19-07-13

EVOLUTION

Evolution refers to all changes that have transformed life on earth from its earliest beginnings to the diversity that exists today.

From the organism point of view, evolution is defined as the devlt of differentiated organisms from pre-existing less differentiated organisms over the course of time.

Or Evolution is the gradual change in the nature of living organisms over long periods of time.

The theory of evolution offers an expln of how the great diversity of present day animals and plants came into existence. It supposes that life on earth began in relatively simple forms wlc over hundreds of millions of years gradually gave rise to a succession of living organisms wlc became more ~~varied~~ varied and more complex.

The evolutionary theory supposes that life itself evolved from non-living matter

THEORIES OF EVOLUTION

The currently accepted theories of evolution have been developed and refined by biologists as evidence has become available to support and extend the mechanisms first proposed by Alfred Wallace and Charles Darwin.

Earlier explns especially those of Lamarck and are not well supported by the current evidence and are generally not accepted by the current Scientists.

1. Lamark - In 1809 proposed an hypothesis to account for the mechanism of evolution based on 2 Conditions;

(i) The use and disuse of parts or organs.
(ii) The inheritence of acquired x-tics in living organisms.

He believed that increased use of a certain organ or structure would lead to increased size or efficiency while disuse would lead to its gradual decrease in size or degeneration.

Lamarck further believed that these changes would be transmitted to the offspring.

He gave many examples to support his theory such as;

(i) Long necks and long legs of giraffes – wh he suggested they are acquired x-tics due to their stretching to reach leaves at higher and higher levels of trees. That each generation passed on their slightly longer necks and legs to their offspring.
(ii) The webbed feet of aquatic birds and long legs of wading birds are acquired structures adapting them to aquatic environment.
(iii) The black acquired black skins because they live in tropics due to too much sunshine.

Generally according to Lamark evolutionary change is due to an interaction between the organism and the env't). If an organ or structure is not fully utilized it degenerates and will not appear in the next generation. Ie The theory of acquired x-ters that any x-ter wh is acquired by the parents can be inherited by the offspring.

2. Darwin.

He proposed that natural selection is the mechanism by which new species arise from pre-existing species.

Here is an outline of Darwin's observations (O) and deductions (D);

(i) All species produce far more offspring than are needed to replace the parents. (O)

(ii) Although populations fluctuate in numbers, they do about a mean (average number) which usually does not change much (O).

(iii) There must offspring must die without reproducing (D)

(iv) Within a population individuals vary ie no 2 individuals are exactly alike. (O)

(v) There some individuals (ie the "fittest") have a better chance of surviving to reproduce (D)

(vi) Since most variations have atleast some genetic basis, the next generation (ie the offspring of the fittest in the previous generation) will resemble their parents more than those that did not survive. (D)

(vii) If the survivors are not the average for the population, then over many generations the population will slowly change ie evolve. (D)

Thus nature selects those organisms best "fitted" to survive ie natural selection or otherwards, "Survival of the fittest"

The basis upon wch natural selection operates is competition between individuals. ie the stronger, the faster (generally def the "fitter") will be able to obtain more food at the expense of weaker animals, which may die before being able to reproduce.

Also the stronger, or more attractive male or female will be more likely to find a mate (ie sexual selection).

(o). Among plants the "fittest" are those best able to compete for light, water and nutrients.

22/2/13

EVIDENCES FOR EVOLUTION

The evidence to show that evolution has taken place, and is still taking place, can be obtained from the following studies:

1. Palaeontology.
2. Comparative anatomy.
3. Comparative embryology.
4. Evidence from biochemistry.
5. Chromosomes structure.
6. Protective resemblance / protective colouration / industrial melanism.
7. Evidence from geographical distribution or Continental / species distribution.
8. Evidence from domestication / Artificial selection.
9. Evidence from Cellular physiology.
10. Evidence from cell biology.
11. Evidence from systematics.
12. Evidence from resistence by Viruses.

Palaeontology

This is the study of fossils. A fossil is a relic or remain of an organism from the Past that was once living, usually preserved in rock.

Different types of fossils.

(i) Compression :— Is where the body parts has been trapped in sediments without being completely decomposed and some of the organic materials remain in the Compression.

(ii) Impression :— Here the body of an organism is preserved but due to too ~~high~~ much pressure and heat during the Compression, the organic matter evaporates. What remains is the shape or Impression of the organism.

(iii) Petrifaction :- Here the original hard parts or tissues may be replaced by minerals such as iron, silica and calcium carbonate.

(iv) Moulds and casts :- moulds are formed by hardening of material surrounding the buried organism (cast)

(v) Entire organism :- At times the whole organism may be preserved e.g an insect trapped inside a plant material like wood which is also preserved or it may be frozen.

(vi) Imprints :- such as foot prints of dinosaurs, trails or tunnels of organisms made in mud, baked rapidly and filled with sand and later sediments.

(vii) Coprolites :- Such as faecal pellets prevented from decomposing and later preserved in sedimentary rocks. These give evidence of the type of food eaten and the type of teeth possessed.

Generally, hard parts of animals such as bones, horns and teeth are often fossilized. Plant tissues such as wood and some leaves may be preserved.

How the fossil record provides evidence for Darwin's theory of evolution.

Fossils are quite a useful evidence for evolution since they show, in general, the way of appearence of the major groups of organisms and support general view that the present life forms, have gradually evolved from ancient ones and are not a result of sudden appearence or special creation. This is possible because:

- The fossil record shows the most primitive types in the lowest and hence oldest strata in the earth and higher (advanced / complex) organisms in the upper most strata. It is believed that these strata have been laid down over the ages (million s of years) on top of the other.

- These rocks can be dated e.g by Carbon-14 dating & the ages of the rocks and the time of existence of life forms preserved can be estimated.

The fossil record has been useful in the study of evolution of whole races e.g the evolution of the present day horse from its primitive ancestor

Short comings of ~~the~~ a fossil record.

Not all organisms that lived in the past were fossilized because the prevailing climate may not have favoured fossilization. And when it did, not all parts of the organism were fossilized. In particular soft parts are often not recorded in the fossil record.

On the other hand we have to appreciate that not all fossils have been dug up thus the fossil record is incomplete.

2. Evidence from Comparative anatomy.

Comparative study of the anatomy of groups of animals and plants reveals that certain structural features are basically similar for instance

i) Homologous structures: These are structures built on the same basic plan but which perform different functions in different groups of organisms possessing them. Example

ii) The pentadactyl limb among different vertebrates. This has been modified in different ways to perform different functions for instance

- for swimming in a whale
- flying in bats.
- grasping in monkeys.
- running in a horse
- digging in a mole.
- tearing in ant eater

These and the general homology in the anatomy of vertebrates confirm the contribution of evolution in the formation of many organisms from similar ancestors.

(b) Vestigial organs.

These are reduced organs with no apparent function in the organisms possessing them. They show that due to evolution organs that were formerly of use in an old env't are rendered useless in the new one and may degenerate due to loss of function but continue to exist as vestigial organs eg

- Coccyx : These are fused vertebrae in man that represent a tail found in other mammals
- Appendix in man is also a vestigial organ representing the once large useful caecum found in ruminants.

(c) The basic flower structure in all flowering plants. It consists of sepals, petals, stamens, stigma, style and ovary yet the size, colour, number of parts and specific structure are different for each individual species.

On the whole homologous structures support the theory of evolution because they manifest the fact that organisms w/c posses them are related and have likely originated from a common ancestor in the past. The difference in them shows how evolution can be divergent suiting them to different functions and thus different habitats. The fact that similarities remain among them is evidence that evolution has not occured by sudden appearance of new forms but by slight modification of existing ones.

Hence adaptive radiation.

(ii) Analogous structures.

Are organs with different basic structure but wlc perform the same functoai eg

(a) The wings of insects and wings of birds.
(b) The jointed legs of insects and legs of vertebrates
(c) Eyes of vertebrates and cephalopod of molluscs
(d) presence of thorns on some Plant Stems and spines on some animals eg porcupine

Clearly these result from the ~~same~~ different ancestry but show how evolution along different lines can solve the same environmental Problem by adapting different organisms to the same envt - This is what is known as Convergent evolution.

3 <u>Evidence from Comparative embryology.</u>

Embryology is a study of the developmoat al stages of embryos of organisms.

In particular embryos of higher vertebrates repete structures of lower animals some of wlc are later lost during devlt since they are of no use in the adult. This is what Karl Ernest Von Baer termed the ~~re~~ recapitulation theory which states that "Ontogeny recapitulates Phylogeny" Which means that the developmental stages of an organism from Zygote to adult repeat the history of the whole race in its evolution through the ages. This law ~~was~~ Stated in modern terms by Ernest Haeckel and known as the Biogenetic law States that "Each organism tends in its ontogeny to recapitulate or repeat the stages which its ancestors Passed through during the Phylogeny of the whole race.

This clearly shows that humans and other higher vertebrates continue to pass via many similar embryonic stages ~~and~~ as those of lower vertebrates. This is bse we have all inherited developmental stages from a common ancestor. Therefore the more closely related to vertebrates are, the longer their embryonic developmental process continue to pass via similar stages and we vice vasa

This theory of recapitulation is also evident in invertebrates eg in insects. During embryonic devt of insects, limb buds appear on each segment just as the legs appear in their ancestors (ie millipedes and centipedes.) By the time they reach adulthood only six legs remain on the thorax.

4 Evidence from Comparative biochemistry.

Similarity in the following components of living matter indicates common ancestry and suggests that any difference between organisms is due to evolution.

(i) All living organisms are made up of the elements of Carbon, hydrogen, oxygen and Nitrogen making up about 90% living matter.

(ii) all are composed of about 70–90% water by weight and water is the most plentiful compound in their protoplasm.

(iii) Carbohydrates, lipids and proteins are the most abundant compounds in their protoplasm.

(iv) In all the Chromosome structure contains DNA.

(v) They show similarity in the distribution of enzymes, hormones (in animals) in related species and groups

A classic example of biochemical evidence is provided by similarity in cytochrome C. Amino acid sequence of cytochrome C among organisms studied has shown striking similarity. It has been found out that the amino acid sequence in positions 78 — 88 were identical among all the eukaryotes studied. The amino acid sequences for cytochrome c of humans and chimpanzees is identical and differs from the Rhesus monkey by only one amino acid. and from that of wheat by 35.

Similar results have been obtained from the study of globin proteins ie haemoglobin and myoglobin.

Similarities and differences between the polypeptide chains of haemoglobin in four primates.

species	α-haemoglobin (141 amino acids)	Polypeptide chains β-haemoglobin (146 a·a)	γ-haemoglobin.
			+
Human	+	+	+
chimpanzee	+	+	1
Gorilla	1	1	1
Gibbon	3	3	2

Haemoglobin is composed of four polypeptide chains, made up of α, β and γ polypeptides.
+ indicates no difference in a·a sequence from that of human, figures indicate number of amino acids differences

The precipitin test is a biochemical test used for desciding degrees of relationship between different species and thus common ancestry. It is based on the types of proteins present in

the ~~Pro~~ blood of animals.

Precipitin is an antibody that combines specifically with and identifies antigens. The test is applied to measure the homology of serum proteins in related groups, genera, species. for example if antiserum containing antibodies against human serum is mixed with some chimpanzee serum, nearly the same amount of ppt is formed which indicates that at this qualitative level the chimpanzee and human sera are apparently almost alike in structure. With dog serum no precipitate is formed indicating that the 2 organisms are distant on the evolutionary tree.

Amounts of precipitate produced by adding serum from the following mammals to rabbit serum containing anti-human antibodies against human serum

Human	100%
Chimpanzee	97%
Gorilla	92%
Gibbon	79%
Baboon	75%
Spider monkey	58%
Lemur	37%
Hedgehog	17%
Pig	8%

5 Evidence from protective resemblance / Coloration.
(INDUSTRIAL MELANISM)

This is one of the recent examples of the evolutionary change. It is provided by the response of moth species to the directional selection pressure produced by the atmospheric pollution which accompanied the industrial revolution. Within the last 100 years darkened forms of about 80 species of moth have appeared in varying frequencies throughout the united kingdom. This phenomenon is known as industrial melanism.

Industrial melanism is a process whereby species of moth have become blacker or darker following industrialization.

This is the work of Dr. H.B.D Kettlewell in the 1950's on British populations of the peppered moth, Biston betularia. From his studies it was established that there are 2 genetically determined patterns of this moth ie

(i) The original light coloured peppered pattern (speckled pattern) ie Biston betularia typica.
(ii) The mutant, a uniformly dark pattern ie Biston betularia carbonaria.

He established that the mutant forms had progressively increased in number in the industrialised towns of manchester from low numbers in 1840's to the extent of constituting about 98% of the total population of the moth in 19th century. He observed that this was possible because the mutant forms were better ~~Camouflaged~~ Camouflaged from birds like robbins, Sparrows and redstarts which were predating on them since all the tree trunks and walls of towns had been covered by soot from the industries since coal was the major industrial source of fuel then.

He urged that in such conditions the light forms were easily seen and eaten and thereby their numbers progressively decreased.

Clearly a change in environmental conditions had caused a change in allele frequency hence evolution

29-07-13

6. Evidence from geographical / Continental species distribution

Studies of distribution of plants and animals allover the earth reveal that;

(a) Different regions often markedly differ in the composition of their flora & fauna

(b) These differences in most cases cannot be explained in climatic terms for instance the southern Continents ie south America, Africa and Australia all have comparable climates and yet each has its own x-tic flora and fauna eg.

✓ (i) South America has Edentats (sloths, anteaters and armadillos), Primitive monkeys (spider monkeys) and rodents (eg be guinea pigs). Non- of which occur naturally in Africa or Australia.

✓ (ii) Africa has a wide variety of antelopes, Zebras & giraffes, Lions, baboons, gorilla, Okapi, Chimpanzees etc. Giraffe in particular occur no where else in the world.

✓ (iii) Australia does not have any natural placentals except a few mice species. All the placentals there eg cattle have been introduced. Its indigenous species are the marsupials (ie pouch animals like the kangaroos). monotremes (ie egg laying mammals like duck-billed platypus and Spiny anteater which do not occur elsewhere in the world.

A better explanation for these distribution studies is provided by geological studies which show that these land masses (continents) in the past were one large mass called Gondwanaland (Pangea) which later began to separate in the

process of Continental drift but remained linked at various points by land bridges and Straits. This suggests that migrations into the different Continents occured but later the land masses became separated from each other and organisms in them evolved differently to occupy all the niches available.

Geological and fossil evidence actually shows that true placental mammals appeared in that late Cretaceous period probably in North America.

Previously monotreames and masupials were abundent in N. America and Europe. They could have then spread over to Asia via land bridges where they evolved into present types. placental mammals could not cross to Australia because the land bridges were broken by the placental mammals had evolved. Thus with no Competition from more vigorous placentals the monotremes and marsupials flourished in Australia. In other areas they were out competed by placentals. S. America and Africa were still Connected to N. America during the periods when and after placental mammals were evolving. These animals thereby spread into both Continents. In Africa they found a rich and diverse environment and there evolved into diverse forms to occupy all the available nitches

That organisms once left alone can evolve to fill all available niches is Confirmed by Darwins finches on Galapagos Island where he discovered that these finches had evolved to achieve great diversity.

7. Evidence from Domestication (Artificial selection)

~~The fact that~~ Man has been able to interfere with natural in selective breeding where he has been able to select, isolate and direct the evolution of new species with desired qualities among his domestic animals and crops. This replicates how evolution could have taken place in the past though this could have been far slower due to dependence on more chance for such useful x-ters to come about.

8. Evidence from cellular physiology

Cellular Physiology strongly suggests the common ancestor of all living organism because of the fundamental similarities between them.

In every organism studied whether it is a prokaryote (eg blue green algae and bacteria) or eukaryote (eg amoeba and human), many physiological and biochemical process are found to be similar in all cases for instance in every cell, energy is derived from glucose through glycolysis and oxidative phosphorylation and also by use of the same enzymes and coenzymes eg NAD and FAD, and cytochromes to produce ATP.

9. Evidence from systematics (classification)

Systematics is the study of different animal and plant groupings. This theory of synthetic change asserts that the change was formed in a tree like manner ie phylogenetic tree.

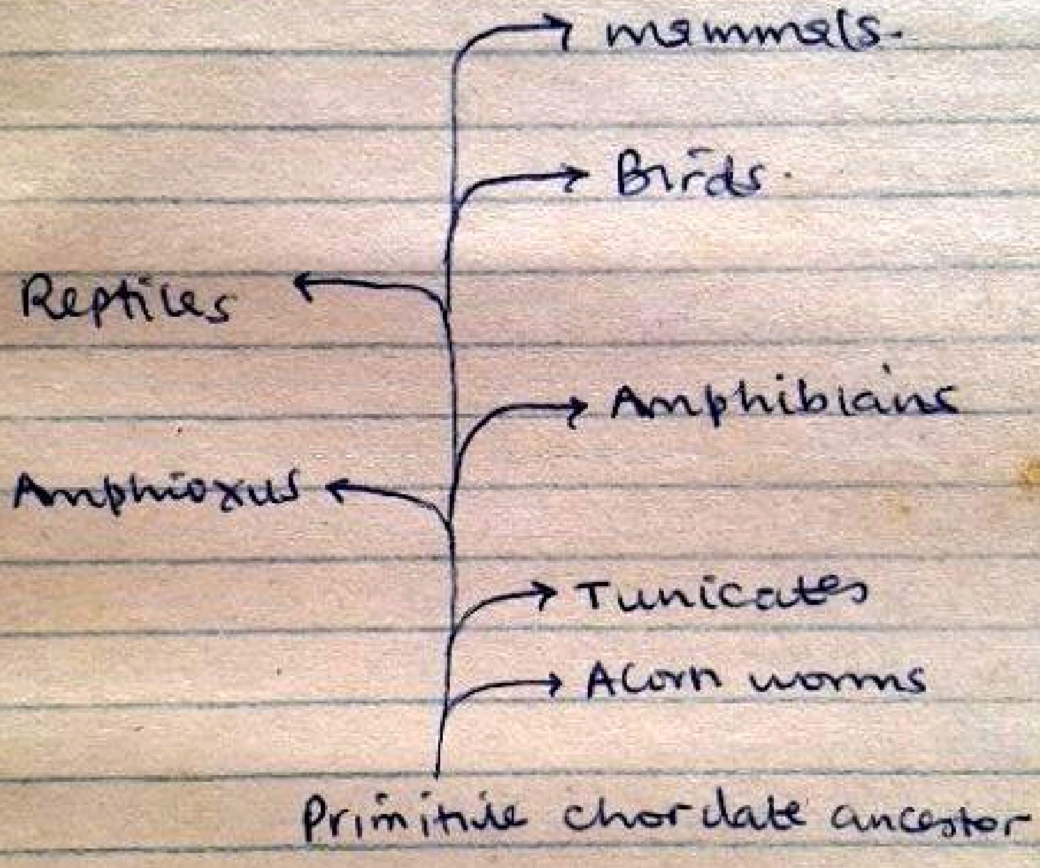
Small variations added up to form larger ones and then the larger ones added up to form the largest variations in more advanced grps.

The natural systems of classification show that the similarities in the basic structure reflect common ancestry and that all living thing are related to one another to a greater

or lesser extent.

The ~~existinct~~ extinct types there4 ~~the~~ constitute links between forms which may seem widely different at the present day.

<u>Evolutionary tree for the chordates based on comparative anatomy, embryology and fossil evidence.</u>



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