LGn0FCkXg%3A1738996927489&ei=v_ymZ_LMHbu9seMP1K2-4QE&ved=0ahUKEwiyqIOxvLOLAxW7XmwGHdSWLxwQ4dUDCBA&uact=5&oq=early+men+on+earth+video+&gs_lp=Egxnd3Mtd2l6LXNlcnAiGWVhcmx5IG1lbiBvbiBlYXJ0aCB2aWRlbyBIpydQpwVYoyFwAXgBkAEAmAHsAaAB6wmqAQUwLjYuMbgBA8gBAPgBAZgCAqACzwHCAgoQABiwAxjWBBhHwgIGEAAYFhgewgILEAAYgAQYhgMYigWYAwCIBgGQBgiSBwMxLjGgB-QO&sclient=gws-wiz-serp#fpstate=ive&vld=cid:cb5593ca,vid:ehV-MmuvVMU,st:0

Commensalism- one gets advantage while other is not harmed oer benefitted.

- **The simplest example of commensalism is a bird making a nest in a tree. The tree provides shelter and protection to the bird without getting significantly harmed or affected by the bird. Another typical example is the cattle egrets (birds) that feed upon the insects stirred up by the feeding cattle.**

Mutualism

- One example of a mutualistic relationship is that of the oxpecker (a kind of bird) and the rhinoceros or zebra. Oxpeckers land on rhinos or zebras and eat ticks and other parasites that live on their skin. The oxpeckers get food and the beasts get pest control i.e., gets rid of pests.
- Hen and dog.

Antagonism

- **Antagonism is an interaction between organisms where one organism benefits at the expense of another. This includes predation, or a predator eating prey. Think of bears killing salmon (fish) . It also includes parasitism, or one organism depending on (but not killing) a host.**
- **Mosquitoes – Caused by mosquito bite which injects Plasmodium parasite from infected person leading to malaria.**

Sympatric speciation (i.e., at same place at the same time)

- One type of sympatric speciation involves crossbreeding of two related species to produce a new hybrid species. This is not common in animals as animal hybrids are usually sterile. This is because during meiosis the homologous chromosomes from each parent are from different species and cannot successfully pair. However, it is more common in plants (Mangoes) because plants often double their number of chromosomes, to form polyploids.
- In insects it is the shift in the location of laying eggs, Hawthorn fly.

Cell division :

- Meiosis- variant genes in daughter cells (creates eggs and sperm cells) and mitosis – identical genes in daughter cells.

- **Meiosis is a process where a single cell divides twice to produce four cells containing half the original amount of genetic information.**
- **Meiosis is the process in which a single cell divides twice to form four haploid daughter cells. These cells are the gametes – sperms in males and egg in females.**

- **Meiosis is the process by which a cell replicates its chromosomes and then segregates them, producing two identical nuclei in preparation for cell division-reproduction.**
- **Mitosis is generally followed by equal division of the cell's content into two daughter cells that have identical genomes-General celldivision.**

- **This allows the chromosomes from each parental species to form matching pairs during meiosis, since each parent's chromosomes are represented by a pair already.**
- **An example of such a speciation event is when the plant species *Arabidopsis thaliana* and *Arabidopsis arenosa* crossbred to give the new species *Arabidopsis suecica*. This happened about 20,000 years ago.**

Extinction

- **Extinction is the disappearance of an entire species. Extinction is not an unusual event, as species regularly appear through speciation and disappear through extinction. Nearly all animal and plant species that have lived on Earth are now extinct and extinction appears to be the ultimate fate of all species.**
- **These extinctions have happened continuously throughout the history of life, although the rate of extinction spikes in occasional mass extinction events.**

Holocene Epoch (11,700 years ago – present day)

- **The Cretaceous–Paleogene extinction event, during which the non-avian dinosaurs became extinct, is the most well-known, but the earlier Permian–Triassic extinction event was even more severe, with approximately 96% of all marine species driven to extinction.**
- **The Holocene extinction, also referred to as the Anthropocene extinction, is an ongoing extinction event caused by human activities during the Holocene epoch.**
- **Lest we Present world perish?**
- **Let us get awakened after learning through this course.**

- **Observers in the future will probably identify the Holocene as the time period when human occupation was the dominant feature of the Earth's biota. The fossil record of the Holocene will no doubt reveal that humans had a dramatic impact on the earth's climate, floras, and faunas.**
- **Humans destroy the habitats of organisms, use them as resources and eliminate them due to many different reasons. Human population increase and its destructive effects on systems that support life on Earth are the main contributoland are polluted.Land are polluted.**
- **Over exploitation to the Holocene mass extinction.**
- **Air, Water and Land are polluted. Overexploitation of resources-Land, water, animals, minerals,. Extraplanets may be the targets?**

Earth worms, Frogs Vultures ?

- **Present-day extinction rates are 100–1000 times greater than the background rate and up to 30% of current species may be extinct by the mid 21st century. Human activities are now the primary cause of the ongoing extinction event global warming may further accelerate it in the future. Despite the estimated extinction of more than 99% of all species that ever lived on Earth, about 1 trillion species are estimated to be on Earth currently with only one-thousandth of 1% described.**

- **The role of extinction in evolution is not very well understood (dinosaurs) and may depend on which type of extinction is considered. The causes of the continuous "low-level" extinction events, which form the majority of extinctions, may be the result of competition between species for limited resources (the competitive exclusion principle).**

- **If one species can out-compete another, this could produce species selection, with the fitter species surviving and the other species being driven to extinction. The intermittent mass extinctions are also important, but instead of acting as a selective force, they drastically reduce diversity in a nonspecific manner and promote bursts of rapid evolution and speciation in survivors.**

Evolutionary history of life- Origin of life

- **The Earth is about 4.54 billion years old. The earliest undisputed evidence of life on Earth dates from at least 3.5 billion years ago, during the Eoarchean Era after a geological crust started to solidify following the earlier molten Hadean Eon Microbial mat fossils have been found in 3.48 billion-year-old sandstone in Western Australia.**

- Other early physical evidence of a biogenic substance is graphite in 3.7 billion-year-old metasedimentary rocks discovered in Western Greenland as well as "remains of biotic life" found in 4.1 billion-year-old rocks in Western Australia.
- In July 2016, scientists reported identifying a set of 355 genes from the last universal common ancestor (LUCA) of all organisms living on Earth.

- **More than 99% of all species, amounting to over five billion species, that ever lived on Earth are estimated to be extinct.**
- **Estimates on the number of Earth's current species range from 10 million to 14 million, of which about 1.9 million are estimated to have been named and 1.6 million documented in a central database to date, leaving at least 80% not yet described.**

- **Highly energetic chemistry is thought to have produced a self-replicating molecule around 4 billion years ago, and half a billion years later the last common ancestor of all life existed. The current scientific consensus is that the complex biochemistry that makes up life came from simpler chemical reactions. The beginning of life may have included self-replicating molecules such as RNA and the assembly of simple cells.**

What was there before the universe?

- **In the beginning, there was an infinitely dense, tiny ball of matter. Then, it all went bang, giving rise to the atoms, molecules, stars and galaxies we see today. Or at least, that's what we have been told by physicists for the past several decades.**
- **The universe is expanding (galaxies drifting away from earch) – (Red shift), till the new entropy is being added to the energy and may not expand infinitely ?**

Common descent

- **All organisms on Earth are descended from a common ancestor or ancestral gene pool. Current species are a stage in the process of evolution, with their diversity the product of a long series of speciation and extinction events. The common descent of organisms was first deduced from four simple facts about organisms.**

- **First, they have geographic distributions that cannot be explained by local adaptation. Second, the diversity of life is not a set of completely unique organisms, but organisms that share morphological similarities. Third, vestigial traits with no clear purpose resemble functional ancestral traits. Fourth, organisms can be classified using these similarities into a hierarchy of nested groups, similar to a family tree.**

- **Due to horizontal gene transfer, this "tree of life" may be more complicated than a simple branching tree, since some genes have spread independently between distantly related species.**
- **Past species have also left records of their evolutionary history. Fossils, along with the comparative anatomy of present-day organisms, constitute the morphological, or anatomical, record – Dinosaurs- Lizards or crocodiles?**
- **Dinosaurs belong to a group called Archosauria, which also includes crocodilians and birds.**

- **While birds are the closest living descendants of dinosaurs, crocodilians are their closest living relatives,.**

Extinct - Dinosaurs

- **By comparing the anatomies of both modern and extinct species, palaeontologists can infer the lineages of those species.**

- **More recently, evidence for common descent has come from the study of biochemical similarities between organisms. For example, all living cells use the same basic set of nucleotides and amino acids. The development of molecular genetics has revealed the record of evolution left in organisms' genomes: dating when species diverged through the molecular clock produced by mutations.**

Evolution of life

- **Prokaryotes (the bacteria and the archaea) inhabited the Earth from approximately 3–4 billion years ago. No obvious changes in morphology or cellular organization occurred in these organisms over the next few billion years.**
- **The eukaryotic cells emerged between 1.6 and 2.7 billion years ago. The next major change in cell structure came when bacteria were engulfed by eukaryotic cells, in a cooperative association called endosymbiosis.**

Macroalgae moved out from water

- **Another engulfment of cyanobacterial-like organisms led to the formation of chloroplasts in algae and plants.**
- **The history of life was that of the unicellular eukaryotes, prokaryotes and archaea until about 610 million years ago when multicellular organisms began to appear in the oceans in the Ediacaran period.**

History of evolutionary thought

- **Classical antiquity : The proposal that one type of organism could descend from another type goes back to some of the first pre-Socratic Greek philosophers, such as Anaximander and Empedocles. Such proposals survived into Roman times.**
- **Religeous thoughts**
- **John Ray applied one of the previously more general terms for fixed natural types, "species", to plant and animal types, but he strictly identified each type of living thing as a species and proposed that each species could be defined by the features that perpetuated themselves generation after generation.**

- **Human beings have existed they will have observed children's resemblance to their parents, the resemblance or non-resemblance of brothers and sisters, and the appearance of characteristic qualities in certain families and races. They will also early have asked for an explanation of these circumstances, which has produced a kind of primitive theory of heredity chiefly on a speculative basis.**

Totipotency

- **According to the most common and stringent definition, totipotency is the ability of a single cell to produce all the cells of the body, as well as the transient structures of the embryo (i.e., placenta and fetal membranes that function only during the prenatal life).**
- **Totipotency in plant tissue culture; It can be defined as the ability to produce a completely new plant from a living plant cell.**
- **A cell (and only a single cell) can be considered as totipotent if it is able to autonomously develop into a whole plant via embryogenesis- Radish, rose etc.**

"Evo-devo," emphasises –Environment Effect

- **C14 and C12 dating – Dinosaurs, mummies in Pyramids- 2500-3800 years old.**
- **One extension, known as evolutionary developmental biology and informally called "evo-devo," emphasises how changes between generations (evolution) act on patterns of change within individual organisms (development). Since the beginning of the 21st century, some biologists have argued for an extended evolutionary synthesis, which would account for the effects of non-genetic inheritance modes, such as epigenetics, parental effects, ecological inheritance and cultural inheritance, and evolvability.**

Theistic evolution i.e., God guided evolution of life

- While various religions and denominations have reconciled their beliefs with evolution through concepts such as theistic evolution (evolution occurred as biologists believe but under the directions of God) , there are creationists who believe that evolution is contradicted by the creation myths found in their religions and who raise various objections to evolution.

Vestiges of the Natural History of Creation – Superiority of man over others

- As had been demonstrated by responses to the publication of Vestiges of the Natural History of Creation in 1844, the most controversial aspect of evolutionary biology is the implication of human evolution that humans share common ancestry with apes and that the mental and moral faculties of humanity have the same types of natural causes as other inherited traits in animals.

- **While other scientific fields such as cosmology and Earth science also conflict with literal interpretations of many religious texts, evolutionary biology experiences significantly more opposition from religious literalists.**

Evolution of Human

- https://www.google.com/search?q=video++where+we+came+from+how+did+we+evolve+&sca_esv=550f8b5888f48c55&rlz=1C1YTUH_enIN1045IN1045&sxsrf=AHTn8zqXAzvBRF7p2ixZ_lzxx5k9qS4meQ%3A1739081371723&ei=m0aoZ87fK9WeseMP5fXA6Qk&ved=0ahUKEwiOmZb79rWLAxVVT2wGHeU6MJ0Q4dUDCBA&uact=5&oq=video++where+we+came+from+how+did+we+evolve+&gs_lp=Egxnd3Mtd2l6LXNlcnAiLHZpZGVvICB3aGVyZSB3ZSBjYW1lIGZyb20gaG93IGRpZCB3ZSBldm9sdmUgMgcQIRigARgKMgcQIRigARgKSL25AVAAWLupAXABeAGQAQCYAZ4CoAH8PqoBBzAuMjkuMTW4AQPIAQD4AQGYAi2gAv4_qAIKwgIHECMYJxjqAsICCxAAGIAEGLEDGIMBwgIOEAAYgAQYsQMYgwEYigXCAggQABiABBixA8ICCBAuGIAEGOUEwgIEECMYJ8ICChAjGIAEGCcYigXCAgoQABiABBhDGIoFwgINEAAYgAQYsQMYFBiHAsICCxAAGIAEGJECGIoFwgIKEAAYgAQYAhjLAcICBRAAGIAEwgIFEC4YgATCAgYQABgWGB7CAggQABgWGAoYHsICCxAAGIAEGIYDGIoFwgIIEAAYogQYiQXCAgUQABjvBcICCBAAGIAEGKIEwgILEAAYFhjJAxgKGB7CAgsQABiABBiSAxiKBcICBRAhGKABwgIEECEYFcICBRAhGJ8FmAMH4gMFEgExIEDxBUU248MQ7HmkkgcHMS4yOC4xNqAHpN8B&sclient=gws-wiz-serp#fpstate=ive&vld=cid:89151c90,vid:liPY6Oo4Lec,st:0