Lamarckism, a theory of evolution based on the principle that physical changes in organisms during their lifetime—such as greater development of an organ or a part through increased use—could be transmitted to their offspring. The doctrine, proposed by the French naturalist Jean-Baptiste Lamarck in 1809, influenced evolutionary thought through most of the 19th century. Lamarckism was discredited by most geneticists after the 1930s, but certain of its ideas continued to be held in the Soviet Union into the mid-20th century.

Acquired characteristics

Biologists define an acquired characteristic as one that has developed in the course of the life of an individual in the somatic or body cells, usually as a direct response to some external change in the environment or through the use or disuse of a part. The inheritance of such a characteristic means its reappearance in one or more individuals in the next or in succeeding generations. An example would be found in the supposed inheritance of a change brought about by the use and disuse of a special organ. The blacksmith's arm (or any other set of muscles) enlarges when used continually against an external resistance, such as the weight of the hammer. If the effect were inherited, the smith's children at birth would have unusually large arms—if not at birth, then when they became adults, even though they had not used their arms excessively. There is no evidence supporting this case. A more subtle illustration is found in the supposed inheritance of an increased dexterity of the hands of a musician through practice. The skill acquired, although causing no visible increase in the size of the fingers, might be imagined to be passed along to the musician's children, and they might then be expected to play skillfully with minimal practice. Just how the intricate interplay of cerebral sequences that has given the dexterity to the musician's fingers could ever be transferred to the musician's sex cells (spermatozoa or ova), and through them to any potential children, has never been brought within the range of biological possibilities.

Lamarck recognized several ways in which the environment brings about changes in plants and animals, and it is significant to note that his attention was directed more particularly to the adaptive character of the response, which, as Henri Bergson points out, implies the teleological, or purposeful, nature of the result. In plants the response is direct and immediate; i.e., not through the mediation of a central nervous reaction system, since this is absent in plants. In animals the adaptive changes are supposed to be more indirect. According to Lamarck, new needs (*besoins*) arise in animals as a result of a change in the environment. This leads to new types of behaviour involving new uses of pre-existing organs. Their use leads to an increase in size or to other methods of functioning. Conversely, the disuse of other parts leads to their decline. It is the resulting material alterations that are inherited.

The examples that Lamarck gives to illustrate his doctrine are illuminating. In animals, as stated above, a new environment calls forth new needs, and the animal seeks to satisfy them by making some effort. Thus, new needs engender new habits, which modify the parts. The effects are inherited. For example, the giraffe, seeking to browse higher and higher on the leaves of trees on which it feeds, stretches its neck. As a result of this habit, continued for a long time in all the individuals of the species, the giraffe's front limbs and neck have gradually grown longer. Birds that need to rest on the water—i.e., to find their food—spread out their feet when they wish to swim. The skin becomes accustomed to being stretched and forms the web between the toes. The horns of ruminants have resulted from the ruminants' butting their heads together during combats. These examples, which appear naive in light of later discoveries, constitute some of the evidence on which Lamarck rested his theory.

The influence of Lamarckism

In *On the Origin of Species*, Charles Darwin accepted the principle of the inheritance of acquired characteristics as one of the factors contributory to evolution. This endorsement of Lamarckism has resulted in some confusion in terminology. Thus, in the Soviet Union, Lamarckism was labeled "creative Soviet Darwinism" until it lost its official endorsement in 1965. In *Variation of Animals and Plants Under Domestication*, Darwin elaborated his view and proposed a "provisional hypothesis" to explain the transmission. This hypothesis he called pangenesis. Each part of the body was imagined to throw off invisible particles called "gemmules," which, passing into the blood stream, were supposed to collect in the germ cells and there combine with like units already present, modifying them in accordance with the changes that had taken place in the peripheral organs from which they came. Thus the next generation arising from the germ cells is a photograph, as it were, of the parent at the particular stage when the germ cells were formed. It is, perhaps, almost needless to point out that this vague conception of the mode of development of the germ cells is totally at variance with modern knowledge concerning the origin of eggs and spermatozoa, which in many cases are present and often developed before the adult stages are reached.

Lamarckism is the first theory of evolution, which was proposed by Jean Baptiste de Lamarck (1744-1829), a French biologist. Although the outline of the theory was brought to notice in 1801, but his famous book "Philosophic Zoologies" was published in 1809, in which he discussed his theory in detail. Lamarck coined the terms "invertebrates" and "Annelida". The term "Biology" was given by Lamarck and Treviranus (1802).

Lamarck's Propositions:

Lamarckism includes four main propositions.

(i) Internal Vital Force:

All the living things and their component parts are continually increased due to internal vital force. Lamarck.

(ii) Effect of Environment and New Needs:

Environment influences all types of organisms. A change in environment brings about changes in organ-isms. It gives rise to new needs. New needs or desires produce new structures and change habits of the organisms. Doctrine of desires is called appetency.

(iii) Use and Disuse of Organs:

If an organ is constantly used it would be better developed whereas disuse of organ results in its degeneration.

(iv) Inheritance of Acquired Characters:

Whatever an individual acquires (to pos-sess) characters in its life time due to internal vital force, effect of environment, new needs and use and disuse of organs, they are inherited (transmitted) to the next generations. The process continues. After several generations, the variations are accumulated upto such extent that they give rise to new species.
Examples in Support of Lamarckism:

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Lamarck explained his theory by giving the following examples.
(i) Evolution of Giraffe:

The ancestors of giraffe were bearing a small neck and fore-limbs and were like horses. But as they were living in places with no surface vegetation, they had to stretch their neck and fore-limbs to take the leaves for food, which resulted in the slight elongation of these parts. Whatever they acquired in one generation was transmitted to the next generation with the result that a race of long necked and long fore-limbed animals was developed.

(ii) Webbed Toes of Aquatic Birds:

Aquatic birds like ducks have been evolved from the terrestrial ancestors.
(iii) Disappearance of Limbs in Snakes:

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The snakes have been evolved from lizard like ancestors which were having two pairs of limbs.
(iv) Flat Fishes:

They are flat and bear both the eyes on one side and live at the bottom of the water. During the embryonic stage their eyes are present laterally, one eye on either side. The body of these fishes is not flat at this stage but later on both the eyes is shifted to one side and the body becomes flat to withstand the pressure of water.

(v) Flightless Birds:

The ancestors of these birds (e.g., Ostrich) were capable of flying, but due to some environmental factors they had plenty of food and were well protected. So they did not use their wings and that is why the latter became vestigial.
(vi) Retractile Claws of Carnivorous Mammals:

The ancestors of carnivorous mammals such as lions, tiger etc. had ordinary claws for tearing the flesh of their preys. As the latter gained in running, the carnivorous mammals also had to run fast for which claws were a hindrance. The animals, therefore, developed retractile claws.
(vii) Deer:

The ancestors of deer were not having so much speed in running, but as they needed protection from other animals of that time they started running, due to which present speed were achieved by the deer.
(viii) Cave Dwellers:

The ancestors of cave dwellers had normal eye sight. On account of living under continuous dark conditions, the animal lost their power to see.

(ix) Emergent Hydrophytes:

The effect of environment and inheritance of acquired characters is clearly seen in emergent hydrophytes like Ranunculus aquatilis. Here the submerged leaves are dissected while the emerged ones are simply lobed. When the plant is grown out of water, all the leaves are un-dissected. In the submerged environment all the leaves are dissected.

Criticism of Lamarckism:

(Evidences against the Inheritance of Acquired Characters):

The first proposition of the theory does not have any ground because there is no vital force in organisms which increases their body parts. As regards the second proposition, the environment can affect the animal but it is doubtful that a new need forms new structures. The third proposition, the use and disuse of the organs is correct up to some extent. The fourth proposition regarding the inheritance of acquired characters is disputed.

Mendel's Laws of Inheritance and Weismann's Theory of Continuity of Germplasm (1892) discarded Lamarck's concept of inheritance of acquired characters.

(i) Theory of Continuity of Germplasm. August Weismann (1834-1914), a German biologist, was the main opposer of the inheritance-of acquired characters. He put forward the theory of continuity of germplasm. According to Weismann, the characters influencing the germ cells are only inherited. There is a continuity of germplasm (protoplasm of germ cells) but the somato-plasm (protoplasm of somatic cells) is not transmitted to the next generation hence it does not carry characters to next generation. Weismann cut off the tails of rats for as many as 22 generations and allowed them to breed, but tailless rats were never born.

(ii) Boring of pinna (external ear) and nose of Indian women is never inherited to the next generations.

(iii) The wrestler's powerful muscles are not transmitted to the offspring.

(iv) European ladies wear tight waist garments in order to keep their waist slender but their offspring at the time of birth have normal waists.

(v) Chinese women used to wear iron shoes in order to have small feet, but their children at the time of birth have always normal feet.

(vi) Circumcision of penis is in Jews and Muslims but it is not inherited to the next generation.

(vii) Dull progeny of Nobel Prize winners cannot be explained by Lamarckism.

Evidences in Favour of the Inheritance of Acquired Characters:

(i) Formation of Germ Cells from Somatic Cells:

In certain cases somatic cells can produce the germ cells, which is against Weismann's theory of continuity of germ-plasm. This occurs in vegetative propagation in plants and regeneration in animals.

(ii) Effect of Environment directly on Germ Cells:

Tower exposed the young de-veloping Potato Beetles to extremes of temperature and humidity at the time of the development of their reproductive organs. This did not produce any change in the beetles themselves. Their offspring, however, had colour variations, which were passed on to the succeeding generations. Tower's observations indicate direct effect of environment on germ cells.

(iii) Effect of Radiation:

Exposure of organisms to high energy radiations (ultra-violet rays, X-rays, gamma rays, etc.) or feeding them with mutagenic chemicals, produces sudden inheritable variations or mutations. For example, Auerbach et al obtained a number of mutations and chromosome aberrations in Drosophila with the help of mustard gas.

(iv) Agar:

Agar reared water fleas in a culture of green flagellates and found that some abnormalities were developed in their structures. The parthenogenetic eggs of such individu-als when kept in ordinary water and allowed to hatch produced individuals with the same abnormalities.

(v) Effect of Chemicals:

There is no isolation of somatic and germ cells. Rather one part of the body affects other parts of the body through chemicals called hormones. Change in the secretion of hormones results in the change of different parts of the body.

(vi) Guyar and Smith:

Guyar and Smith took the solution of the eye lens of rabbit and inoculated the same into fowl. The fowl's serum containing antibodies was injected into pregnant rabbits. Some of the offspring were found to have malformed or degenerate eyes.

(viii) Effect of Change of Environment:

Radish is a two-year crop in cold countries but completes its growth in one year in tropical areas. Similarly, deciduous European Peach becomes evergreen in India.

Neo-Lamarckism:

Modified form of Lamarckism is called Neo-Lamarckism (neo = new). Neo-Lamarckism proposes that

(i) Environment does influence an organism and change its heredity.

(ii) At least some of the variations acquired by an individual can be passed on to the offspring.

(iii) Internal vital force and appetency do not play any role in evolution.

(iv) Only those variations are passed on to the offspring which also affect germ cells or where somatic cells give rise to germ cells.

Evidences in favour of the inheritance of acquired characters support the Neo-Lamarckism.

Charles Darwin's Concept of Natural Selection: 5 Criticism Points with Neo- Darwinism
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Charles Darwin's Concept of Natural Selection: 5 Criticism Points with Neo- Darwinism!

Charles Darwin's concept of natural selection was explained clearly and convincingly by him in his masterpiece—The Origin of Species' (The full title of the book was 'On the Origin of Species by Means of Natural Selection' or The Preservation of Favoured Races in the Struggle for Life) in 1859.

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Its essence is that the animal and the plant worlds came into existence by a process of dynamic descent. Darwin's explanation of the way in which evolution occurs may be generalized as follows.

The change in species by the survival of an organismal type exhibiting a natural variation that gives it an adaptive advantage in an environment, thus, leading to a new environmental equilibrium, is evolution by natural selection. Thus natural selection is a con-tinuous process of trial and error on a gigantic scale, for all of living matter is involved. It includes the following element.
1. The universal occurrence of variation:

The difference between individuals within a popula-tion of a species constitutes variations. Variations are the characteristic of every group of animals and plants and there are many ways in which organisms may differ. Due to the variations some individuals would be better adjusted towards the surroundings than the others. Adaptive modifications are caused through the struggle for existence. According to Darwin, the varia-tions are continuous and those which are helpful in the adaptations of an organism towards its surroundings would be passed on to the next generation, while the others disappear.
2. Over production (rapid multiplication):

Every species, in the absence of environmental checks, tends to increase in a geometrical manner. If a population of a given species doubles in one year and if there are no checks on its increase, it will quadruple the next year, and so on. A salmon produces 28,000 eggs in a season. A female rabbit gives birth to six young ones in one litter and produces four litters in a year. Six-month old rabbit is capable of reproduction.

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If all the rabbit survives and multiplies at this rate, their number would be very large after some time. Darwin calculated that even a pair of elephants which are about the slowest breeding animals known, could in the absence of any checks, have 29 million descendants at the end of 800 years.

Thus, more organisms of each kind are born than can possibly obtain food and survive. Since the number of each species remains fairly constant under natural conditions, it must be as-sumed that most of the offsprings in each generation perish. If all the offsprings of any species remained alive and reproduced they would soon crowd all other species from the earth.

3. Struggle for existence:

Since more individuals are born than can survive there is an intraspecific of interspecific or environmental struggle for survival, a competition for food, mates and space.

(a) Intraspecific struggle is among the members of the same species. It is the keenest form of struggle for existence because the requirements of life are identical for the combatants.

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(b) Interspecific struggle is the one waged between the members of different species. This is best seen in a newly exposed land where to begin with might be counted the seedlings of at least 20 different species of plants but ultimately seedlings of 2 or 3 species grow to matu-rity. That is to say, these 2 or 3 species have survived where the other 17 or 18 could not.

(c) Environmental struggle is the struggle between the organism and the environment in which it is placed. Natural catastrophes like earthquakes, tidal waves, bursting of volca-noes are all causes for killing large populations of many species of animals and plants.

4. Survival of the fittest:

In this struggle for existence as we have seen few survive: majority dies out. This is explained as being due to the fact those few which survive have necessary advan-tageous variations which though small have been of a high survival value to the individual concerned, i.e., such of them as are fit to survive have survived and such of them as are unfit for survival have perished. This idea of “the survival of the fittest” is the core of the theory of natural selection.

5. Inheritance of useful variations:

The organisms after getting fitted to the surroundings trans-mit their useful variations to the next generation, while the non-useful variations are elimi-nated. Darwin could not differentiate between continuous and discontinuous variations. Hence, upto some extent, he agreed with Lamarck’s views, because according to Darwin acquired characters which are useful to the possessor could be inherited.

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Darwin considered that useful variations are transmitted to the offspring and appear more prominently in succeeding generations. After some generations these continuous and gradual variations in the possessor would be so distinct that they form a new species.

Criticism of the Natural Selection Theory:

1. While natural selection theory explains survival of the fittest, it does not explain the arrival of the fittest. Thus, to give rise to such specializations as elaborate mimicry, or the electric organ of the

torpedo, etc., which are of apparent advantage only in the perfected state, natural selection, acting only upon minute gradations towards perfections, seems inadequate.

2. Over-specialization of some organs like tusks of elephants, antlers of deer have developed so much that instead of providing usefulness to the possessor they often give hindrance to them. These organs or body structures should not have reached a harmful stage, if natural selection was operating. However, such cases of overspecializations have been explained by Darwin on the basis of discontinuous variations or "sports" which, according to him, do not play any role in evolution.

3. Natural selection cannot account for degeneracy—To say an organ is no longer useful and, hence, disappears, is to state the effect and not the cause.

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4. One of classical objections to natural selection is that new variations would be lost by "dilu-tion" as the individuals possessing them bred with others without them. We now know that although the phenotypic expression of a gene may be altered when it exists in combination with certain other genes, yet the gene itself is not altered and is transmitted to succeeding generations.

5. Darwin indirectly accepted the Lamarckian idea of inheritance of acquired characters in the form of pangenesis hypothesis, which cannot be accepted in the light of present knowledge of genetics.
Neo-Darwinism:

Neo-Darwinism is a modified form of Darwinism. The Neo-Darwinians like T.H. Huxley, Herbert Spencer, D.S. Jordan, Asa Gray, E. Haeckel and A. Wiesmann believed that natural selection has accounted everything that is involved in evolution.

Certain Neo-Darwinians such as A. Wiesmann and his followers rejected Darwin's theory except its principal element of natural selection. These Neo-Darwinians, though distinguished between gerinplasm and somatoplasm of living organisms in their germplasm theory, yet they could not appreciate the role of mutations in evolution.

Neo-Darwinians thought that adaptations result from multiple forces and natural selections is only one of these many forces in contrast to Darwin's belief who held that adaptations result mainly by a single source, i.e., natural selection Neo-Darwinians also believed that characters are not inherited as such but there are character determiners, the determinants or biophores, which control only the development.

The ultimate character would result out due to the interaction of the determiners, activity of the organism and the environment during development. Thus, Neo-Darwinism was incomplete and partly wrong because it lacked present understanding of genetics.

What is neo lamarckism?
Definition of **neo-Lamarckism**. : a modern theory of evolution based on **Lamarckism** and retaining the fundamental concept that acquired characters are inherited: such as. a : the theory that evolution results from the action of natural selection upon acquired characters.
Who proposed neo Darwinism?
August Weismann
The term **neo-Darwinism** was first used in the 1880s by August Weismann, a German naturalist, who incorporated his theory of the germ plasm into **Darwin's** theory of evolution by natural selection.

What is Darwin's law?
Darwin's Law of Evolution by Natural Selection (traditionally referred to as a "theory" to honor **Darwin's** original treatise, but now confirmed through observation and experiment) consists of four main tenets. First, he describes how species can change in shape and character through selective breeding.
What are the 4 steps of Darwin's theory?
The **four** key points of **Darwin's Theory** of Evolution are: individuals of a species are not identical; traits are passed from generation to generation; more offspring are born than can survive; and only the survivors of the competition for resources will reproduce.

4 Main Theories of Evolution (explained with diagram and tables) | Biology
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So main theories of evolution are:

(I) Lamarckism or Theory of Inheritance of Acquired characters.

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(II) Darwinism or Theory of Natural Selection.

(III) Mutation theory of De Vries.

(IV) Neo-Darwinism or Modern concept or Synthetic theory of evolution.
I. Lamarckism:

It is also called “Theory of inheritance of acquired characters” and was proposed by a great French naturalist, Jean Baptiste de Lamarck (Fig. 7.34) in 1809 A.D. in his famous book “Philosphic Zoologique”. This theory is based on the comparison between the contemporary species of his time to fossil records.
His theory is based on the inheritance of acquired characters which are defined as the changes (variations) developed in the body of an organism from normal characters, in response to the changes in environment, or in the functioning (use and disuse) of organs, in their own life time, to fulfill their new needs. Thus Lamarck stressed on adaptation as means of evolutionary modification.
A. Postulates of Lamarckism:

Lamarckism is based on following four postulates:

1. New needs:

Every living organism is found in some kind of environment. The changes in the environmental factors like light, temperature, medium, food, air etc. or migration of animal lead to the origin of new needs in the living organisms, especially animals. To fulfill these new needs, the living organisms have to exert special efforts like the changes in habits or behaviour.

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2. Use and disuse of organs:

The new habits involve the greater use of certain organs to meet new needs, and the disuse or lesser use of certain other organs which are of no use in new conditions. This use and disuse of organs greatly affect the form, structure and functioning of the organs.

Continuous and extra use of organs make them more efficient while the continued disuse of some other organs lead to their degeneration and ultimate disappearance. So, Lamarckism is also called "Theory of use and disuse of organs."

So the organism acquires certain new characters due to direct or indirect environmental effects during its own life span and are called Acquired or adaptive characters.

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3. Inheritance of acquired characters:

Lamarck believed that acquired characters are inheritable and are transmitted to the offsprings so that these are born fit to face the changed environmental conditions and the chances of their survival are increased.

4. Speciation:

Lamarck believed that in every generation, new characters are acquired and transmitted to next generation, so that new characters accumulate generation after generation. After a number of generations, a new species is formed.

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So according to Lamarck, an existing individual is the sum total of the characters acquired by a number of previous generations and the speciation is a gradual process.

Summary of four postulates of Lamarckism:

1. Living organisms or their component parts tend to increase in size.

2. Production of new organ is resulted from a new need.

3. Continued use of an organ makes it more developed, while disuse of an organ results in degeneration.

4. Acquired characters (or modifications) developed by individuals during their own lifetime are inheritable and accumulate over a period of time resulting a new species.

B. Evidences in favour of Lamarckism:

1. Phylogenetic studies of horse, elephant and other animals show that all these increase in their evolution from simple to complex forms.

2. Giraffe (Fig. 7.35):

Development of present day long-necked and long fore-necked giraffe from deer-like ancestor by the gradual elongation of neck and forelimbs in response to deficiency of food on the barren ground

in dry deserts of Africa. These body parts were elongated so as to eat the leaves on the tree branches. This is an example of effect of extra use and elongation of certain organs.
3. Snakes:

Development of present day limbless snakes with long slender body from the limbed ancestors due to continued disuse of limbs and stretching of their body to suit their creeping mode of locomotion and fossorial mode of living out of fear of larger and more powerful mammals. It is an example of disuse and degeneration of certain organs.

4. Aquatic birds:

Development of aquatic birds like ducks, geese etc. from their terrestrial ancestors by the acquired characters like reduction of wings due to their continued disuse, development of webs between their toes for wading purposes.

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These changes were induced due to deficiency of food on land and severe competition. It is an example of both extra use (skin between the toes) and disuse (wings) of organs.

5. Flightless birds:

Development of flightless birds like ostrich from flying ancestors due to continued disuse of wings as these were found in well protected areas with plenty of food.

6. Horse:

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The ancestors of modem horse (Equus caballus) used to live in the areas with soft ground and were short legged with more number of functional digits (e.g. 4 functional fingers and 3 functional toes in Dawn horse-Eohippus). These gradually took to live in areas with dry ground. This change in habit was accompanied by increase in length of legs and decrease in functional digits for fast running over hard ground.
C. Criticism of Lamarckism:

A hard blow to Lamarckism came from a German biologist, August Weismann who proposed the "Theory of continuity of germplasm" in 1892 A.D. This theory states that environmental factors do affect only somatic cells and not the germ cells.

As the link between the generations is only through the germ cells and the somatic cells are not transmitted to the next generation so the acquired characters must be lost with the death of an organism so these should have no role in evolution. He suggested that germplasm is with special particles called "ids" which control the development of parental characters in offsprings.

Weismann mutilated the tails of mice for about 22 generations and allowed them to breed, but tailless mice were never born. Pavlov, a Russian physiologist, trained mice to come for food on hearing a bell. He reported that this training is not inherited and was necessary in every generation. Mendel's laws of inheritance also object the postulate of inheritance of acquired characters of Lamarckism.

Similarly, boring of pinna of external ear and nose in Indian women; tight waist, of European ladies circumcising (removal of prepuce) in certain people; small sized feet of Chinese women etc are not transmitted from one generation to another generator.

Eyes which are being used continuously and constantly develop defects instead of being improved. Similarly, heart size does not increase generation after generation though it is used continuously.

Presence of weak muscles in the son of a wrestler was also not explained by Lamarck. Finally, there are a number of examples in which there is reduction in the size of organs e.g. among Angiosperms, shrubs and herbs have evolved from the trees.

So, Lamarckism was rejected.
D. Significance:

1. It was first comprehensive theory of biological evolution.

2. It stressed on adaptation to the environment as a primary product of evolution.

II. Darwinism (Theory of Natural Selection):

A. Introduction:

Charles Darwin (Fig. 7.36) (1809- 1882 A.D.), an English naturalist, was the most dominant figure among the biologists of the 19th century. He made an extensive study of nature for over 20 years, especially in 1831-1836 when he went on a voyage on the famous ship "H.M.S. Beagle" (Fig. 7.37) and explored South America, the Galapagos Islands and other islands.

Fig. 7.36. Charles Robert Darwin (1809-1882 A.D.).

He collected the observations on animal distribution and the relationship between living and extinct animals. He found that existing living forms share similarities to varying degrees not only among themselves but also with the life forms that existed millions of years ago, some of which have become extinct.

He stated that every population has built in variations in their characters. From the analysis of his data of collection and from Malthus's Essay on Population, he got the idea of struggle for existence within all the populations due to continued reproductive pressure and limited resources and that all organisms, including humans, are modified descendents of previously existing forms of life.

In 1858 A.D., Darwin was highly influenced by a short essay entitled "On the Tendency of Varieties to Depart Indefinitely from the Original Type" written by another naturalist, Alfred Russel Wallace (1812-1913) who studied biodiversity on Malayan archipelago and came to similar conclusions.

Darwin and Wallace's views about evolution were presented in the meeting of Linnean Society of London by Lyell and Hooker on July 1, 1858. Darwin's and Wallace's work was jointly published in "Proceedings of Linnean Society of London" in 1859. So it is also called Darwin-Wallace theory.

Darwin explained his theory of evolution in a book entitled "On the Origin of Species by means of Natural Selection". It was published on 24th Nov., 1859. In this theory, Charles Darwin proposed the concept of natural selection as the mechanism of evolution.

B. Postulates of Darwinism:

Main postulates of Darwinism are:

1. Geometric increase.

2. Limited food and space.

3. Struggle for existence.

4. Variations.

5. Natural selection or Survival of the fittest.

6. Inheritance of useful variations.

7. Speciation.

1. Geometric increase:

According to Darwinism, the populations tend to multiply geometrically and the reproductive powers of living organisms (biotic potential) are much more than required to maintain their number e.g.,

Paramecium divides three times by binary fission in 24 hours during favourable conditions. At this rate, a Paramecium can produce a clone of about 280 million Paramecia in just one month and in five years, can produce Paramecia having mass equal to 10,000 times than the size of the earth.

Other rapidly multiplying organisms are: Cod (one million eggs per year); Oyster (114 million eggs in one spawning); Ascaris (70, 00,000 eggs in 24 hours); housefly (120 eggs in one laying and laying eggs six times in a summer season); a rabbit (produces 6 young ones in a litter and four litters in a year and young ones start breeding at the age of six months).

Similarly, the plants also reproduce very rapidly e.g., a single evening primrose plant produces about 1, 18,000 seeds and single fern plant produces a few million spores.

Even slow breeding organisms reproduce at a rate which is much higher than required e.g., an elephant becomes sexually mature at 30 years of age and during its life span of 90 years, produces only six offsprings. At this rate, if all elephants survive then a single pair of elephants can produce about 19 million elephants in 750 years.

These examples confirm that every species can increase manifold within a few generations and occupy all the available space on the earth, provided all survive and repeat the process. So the number of a species will be much more than can be supported on the earth.

2. Limited food and space:

Darwinism states that though a population tends to increase geometrically, the food increases only arithmetically. So two main limiting factors on the tremendous increase of a population are: limited food and space which together form the major part of carrying capacity of environment. These do not allow a population to grow indefinitely which are nearly stable in size except for seasonal fluctuation.

3. Struggle for existence:

Due to rapid multiplication of populations but limited food and space, there starts an everlasting competition between individuals having similar requirements. In this competition, every living organism desires to have an upper hand over others.

This competition between living organisms for the basic needs of life like food, space, mate etc., is called struggle for existence which is of three types:

(a) Intraspecific:

Between the members of same species e.g. two dogs struggling for a piece of meat.

(b) Interspecific:

Between the members of different species e.g. between predator and prey.

(c) Environmental or Extra specific:

Between living organisms and adverse environmental factors like heat, cold, drought, flood, earthquakes, light etc.

Out of these three forms of struggle, the intraspecific struggle is the strongest type of struggle as the needs of the individuals of same species are most similar e.g., sexual selection in which a cock with a more beautiful comb and plumage has better chances to win a hen than a cock with less developed comb.

Similarly, cannabilism is another example of intraspecific competition as in this; individuals eat upon the members of same species.

In this death and life struggle, the majority of individuals die before reaching the sexual maturity and only a few individuals survive and reach the reproductive stage. So struggle for existence acts as an effective check on an ever-increasing population of each species.

The nature appears saying, “They are weighed in the balance and are found wanting.” So the number of offsprings of each species remains nearly constant over long period of time.

4. Variations:

Variation is the law of nature. According to this law of nature, no two individuals except identical (monozygotic) twins are identical. This everlasting competition among the organisms has compelled them to change according to the conditions to utilize the natural resources and can survive successfully.

Darwin stated that the variations are generally of two types—continuous variations or fluctuations and discontinuous variations. On the basis of their effect on the survival chances of living organisms, the variations may be neutral, harmful and useful.

Darwin proposed that living organisms tend to adapt to changing environment due to useful continuous variations {e.g., increased speed in the prey; increased water conservation in plants; etc.), as these will have a competitive advantage.

5. Natural selection or Survival of the fittest:

Darwin stated that as many selects the individuals with desired characters in artificial selection; nature selects only those individuals out of the population which are with useful continuous variations and are best adapted to the environment while the less fit or unfit individuals are rejected by it.

Darwin stated that if the man can produce such a large number of new species/varieties with limited resources and in short period of time by artificial selection, then natural selection could account for this large biodiversity by considerable modifications of species with the help of unlimited resources available over long span of time.

Darwin stated that discontinuous variations appear suddenly and will mostly be harmful, so are not selected by nature. He called them “sports”. So the natural selection is an automatic and self going process and keeps a check on the animal population.

This sorting out of the individuals with useful variations from a heterogeneous population by the nature was called Natural selection by Darwin and Survival of the fittest by Wallace. So natural selection acts as a restrictive force and not a creative force.

6. Inheritance of useful variations:

Darwin believed that the selected individuals pass their useful continuous variations to their offsprings so that they are born fit to the changed environment.

7. Speciation:

According to Darwinism, useful variations appear in every generation and are inherited from one generation to another. So the useful variations go on accumulating and after a number of generations, the variations become so prominent that the individual turns into a new species. So according to Darwinism, evolution is a gradual process and speciation occurs by gradual changes in the existing species.

Thus the two key concepts of Darwinian Theory of Evolution are:

1. Branching Descent, and 2. Natural Selection.

C. Evidences in favour of Darwinism:

1. There is a close parallelism between natural selection and artificial selection.

2. The remarkable cases of resemblance e.g. mimicry and protective colouration can be achieved only by gradual changes occurring simultaneously both in the model and the mimic.

3. Correlation between position of nectaries in the flowers and length of the proboscis of the pollinating insect.

D. Evidences against Darwinism:

Darwinism is not able to explain:

1. The inheritance of small variations in those organs which can be of use only when fully formed e.g. wing of a bird. Such organs will be of no use in incipient or underdeveloped stage.

2. Inheritance of vestigial organs.

3. Inheritance of over-specialised organs e.g. antlers in deer and tusks in elephants.

4. Presence of neuter flowers and sterility of hybrids.

5. Did not differentiate between somatic and germinal variations.

6. He did not explain the causes of the variations and the mode of transmission of variations.

7. It was also refuted by Mendel's laws of inheritance which state that inheritance is particulate.

So this theory explains only the survival of the fittest but does not explain the arrival of the fittest so Darwin himself confessed, "natural selection has been main but not the exclusive means of modification."

Principle of Natural Selection (Table 7.7):

It was proposed by Ernst Mayer in 1982. It stems from five important observations and three inferences as shown in Table 7.7. This principle demonstrates that natural selection is the differential success in reproduction and enables the organisms to adapt them to their environment by development of small and useful variations.

These favourable Variations accumulate over generation after generation and lead to speciation. So natural selection operates through interactions between the environment and inherent variability in the population.

III. Mutation Theory of Evolution:

The mutation theory of evolution was proposed by a Dutch botanist, Hugo de Vries (1848-1935 A.D.) (Fig. 7.38) in 1901 A.D. in his book entitled "Species and Varieties, Their Origin by Mutation". He worked on evening primrose (Oenothera lamarckiana).

A. Experiment:

Hugo de Vries cultured O. lamarckiana in botanical gardens at Amsterdam. The plants were, allowed to self pollinate and next generation was obtained. The plants of next generation were again subjected to self pollination to obtain second generation. Process was repeated for a number of generations.

B. Observations:

Majority of plants of first generation were found to be like the parental type and showed only minor variations but 837 out of 54,343 members were found to be very different in characters like flower size, shape and arrangement of buds, size of seeds etc. These markedly different plants were called primary or elementary species.

A few plants of second generation were found to be still more different. Finally, a new type, much longer than the original type, called O. gigas, was produced. He also found the numerical chromosomal changes in the variants (e.g. with chromosome numbers 16, 20, 22, 24, 28 and 30) upto 30 (Normal diploid number is 14).

C. Conclusion:

1. The evolution is a discontinuous process and occurs by mutations (L. mutate = to change; sudden and inheritable large differences from the normal and are not connected to normal by intermediate forms). Individuals with mutations are called mutants.

2. Elementary species are produced in large number to increase chances of selection by nature.

3. Mutations are recurring so that the same mutants appear again and again. This increases the chances of their selection by nature.

4. Mutations occur in all directions so may cause gain or loss of any character.

5. Mutability is fundamentally different from fluctuations (small and directional changes).

So according to mutation theory, evolution is a discontinuous and jerky process in which there is a jump from one species to another so that new species arises from pre-existing species in a single generation (macrogenesis or saltation) and not a gradual process as proposed by Lamarck and Darwin.

D. Evidences in favour of Mutation theory:

1. Appearance of a short-legged sheep variety, Ancon sheep (Fig. 7.39), from long-legged parents in a single generation in 1791 A.D. It was first noticed in a ram (male sheep) by an American farmer, Seth Wright.

2. Appearance of polled Hereford cattle from horned parents in a single generation in 1889.

3. De Vries observations have been experimentally confirmed by McDougal and Shull in America and Gates in England.

4. Mutation theory can explain the origin of new varieties or species by a single gene mutation e.g. Cicer gigas, Nuval orange. Red sunflower, hairless cats, double- toed cats, etc.

5. It can explain the inheritance of vestigial and over-specialized organs.

6. It can explain progressive as well as retrogressive evolution.

E. Evidences against Mutation theory:

1. It is not able to explain the phenomena of mimicry and protective colouration.

2. Rate of mutation is very low, i.e. one per million or one per several million genes.

3. Oenothera lamarckiana is a hybrid plant and contains anamolous type of chromosome behaviour.

4. Chromosomal numerical changes as reported by de Vries are unstable.

5. Mutations are incapable of introducing new genes and alleles into a gene pool.

IV. Neo-Darwinism or Modern Concept or Synthetic Theory of Evolution:

The detailed studies of Lamarckism, Darwinism and Mutation theory of evolution showed that no single theory is fully satisfactory. Neo-Darwinism is a modified version of theory of Natural Selection and is a sort of reconciliation between Darwin's and de Vries theories.

Modern or synthetic theory of evolution was designated by Huxley (1942). It emphasises the importance of populations as the units of evolution and the central role of natural selection as the most important mechanism of evolution.

The scientists who contributed to the outcome of Neo-Darwinism were: J.S. Huxley, R.A. Fischer and J.B.S. Haldane of England; and S. Wright, Ford, H.J. Muller and T. Dobzhansky of America.
A. Postulates of Neo-Darwinism:

1. Genetic Variability:

Variability is an opposing force to heredity and is essential for evolution as the variations form the raw material for evolution. The studies showed that the units of both heredity and mutations are genes which are located in a linear manner on the chromosomes.

Various sources of genetic variability in a gene pool are:

(i) Mutations:

These are sudden, large and inheritable changes in the genetic material. On the basis of amount of genetic material involved, mutations are of three types:

(a) Chromosomal aberrations:

These include the morphological changes in the chromosomes without affecting the number of chromosomes. These result changes either in the number of genes (deletion and duplication) or in the position of genes (inversion).

These are of four types:

1. Deletion (Deficiency) involves the loss of a gene block from the chromosome and may be terminal or intercalary.

2. Duplication involves the presence of some genes more than once, called the repeat. It may be tandem or reverse duplication.

3. Translocation involves transfer of a gene block from one chromosome to a non-homologous chromosome and may be simple or reciprocal type.

4. Inversion involves the rotation of an intercalary gene block through 180° and may be paracentric or pericentric.

(b) Numerical chromosomal mutations:

These include changes in the number of chromosomes. These may be euploidy (gain or loss of one or more genomes) or aneuploidy (gain or loss of one or two chromosomes). Euploidy may be haploidy or polyploidy.

Among polyploidy, tetraploidy is most common. Polyploidy provides greater genetic material for mutations and variability. In haploids, recessive genes express in the same generation.

Aneuploidy may be hypoploidy or hyperploidyl Hypoploidy may be monosomy (loss of one chromosome) or nullisomy (loss of two chromosomes). Hyperploidy may be trisomy (gain of one chromosome) or tetrasomy (gain of two chromosomes).

(c) Gene mutations (Point mutations):

These are invisible changes in chemical nature (DNA) of a gene and are of three types:

1. Deletion involves loss of one or more nucleotide pairs.

2. Addition involves gain of one or more nucleotide pairs.

3. Substitution involves replacement of one or more nucleotide pairs by other base pairs. These may be transition or transversion type.

These changes in DNA cause the changes in the sequence of amino acids so changing the nature of proteins and the phenotype.

(ii) Recombination of genes:

Thousands of new combinations of genes are produced due to crossing over, chance arrangement of bivalents at the equator during metaphase – I and chance fusion of gametes during fertilization.

(iii) Hybridization:

It involves the interbreeding of two genetically different individuals to produce ‘hybrids’.

(iv) Physical mutagens (e.g. radiations, temperature etc.) and chemical mutagens (e.g. nitrous acid, colchicine, nitrogen mustard etc.).

(v) Genetic drift:

It is the elimination of the genes of some original characteristics of a species by extreme reduction in a population due to epidemics or migration or Sewell Wright effect.

The chances of variations are also increased by non-random mating.

2. Natural Selection:

Natural selection of Neo- Darwinism differs from that of Darwinism that it does not operate through "survival of the fittest" but operates through differential reproduction and comparative reproductive success.

Differential reproduction states that those members, which are best adapted to the environment, reproduce at a higher rate and produce more offsprings than those which are less adapted. So these contribute proportionately greater percentage of genes to the gene pool of next generation while less adapted individuals produce fewer offsprings.

If the differential reproduction continues for a number of generations, then the genes of those individuals which produce more offsprings will become predominant in the gene pool of the population as shown in Fig. 7.40.

Spread of Genetic Variability by Differential Reproduction

Due to sexual communication, there is free flow of genes so that the genetic variability which appears in certain individuals, gradually spreads from one deme to another deme, from deme to population and then on neighbouring sister populations and finally on most of the members of a species. So natural selection causes progressive changes in gene frequencies, 'i.e. the frequency of some genes increases while the frequency of some other genes decreases.

Which individuals produce more offsprings?

(i) Mostly those individuals which are best adapted to the environment.

(ii) Whose sum of the positive selection pressure due to useful genetic variability is more than the sum of negative selection pressure due to harmful genetic variability?

(iii) Which have better chances of sexual selection due to development of some bright coloured spots on their body e.g. in many male birds and fish.

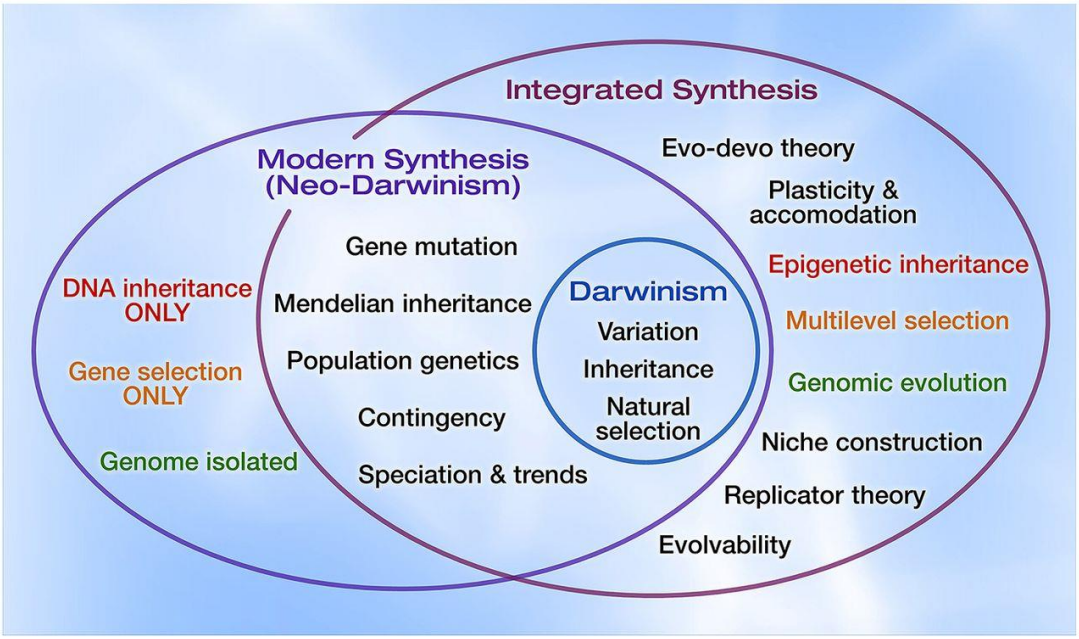
(iv) Those who are able to overcome the physical and biological environmental factors to successfully reach the sexual maturity.

So natural selection of Neo-Darwinism acts as a creative force and operates through comparative reproductive success. Accumulation of a number of such variations leads to the origin of a new species.

3. Reproductive isolation:

Any factor which reduces the chances of interbreeding between the related groups of living organisms is called an isolating mechanism. Reproductive isolation is must so as to allow the accumulation of variations leading to speciation by preventing hybridization.

In the absence of reproductive isolation, these variants freely interbreed which lead to intermixing of their genotypes, dilution of their peculiarities and disappearance of differences between them. So, reproductive isolation helps in evolutionary divergence.



Darwin's theory of evolution	Hugo deVries theory of evolution
• Minor variations in characteristics bring about evolution.	• Mutation or large and sudden differences cause evolution.
• Darwin's variations are small changes.	• Mutations are random changes
• Variations are directional (positively directed were the good adaptations which favour the better survival of species are selected by nature)	• Mutations are directionless (it can have positive-favouring survival, negative-endanger them or neutral- no impact on species)
• Evolution for Darwin was a gradual process.	• Hugo deVries believed single step large mutation had caused evolution.

Neo-Darwinism

An Explanation for the Origin of Species

- Natural Selection could explain gradual changes in the phenotype of an organism (phyletic gradualism), but what gave rise to abrupt changes and new species?
- The development of population genetics in the 1930's & 40's began looking at evolution by natural selection in a mathematical and statistical manner was called - Synthetic Theory of Evolution or Neo-Darwinism
  - 1938 – *Genetics and the Origin of Species* (Dobzhansky) integrated genetic theory with evolutionary biology
  - 1942 – *Systematics and the Origin of Species* (Mayr) applied Natural Selection Theory to current species
  - 1944 – *Tempo and Mode of Evolution* (Simpson) showed evidence evolution in the fossil record