

All the living organisms have a capacity of rapid increased in their numbers by reproduction and caused the over population of off springs. Such reproductive potential of living organisms may be easily observed in the nature. For examples

- *Paramecium* reproduces 3 times in 48 hours. If the rate of reproduction remains same and all off springs will survive, their volume at end of 9000th generation would be equal to 10000 times the volume of the earth.
- An oyster lays about 80 million of eggs in a year. If the rate of reproduction remains same and all off springs will survive, the shell of off springs in five generation would be equal to eight times the size of the earth.
- A single pair of English house sparrow would be ancestor of over 275 billion of individuals within 10 years if all descendants were survived and reproduced at their natural rate.
- In case of slow breeding animals like elephants, a pair of elephants could have 28 million of descendants in absence of any check in 800 years.

B. Struggle for existence

Although all the living beings have enormous power of fertility to increased their numbers, population of organisms remain more or less constant over a period of time related to the length of their life cycle. This is due to the availability foods, water and other resources like shelter, suitable climate, breeding area and mate etc. that can support only a limited number of organisms. To survive and continue the generation, an organism must be competed or struggled for its existence with other organisms or its environment. There are three different types of struggles. They are;

- i. **Intra specific competition or struggle**
- ii. **Inter specific competition or struggle**
- iii. **Environmental competition or struggle**

The competition between the organisms or individuals of the same species for suitable space, foods, water and mate etc. is called intra specific competition.

ii. Inter specific competition

The competition between the organisms of different species is called inter specific competition. This type struggle occurs due to similar requirement of these organisms.

iii. Environment competition

The competition between the organisms with adverse environmental conditions like heavy rainfall, drought, heat, cold, natural calamities etc. for survival is called environment competition.

C. Variation and Heredity

According to Darwin, the competition among the organisms has forced or compelled them to change themselves according to needs to utilize the natural resources for survival and reproductive success. Such changes are called variation. The variations are two types; useful variations and harmful variations. The harmful variations make the organisms unfitted in the struggle for existence and caused them elimination from competition. The useful variations are quite significant and make them fitted in their environment. These variations are transmitted or inherited to off springs and it is called heredity. Therefore, progeny have better chance of survival.

D. Natural selection or Survival of the fittest

The useful variations are transmitted to the off springs. So, generation after generation this process would continue and making the organisms better adapted to their environment. Those organisms which are better adapted will survive and reproduce that give them an advantage over other organisms which have harmful variations. Those organisms which have harmful variations will decline and eliminate. This process is known as survival of the fittest or natural selection. This process leads to increase the population of those species which possess useful variations and ensure the survival of that species.

E. Origin of new species

Due to inheritance of useful variations in every generation, the successive generation become more adapted to their environment. If any changed occur in nature further adaptation follows. Due to continuous natural selection, in due course of time descendants or off springs produced will be entirely different from their ancestors and look like a separate sub species. These new sub species again adapted in the changing environment and the variation of one group may occurs in one way and other group in different ways. Thus, two or more new species may originate from single ancestral species. In this way new species is originated by process of variation with heredity accompanied by natural selection over the vast geological time to produce all the living organisms of today.

Examples:

A. Origin of long necked giraffe

The origin of present day long necked giraffe can be explained on the basis of Darwinism in following way;

It is believed that giraffe had originally long neck. As the leaves on the lower branches of tree become scare, the giraffes were forced to reach the leaves on higher branches of

trees. Then, the animals with comparatively longer neck became more fitted, because they could reach the leaves on higher branches and had better chances of survival. But those with comparatively shorter neck were not selected by the nature. Thus, longer neck animals fed comfortably and reproduced continuously.

B. Industrial Melanism

Two species of Peppered moths occurred in city of England; light-colored peppered moths (*Biston betularia*) and dark-colored peppered moths (*Biston carbonaria*). Before industrialization of city, light-colored moths were dominated because they were easily blended with the light background of lichens covered tree trunks. But dark-colored moths were very rare because they could not escape from their enemies and the dark body color become disadvantageous for them at that time. After industrialization, atmosphere became polluted and soot from industries got deposited on the tree trunks making them darker in shade. Then, the population of dark colored moths were dominated while light-colored moths were rare. But, in recent years due to decrease of environment pollution, the deposition of soot on the tree trunks started declining. So, the tree trunks again become lighter in color. Therefore, the dark colored forms again become conspicuous and were easily preyed by their enemies. Hence, the light-colored forms again started increasing in number, as they are found today. This is an example of industrial melanism in favor of Natural selection.

C. Sickle cell anemia

Sickle cell anemia is disease, caused by genetic disorder. In this disease, the RBCs become sickle shaped and disintegrated. Then, the percentage of haemoglobin is decrease drastically resulting severe anemia. It is because the haemoglobin synthesized is defective and controlled by its recessive homozygous gene. So, homozygous person having this defect die at early age. It not only happens in this but also in heterozygous condition. The cells containing defective haemoglobin become sickle shaped and are not able to transport oxygen. The person bearing this gene is mostly reported from the areas where malaria is very common. It is supposed that when an RBC in heterozygous person becomes sickle shaped, it kills the malaria parasite. Therefore, heterozygous persons can cope better with malarial infection and live relative normal lives than those people which have normal haemoglobin. The process of natural selection thus maintains the abnormal form in the region where malarial infection is common.

D. Resistance of mosquito to DDT

Mosquitoes spread the parasites which cause malaria to human. It was found that an insecticide known as Dichloro-Diphenyl Trichloroethane (DDT) was very effective in killing the mosquitoes, but a few numbers of mosquitoes survived. These surviving mosquitoes had unique ability of resistance to DDT. With the repeated spray of DDT, the

susceptible mosquitoes were killed. The resistance mosquitoes (which were originally present in small population) started multiplying very fast. Therefore, the population of resistance mosquitoes increased enormously and hence DDT brought about genetic change and gave a direction for the evolution of DDT resistant mosquitoes.

Criticisms or Drawbacks or objections of Darwinism

- i. Mutation is the process by which sudden large variation occurred in the organisms. It is now proved that mutation has powerful role in evolution. But Darwin ignored this process and regarded only Natural Selection as the main caused of evolution of new species.
- ii. Darwin's theory did not explain between the heritable and non-heritable variations.
- iii. It did not explain the origin of variations which must be present before any selection.
- iv. Natural selection is not a creating force or initiating force but only directing or controlling factor in evolution. Since it operated only after variations have appeared. It accounts for preservation rather than origin of favorable variations.
- v. Darwin's theory neither explained how selection is brought nor explain the origin of harmful variations.
- vi. It is not always the case that useful variations are selected. Useful variation can develop to such extent that it may lethal for the individual.
- vii. This theory explained the survival of fittest but not arrival of the fittest.
- viii. This theory did not explain the occurrence of vestigial organs in animals.

3. Neo- Darwinism or Modern Synthetic theory

Neo- Darwinism is modified form of Darwinism. Darwin and contemporaries were unaware of cytology, molecular biology and genetics which could help to explain the theory of evolution. This information now available, which are utilized to explain the process of evolution. At present the most accepted theory of evolution is put forward which is mainly based on the framework of Darwinism blended with genetics, molecular biology and cytology. Scientists like Dobzhansky, R.A Fischer, Julian Huxley, JBS Haldane, Sewell Wright and Hugo de Vries etc. contributed to formulated the Neo- Darwinism. It is based on following facts:

I. Gene mutation

Sudden heritable change occurred in a gene due to addition, deletion or transversion of Nitrogen-base sequence is called gene mutation. It is able to change the phenotypes of organism and can produce drastic changes. There is equal chance of mutant gene to mutate back to the normal. Most of the mutant genes are recessive to normal genes and only express their characters in homozygous condition.

II. Chromosomal mutation/aberration

The heritable change in structure and number of chromosomes is called chromosomal mutation which caused phenotypic and genotypic variation in an organism. The change in structure of chromosome due to breaking down and reattachment of chromosome or addition of extra chromosome by deletion or duplication or rearrangement is called chromosomal aberration.

III. Genetic recombination

Genetic variation causes by reshuffling or interchanging of genes during sexual reproduction is known as genetic recombination. This causes the production of new genotypes from already existing genes.

IV. Genetic drift

Any alteration in gene frequency of a small size population which are suddenly isolated from the original population by a chance is called genetic drift or Sewell effect. Loss or elimination of genes of certain traits when the population of particular species migrates or dies of natural calamity. This changes the basic characteristics of a species in new generation and such population starts differing from the original population to become distinct stock or different race.

V. Natural selection

Natural selection brings about evolutionary changes by favoring different reproduction of genes and differential reproduction of genes produce change in gene frequency from one generation to the next. Natural selection does not produce genetic change, but once the genetical change has occurred it acts to encourage some gene combination over others. Natural selection also creates new adaptive relation between population and environment by favoring some gene combination and rejecting other. This process constantly molds and modifies the gene pool. Hence, natural selection guides the population towards adaptation.

VI. Reproductive Isolation

Isolation of organisms of species into several groups or population under different physiological or geographical factors is supposed to be most significant reason that responsible for evolution. Geographical factors include high mountains, river, ocean and dessert etc. that prevent the interbreeding between individuals of related or same species. This helps in maintaining the individuality of species because it does not allow the interbreeding of organisms of different species. This phenomenon is called reproductive isolation. Similarly, migration and hybridization also help to increase the genetic variability to population of a species.

VII. Speciation

The population of a species present in the different environment which are separated by geographical and physiological barriers, accumulated different genetic variation due to mutation, chromosomal aberration, genetic recombination, genetic drift, hybridization, natural selection etc. Population become different morphology and genetic from each other. Then, they become reproductively isolated and help in formation of new species is called speciation.

[Note: Theory of Mutation: **Phenotypic variation arise due to Sudden and distinct changes in germplasm or hereditary material (like gene or chromosome) of an organism.** Mutation is two types; gene mutation or point mutation, and chromosomal mutation. This process was first discovered by Dutch botanist **Hugo de Vries (1886-1887).**]