By MBC - Mridul Bhaiya Classes

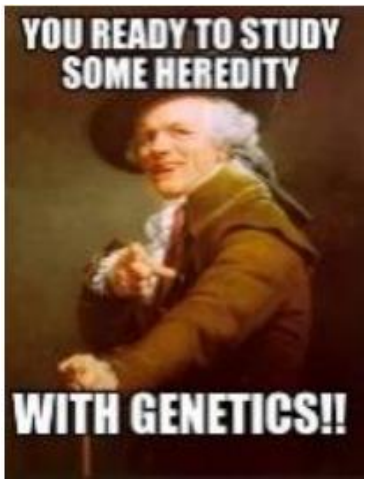
HEREDITY AND EVOLUTION

NOTES BY MRIDUL BHAIYA

HERIDITY AND EVOLUTION

Genetics: [AI - 2019]

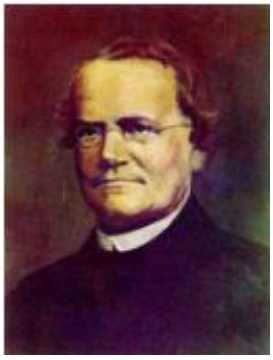
"Branch of Biology that deals with study of Heredity and variation"



Heredity: [AI - 2014]

Heredity is transmission of characters from parent to offspring.

Father of Genetics:



"Gregor Johann Mendel"

i. He was the first to demonstrate the mechanism of transmission of characters from one generation to the other
ii. Mendel proposed the concept of hereditary unit "Equal numbers of Factors inherited from each Parent"
iii. Mendel's work remained unnoticed for 34 years.

Variation During Reproduction:

• The difference in the characters among the individuals of a species is termed as variations.
• These variations are accumulated by the process of sexual reproduction.

• Slight changes, the variations, which are responsible for difference in the offspring, generation after generation.
• Errors during DNA replication at the time of cell division is the reason for appearance of variations.
• A common basic body design which is reflected in the form of similarities between parent and offspring.
• Variations produced during asexual reproduction are much less than the variation produced during sexual reproduction, because during sexual reproduction there is no fusion of male and female gamete

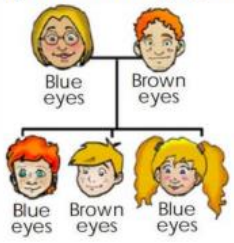
Type of Variations

Somatic Variations

- It takes place in the body cell
- It is neither inherited nor transmitted
- It is also known as acquired traits
  eg. Cutting of tails in dogs, boring of pinna etc.

Gametic Variations

- Takes place in the gametic
- Inherited as well as transmitted
- Also known as inherited traits
  eg. Human height, Skin colour



Accumulation of Variations during Reproduction:

⇒ Variations that appear in the off springs of one generation are passed on to the off spring of next generation and so on. Also in each generation, they acquire and add some new variations. Thus variations accumulate and passed on to more individual.

⇒ Variations increase with each passing generation and diversity spreads over next generation.

⇒ Selection of Variants by environmental factors form the basis for evolutionary process.

Heredity:

Heredity is also called inheritance. It is the transmission of character from parent to child; It help us in understanding the basis of similarities between closely related individuals.

Inherited Traits	Acquired Traits
➢ Characteristic features that are inherited from the previous generation	➢ Traits or characteristics which develop in response to the environment and cannot be inherited
➢ Occur due to a change in a genes or DNA	➢ No change in genes or DNA is involved
➢ Pass on from one generation to another eg. Red Curly hair, Brown eye.	➢ Cannot pass on from on e generation to another eg. Cycling and Swimming

Terminologies :

1. Gene: A gene is the basic Physical and Functional unit of heredity; genes are made up of DNA, and it control the expression of a character.

2. Allele: Alternative form of a gene, there are two alleles of a gene which govern the expression of a pair of contrasting character. (Alleles are also called alleleomorph)

3. Monohybrid Cross: A cross in which single pair of contrasting character is studied at a time.

4. Dihybrid Cross: A cross involving two pairs of contracting characters; eg. Cross involving round and yellow seeded plants and Green rinkled plant

5. F1 – Generation: (First Filial Generation) The off springs produced by the selfing of Parental generation

6. F2 – Generation: (Second Filial Generation) The off spring produced by the selfing of F1 generation

7. Dominant Character: An inherited trait that results from the expression of dominant allele over the recessive allele.

Or

Character which can express it self even if only one dominant allele is present.

8. Recessive Character: Any character present in the parental generation that does not appear in the F1 generation but reappear in the F2 – generation.

Or

The character which cannot expresses it self in the presence of dominant allele.

Off springs/Progeny

Organisms produced as a result of sexual reproduction

Homozygous Condition:

Homozygous refers to a cell that has two identical alleles for a single trait from both father and mother cell. Eg. TT or tt

Heterozygous Condition :

Heterozygous is the state in which an organism has inherited different forms of a particular gene from each one of the biological parents. eg – Tt

Gamete:

Reproductive cells containing only one set of dissimilar chromosomes. **Genotype:**

Genetic make up of an individual

Phenotype:

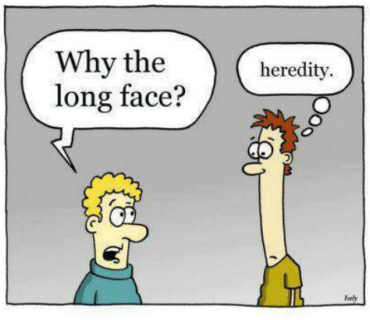
An individual's phenotype consists of the traits we can observe; These can include features of appearance behaviour, metabolism, or anything we can detect.

Test Cross:

Crossing F1 heterozygous with homozygous recessive parent e.g. F1 hybrid tall plant (Tt) with pure dwarf plant tt.

Mendel's Experiment: [Exemplar]

Mendel selected Garden pea (Pisum Sativum) for his experiment why Mendel selected pea plant?



Gene took his answer at face value.

- Large number of seeds are produced per plant
- Plant is grown easily.
- Pea flower normally remain closed and undergo self-pollination.
- It is a annual plant and gives result in a year time.
- Pea plants showed a number of easily detectable contrasting characters.
- Pure varieties of Pea plants are available.

Selection of Parents:

- Mendel selected 7 pairs of pure or true breeding varieties for his experiment .
- All the characters had easily distinguishable alternate traits e.g tallness and dwarfness, violet or white flowers

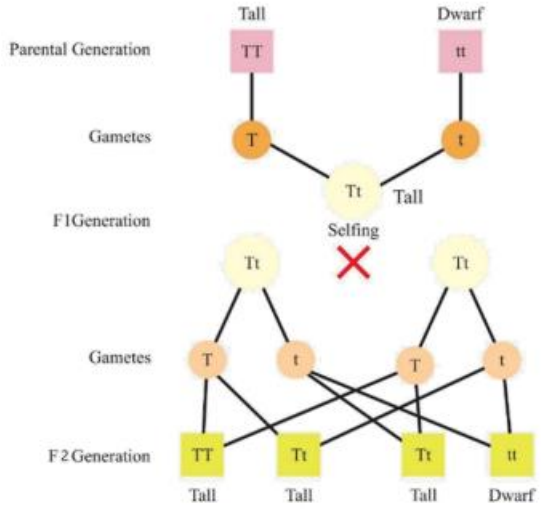
Monohybrid Cross: [Delhi – 2016, 2019, AI – 2017, 2014, 2012]

A cross between two parents taking the alternative trait of single character.

Eg. a cross between alternative TT and tt

TT – Dominant

tt – Recessive



Trait	Character
• A state of character	• A distinguishing feature of a particular organism.
• two traits occur in combination	• A single character occurs in a group of organisms.
• Tallness or Dwarfness is a trait.	• Height of Pea plant is character
• Blue eye colour is an example of a trait	• Colour of the eye is an example of a character.

1. Mendel took pea plants with different characteristics such as height.

2. The progeny produced from them were all tall (F1 – gen)

3. Mendel then allowed F1 Progeny plants to undergo self-pollination.

4. In the F2 – Generation, He found that all plants were not tall, three quarter were tall and one quarter of them were short.

5. This observation indicated that both the traits of shortness and tallness were inherited in F1 – generation. But, only the tallness trait were expressed in F1 – generation.

Mendel Assumption:

• Something was being stably down, unchanged, from parent to off spring.

• Gene are the unit of inheritance.

We use alphabetical symbols for each gene, capital letter is used for the trait expressed at the F1 stage/For Dominant trait and small letter show recessive trait.

Dihybrid Cross (Inheritance of Traits for two visible contrasting characters):

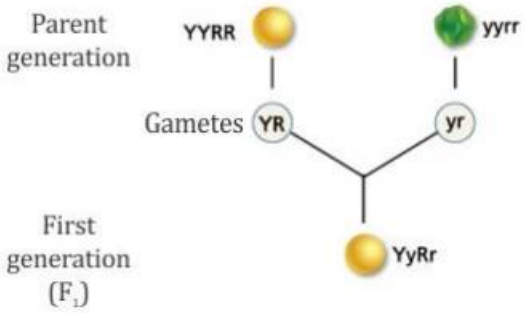
1. Mendel took pea plants with two contrasting character i.e. one with a green round seed and other one with a yellow wrinkled seed.

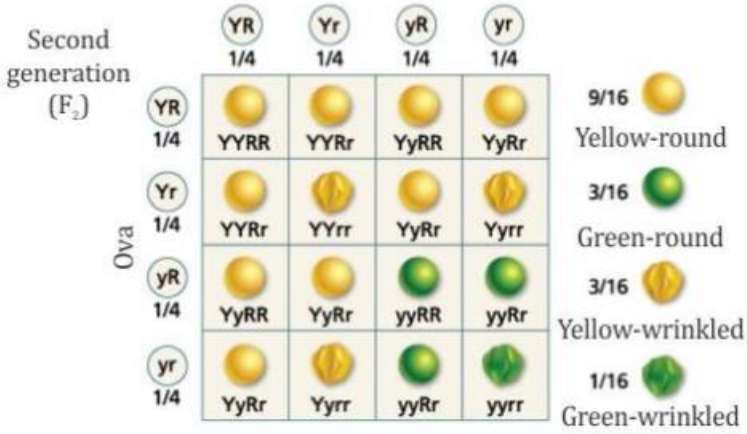
2. When the F1 progeny was obtained, they had round and yellow seeds, which means round and yellow are dominant traits.

3. Mendel then allowed the F1 – progeny to be self – crossed (self – pollination) to obtain, F1 – progeny. He found that seeds were round yellow, round green wrinkled yellow and some wrinkled green.

4. In F2 – generation all the four characters were assorted out independent of all the others; he said that a pair of alternating or contrasting characters, behave independent of the other pair.

Dihybrid Cross: [AI – 2016, Delhi – 2013, 2014]





yellow	:	yellow	:	Green	:	Green
Round	:	wrinkled	:	Round	:	wrinkled
9	:	3	:	3	:	1

Law of Inheritance:

The law of inheritance was proposed by "Gregor Mendel" after conducting experiment on pea plant for seven years.

1. Law of Dominance
2. Law of Segregation (Purity of gamete)
3. Law of independent assortment

Law of Dominance: [CBSE – 2020]

Characters are controlled by discrete unit called factors (genes), Factors occur in pairs. In a dissimilar pair of factors one member of the pair dominates (dominant) over the other (recessive)

Law of Segregation (Purity of gamete):

This law is based on the fact that the alleles do not show any blending and both the characters are recovered as such in F2 generation, though one of these is not seen at the F1 – stage; The parents contain two allele during gamete formation, the paired alleles separate or segregate from each other; such that the gamete receive only on factor.

Law of Independent Assortment: [AI – 2016]

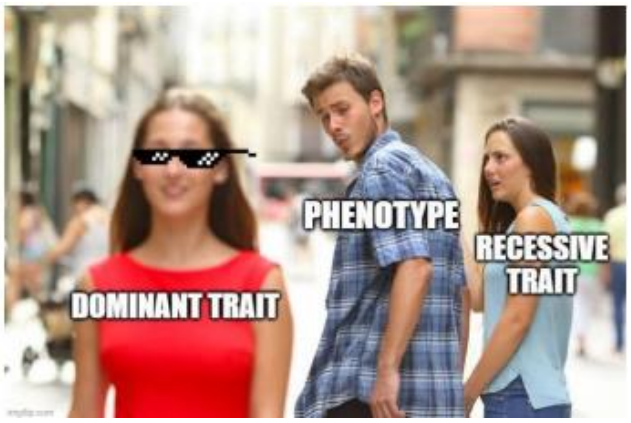
Law of independent assortment states that the alleles of two different genes get sorted into gametes independently of one another.

In other works, the allele a gamete receives for one gene does not influence the allele received from another gene.

Expression by Dominant and Recessive Factors:

1. Factors or alleles are actually genes or segments of DNA that control the expression of traits

2. They control the synthesis of proteins or enzymes formed from them



3. A dominant factor takes part in the synthesis of protein or enzyme so that it produces its morphological or physiological effect.
4. A recessive factor is unable to produce to fully effective proteins or enzyme.
5. A protein that is important for this process is synthesized by the factor for tallness more efficiently than the factor for dwarfness.

Sex Determination: [NCERT, Foreign – 2011, 2012, CBSE – 2020]

Autosomes	Allosomes
❖ Autosomes are chromosomes a part from the sex chromosomes ❖ These determine the somatic traits. ❖ There are 22 homologous pairs of autosomes.	❖ An Allosome is a sex chromosome that differ in size, form and behaviour from an autosome ❖ Hymans have one pair of allosome ❖ These chromosomes contain genes that determine the biological sex of an organism.

1. Out of 23 pairs of Chromosomes, Autosome (22 pair),Allosome (1 − pair)

2. A pair of X-Chromosomes is present in the female while the X and Y Chromosomes are present in male.

3. During sperm formation, 50% sperm carry the X-Chromosome and 50% have Y-Chromosome

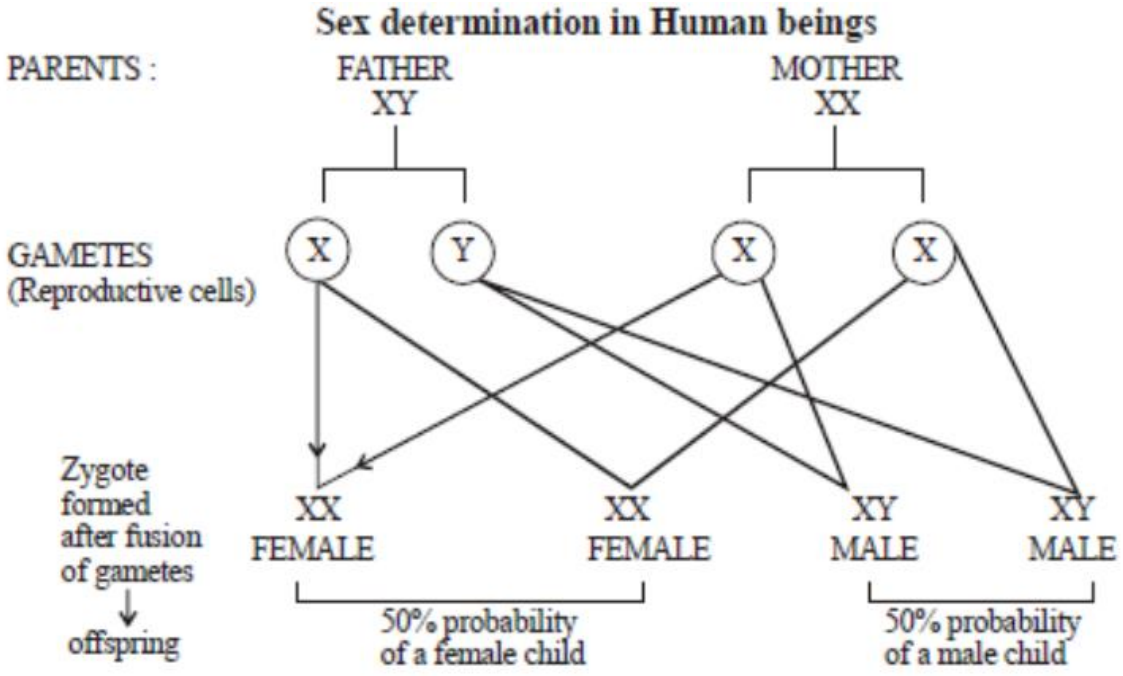
4. There is an equal probability of fertilisation of the ovum with the sperm carrying either x or y chromosomes

5. In case, the ovum fertilizes with a sperm carrying X-Chromosomes, the zygote develops into Female (XX)

6. Fertilisation of ovum with Y-Chromosome Carrying sperm results into a male offspring

7. It is evident that in each pregnancy there is always 50% probability of either a male and Female child.

8. It is unfortunate that in our society women are blamed for producing female children.



Previous Years Questions

Q. Why did Mendel carry out an experiment to study inheritance of two traits in pea? **[CBSE – 2020]**

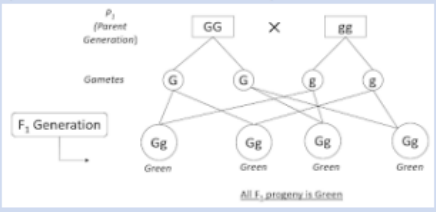
Ans. Mendel Carried out crosses with two traits to see the interaction and basis of inheritance between them in a dihybrid Cross given by Mendel, it was observed that when two pairs of characters were considered, each trait express independent of the other.

Q. A green stemmed rose plant denoted by GG and a brown stemmed rose plant denoted by gg are allowed to under a cross with each other. **[CBSE – 2020]**

a) List your observation regarding.
   i) Colour of stem in their F_1 progeny
   ii) Percentage of Brown stemmed plants in F_2 Progeny if plants are self - pollinated.
   iii) Ratio of GG and Gg in the F_2 progeny

b) Based on the Findings of this cross, what conclusion can be drawn?

Ans. a) i) Green ii) 25% iii) 1 : 2



b) This is a monohybrid cross. This shows that out of two contrasting traits only one dominant trait appears in F_1 – generation and the traits which does not express is recessive on selling the F_1 plants, both the traits appears in next generation but in a definite proportion.

Q. How do Mendel's experiment shown that traits are inherited independently? **[AI – 2016]**

Ans. In a dihybrid cross given by Mendel, it was observed that when two pairs of traits or characters are considered each trait expressed independent of the other.
Thus, Mendel was able to propose the law of independent Assortment, this could be explained.

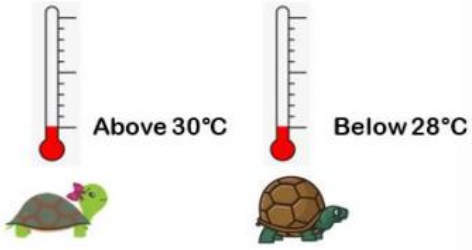
Q. A Blue Colour Flower plant denoted by BB is cross – bred with that of white colour flower plant denoted by bb. **[AI – 2012]**

a) State the colour of Flower you would expect in their F_1 generation Plant
b) What must be the percentage of white flower plant in F_2 – generation, if flowers of F_1 plant are self – pollinated
c) State the expected ratio of the genotypes BB and Bb in the F_2 – Progeny.

Ans. a) The colour of the flower in F_1 – generation will be Blue.
b) If the Flowers of F_1 – generation are self – Pollinated then the percentage of white Flowers in F_2 – generation must be 25%
c) The expected ratio of the genotype BB and Bb in the F2 - generation progeny is 1 : 2

Environmental Determination of Sex:

1. In turtle, an incubation temperature above $30°C$ produces female, While the temperature below $28°C$ produces only males.
2. In Lizard, high incubation temperature produces male offsprings.
3. Marine, Molluscs and marine worm develop into female if growing alone. In the company of a female they develop into male.



Questions

Q. Dog genetic combination of mother play a significant role in demining the sex of a new born? **[Exemplar]**

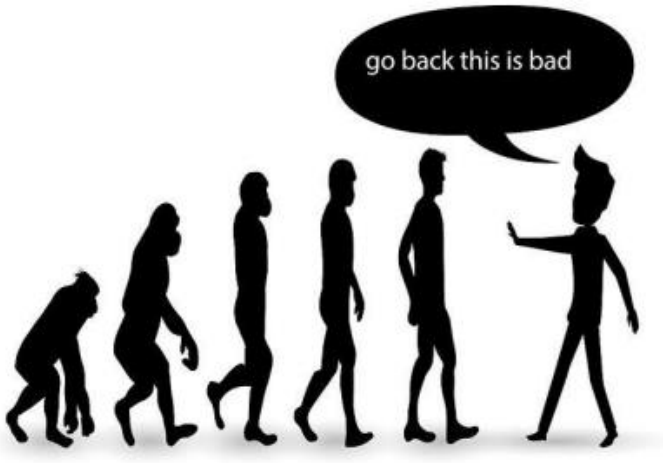
Ans. Mother have a pair of 'X' chromosome, so they do not play significant role in determining the sex of a New born.
All children will inherit an 'X' chromosome from mother regardless whether they are boy or a girl. Therefore sex is always determined by father because, Father have 'XY' chromosome.

Q. If a trait 'A' exists in 10% of the population of an asexually reproducing species and a trait B exists in 60% of the same population, which trait is likely to have arisen earlier? **[NCERT]**

Ans. In a population of a sexually reproducing species, the chances of appearance of New traits due to variation are very low and the traits which is already present in the population is likely to be in higher percentage and would have been arisen earlier. So, the trait B present in 60% of the population is the trait which have arisen earlier.

Evolution: (Charles Darwin is the Father of Evolution) [AI - 2016]

Evolution is the sequence of gradual changes which takes place in the primitive organisms, over millions of years in which New Species are produced.



Case 1 : (Group of Red and Green Beetles)

1. Colour Variations in Beetles arises during reproduction.

2. All beetles are red except one that is green. Red beetles are easily detected by the crows so; Crows Feeds on red beetle so no of Red beetles reduces.

3. On Beetle is green → Progeny Beetles are also green crows could not feed on green as they got hide in green bushes, so the no. of green beetles increases.

Conclusion

Green beetles are naturally selected.

Case 2 : (Group of Red and Green Beetles)

1. Reproduction in group of Red Beetles → All beetles are Red except one that is blue, both red and blue beetles increase in number

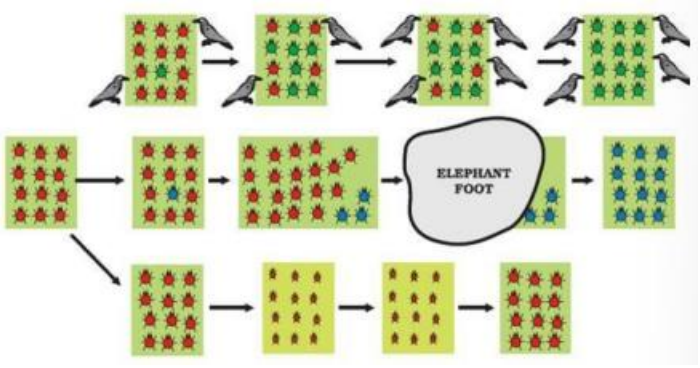
2. Crows can see both blue and red beetles and can eat them, number reduces but still red beetles are more, and blue once are few, but suddenly elephant comes and stamp on the bushes, now all the red beetles died now beetles left are mostly Blue.

Conclusion

1. Blue colour of Beetles did not survival advantage elephant suddenly caused major havoc in beetles population

2. Accidents can change the frequency of some genes even if they do not get survival advantage, this is known as “Genetic Drift”.

Case 3 : (Group of Red Beetles and Bushes)



1. Bushes suffer form plant disease, so Average weight of beetles decreases due to poor nourishment.

2. Number of beetles kept on Reducing, later plant disease get eliminated

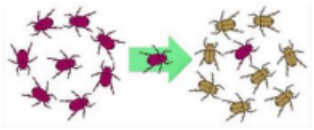
3. Number and average weight of beetles increases again

Conclusion

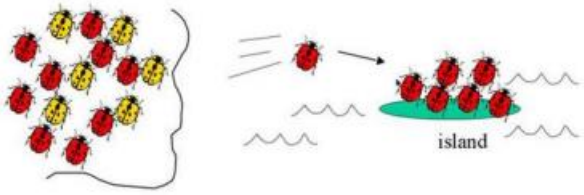
No genetic changes have occurred in the population of beetles due to the plant disease

Speciation: [AI – 2011, Delhi – 2012]

Speciation takes place when variation is combined with geographical isolation.



1. Gene Flow (Gene flow is the transfer of genes from one population to the next) : Occurs between population that are partly but not completely separated.



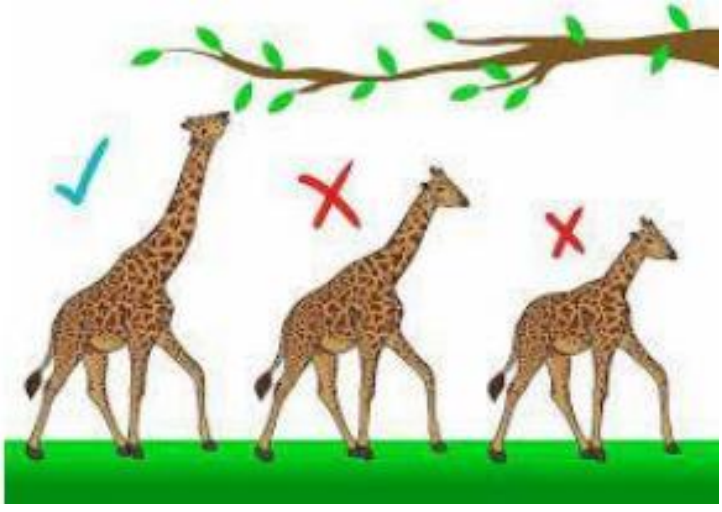
2. Genetic drift: It is the random change in the frequency of gene pair in a population over successive generation genetic drift takes place due to:

Several changes in the DNA

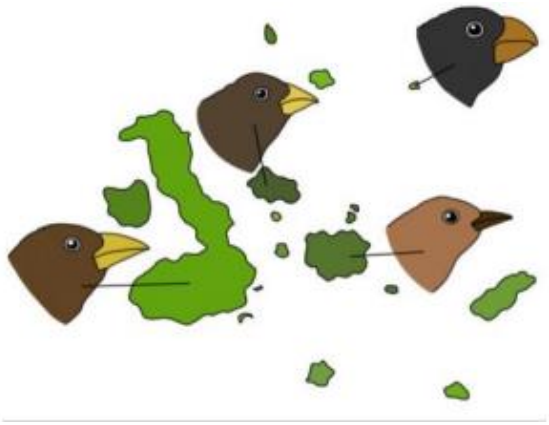
Change in number of chromosomes

3. Natural Selection:

The process by which nature selects and consolidate those organisms which are more suitable adapted. Example. Green beetles are naturally selected



4. Geographical Isolation: It is caused by mountain ranges, river etc. Geographical isolation leads to reproductive isolation due to which there is no flow of genes between separated groups of population.



"Speciation is the process of formation of a new species from existing ones due to several evolutionarily Forces like genetic drift, isolation of population, Natural selection etc. speciation leads to diversity in the ecosystem and the diver sity and diversity lead to evolution."

Father of Evolution – Charles Robert Darwin:

• Conducted various experiments that led him to formulate his hypothesis, that evolution took place due to natural selection.

• Book origin of species was written by "Charles Darwin"

• He was an accomplished naturalist, and one of the studies he conducted was to do with the role of earth worm is soil Fertility

Origin of Life on Earth:

"Oparin – Haldane theory of Life"

• A.I Oparin and J.B.S Haldane Belived that methane, ammonia and water vapour contains the kind of atom needed to form various substances such as Alcohol and Amino acids.

• Accumulation of such organic compound with in the oceans, lake, ponds, pools etc. over millions of years must have produced a kind of Hot soup.

• In this hot soup smaller organic compounds must have combined together to form large organic compound and various macromolecules like polypeptide, proteins, nucleic acids, Carbohydrates etc. These compounds then interacted to produce the first living cell Apni Kaksha

• According to this theory, the first living cell arose from simple inorganic and organic Non-living elements.

• The energy for such chemical reactions must have come from the heat of the atmosphere and from the electrical energy of light.

• The most have aggregate in various combination and must have formed the colloidal masses at the base of ocean, they formed the small globules; such type of cells are known as pre-cells and then they gradually transformed into living cell.

• Then enzymes and other important compounds inside are formed, enzymes are protein in Nature.

Urey and Miller Experiment:

1. Stanley Miller and Harold C. Urey in 1953 tested the Oparin – Haldane theory

2. They made an apparatus to circulate methane, Ammonia water vapour and Hydrogen gas.

3. All these gases were put in a Flask Fitted with electrodes.

4. In another flask water is being boiled continuously

5. The electrical charges, to provide energy similar to lightening were passed for one week or more.

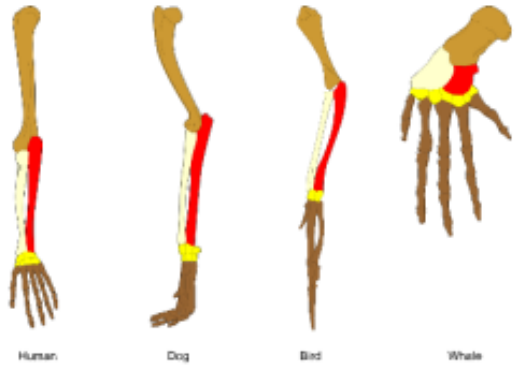
6. He was able to get the number of Amino acids some of which are known to be present in the proteins.

Evolution and Classification: [AI - 2016]

- Both evolution and Classification are interlinked
- Classification of species is reflection of their evolutionary relationship.
- The more characteristic two species have in common the more closely they are related.
- Similarity among organisms allow us to group them together and to study their characteristic.

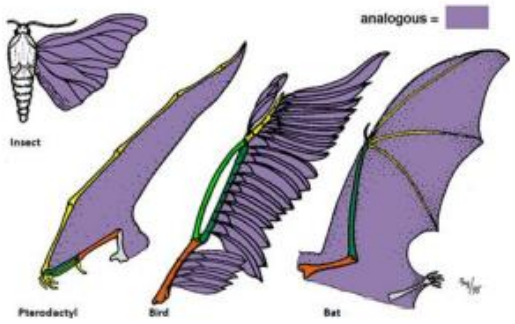
Evidences of Evolution: [Delhi – 2017, 2011, 2012, AI – 2015]

Evidences From Morphology and Comparative Anatomy



1. Homology/Homologous Organs: The term Homologous organs which means organs having the same origin and structure but their function may be same or different; this is also known as Divergent Evolution.

Examples: Hands of Man, wings of bat, wings of Birds, Flipper of whale and forelimb of Cow are similar, but have different functions.



2. Analogy/Analogous Organs: These are the organs that have different origin and structural plan but same functions. (Convergent Evolution)

Example: Wings of insect, Bat and Birds are of different origin but have similar function.

3. Fossils (Paleontological Evidences): [Delhi – 2013, AI – 2011]

Fossils are dead remains of organisms of the past, they are preserved traces of living organisms. "Archaeopteryx χ" possess features of

reptiles as well as Birds, suggests that birds have evoloved from Reptiles.

Example:

1. Ammonite – Fossil of invertebrate
2. Trilobite – Fossils of invertebrate
3. Knightia – Fossil (Fish)
4. Rajasaurus – Fossil – dinosaur skull (Raja Saurus)

Age of the Fossil:

1. Deeper the fossil, older it is
2. Detecting the ratios of difference of the same element in the fossil material, for example carbon dating.

Formation of Fossils:

Fossil formation occurred by total replacement of organic molecules by minerals like iron pyrites, silica calcium carbonate. It was the main and most common way of fossil formation.

Evolution by Stages: [Delhi – 2015]

"Evolution takes place in stages"

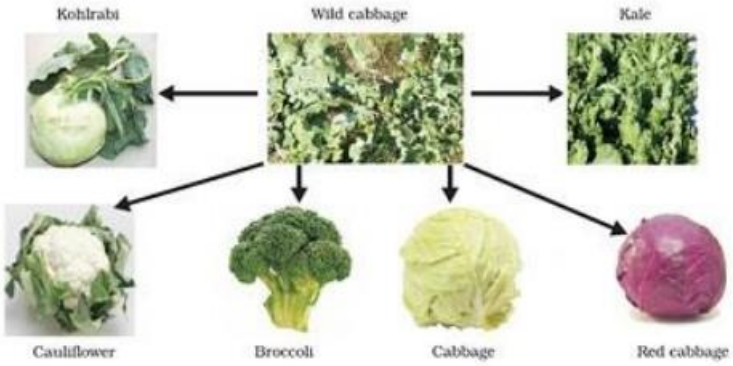
1. Fitness Advantage (Evolution of Eyes): Evolution of complex organs is not sudden. It occur due to minor changes in DNA, however takes place bit by bit over generation.

- Flat worms have rudimentary eyes (enough to give fitness advantage)
- Insects have compounds eyes
- Humans have binocular eyes.

2. Functional Advantage (Evolution of Feathers): Feathers provide insulation in cold weather but later they might become useful of flight.

Example: Dinosaurs had feathers, but could not fly using feathers. Birds seem to have later adapted the feathers to flight

Evolution by Artificial Selection:



- Humans have been a powerful agent in modifying wild Species to suit their own requirement throughout ages by using Artificial selection.
- From the wild cabbage many varieties like Broccoli, cauliflower, red cabbage, kohlrabi were obtained by artificial selection.
- Many varieties ↓ obtained due to artificial selection of wheat.

Molecular Phylogeny:

1. Changes in the DNA during cell division would lead to changes in the proteins

2. These changes would accumulate from one generation to the next generation

3. Organisms which are more distantly related will accumulate a greater number differences in their DNA.

4. Molecular phylogeny, also known as molecular systematics, is the use of structure of molecule to gain information on an organism's evolutionary relationship.

Human Evolution:

➢ Tools for tracing evolutionary relationship – excavating, time – dating, studying fossils, determining DNA sequences – have been used for studying human evolution.

➢ There is great diversity of Human forms all over the world, yet all humans are a single species.

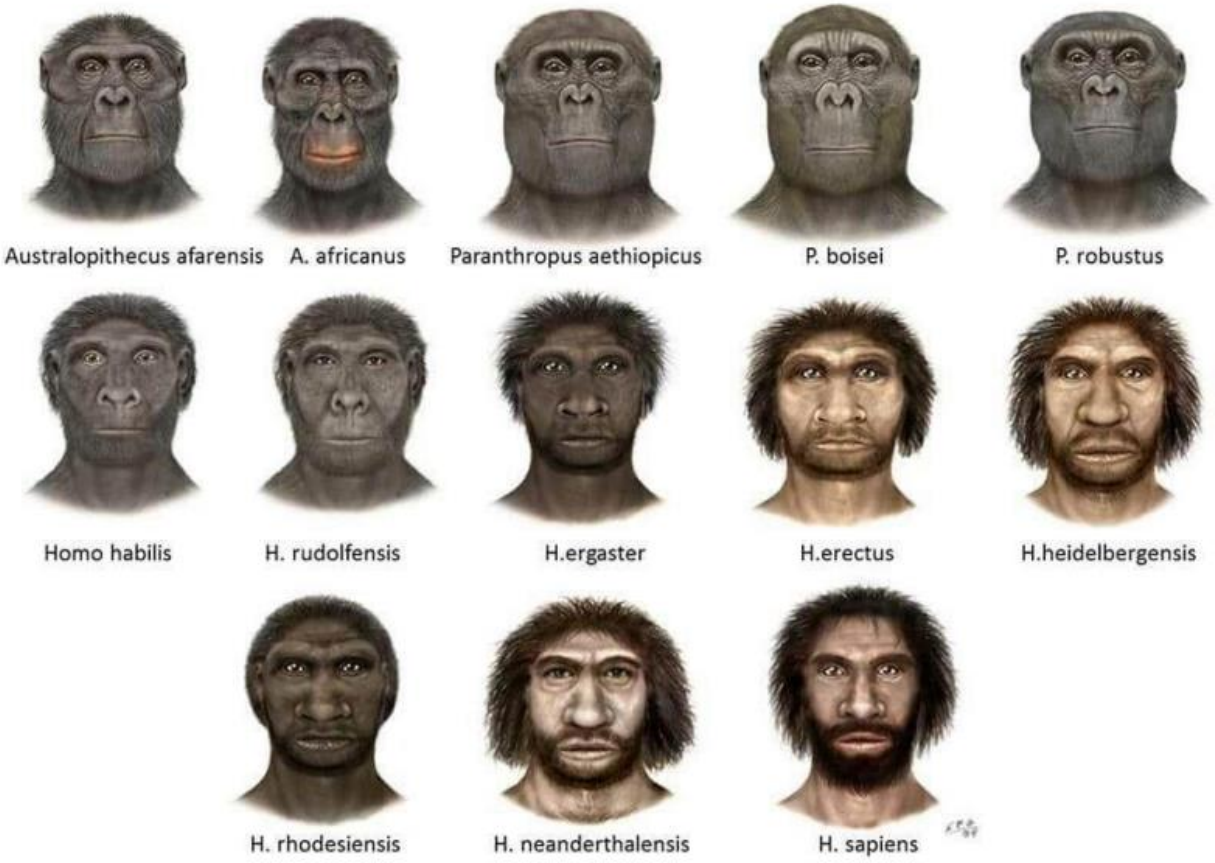
➢ All humans come from Africa. The earliest members of the human species, Homo sapiens, can be traced there; our genetic foot prints can be traced back to our African roots.

➢ The residents spread across Africa, the migrants slowly spread a cross the planet from Africa to west Asia, then to central Asia, Eurasia south Asia.

➢ They travelled down the islands of Indonesia and the Philippines to Australia. Apni Kaksha

➢ They did not go in a single line.

➢ They went forwards and backwords with groups sometimes separating from each other.



Previous Years Question

Q. Write the contribution of Charls Darwin in the field of evolution? **[Delhi – 2014]**

Ans. Darwin explained the phenomenon of "Natural selection" that is only the organism which can adapt to the changing environmental conditions can survive, and he also stated that the Natural selection is a process which plays very important role in evolution of plants and animals by selecting the organism with traits favourable to the environment.

Q. With the help of suitable examples, explain why certain traits cannot be passed on to the next generation? What are such traits called? **[AI – 2014]**

Ans. Certain experiences and traits earned by people during their life time are not passed on to their next generation because all these characters are acquired by people during life time. People are not born with these traits and they cannot pass on these traits to their children

Example:

1. Child of a very good swimmer may not know how to swim. This is so because the technique of swimming is not inherited from parents but it is learnt by the person himself or herself.
2. A person may have a scar on the face from a cut he got in an accident. This is also an example of acquired trait which cannot be passed to the next generation.

Traits can be passed on to the future generation in which changes have occurred in the genes present in the reproductive cell of the parent organism, these traits or characters are know as inherited traits.

Q. a) Classify the following as Homologous or Analogous Pairs: **[CBSE – 2020]**

i) Broccoli and Cabbage
ii) Ginger and Radish
iii) Forelimbs of Birds and lizard
iv) Wings of a Bat and Wings of a Bird

b) State the main feature that categorises a given pair of organs as homologous or analogous.

Ans. a)

i) Broccoli and Cabbage are Homologous
ii) Ginger and Radish are Analogous
iii) Forelimbs of Birds and lizards are Homologous
iv) Wings of Bats and Wings of a bird are Analogous

b) Homologous organs have the same fundamental structure but different internal structure but similar function.

Q. "During the Course of Evolution, organs or Features may be adapted for new functions". Explain this fact by choosing an appropriate example. **[CBSE – 2020]**

Ans. Evolution is the sequence of gradual changes from simple life form to complex life form. During evolution process, many organs are adapted for new functions. The organs which perform different functions in different species but have similar basic structure and similar origin Homologous structure are a result of divergent evolution homology indicated common ancestry.

Go to Practice Questions, Solve Dpps attend MCQs and revise the notes after some 2nd 4th and 7th day

To get 95+ you have to keep on revising what you studied.

[Remember Consistency and HardWork Gives Great Result]

NOTES MADE BY

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