Block 2
Human Evolution and Variation
UNIT 6 THEORIES OF ORGANIC EVOLUTION*

Contents

6.0 Introduction

6.1 Theories of Evolution
   6.1.1 Lamarckism
   6.1.2 Neo – Lamarckism
   6.1.3 Darwinism
   6.1.4 The Mutation Theory
   6.1.5 The Modern Synthetic Theory

6.2 Summary

6.3 References

6.4 Answers/Hints to Check Your Progress

Learning Objectives

After going through this unit you will:

- understand the concept of organic evolution;
- comprehend patterns of evolution; and
- know about different theories of organic evolution.

6.0 INTRODUCTION

Biological evolution is one of the major concerns of Physical/Biological Anthropology. Let us first understand about evolution. Evolution simply means ‘change’. Herbert Spencer (1857) first used the term evolution to refer to the development of more complex forms of life (plants and animals) from simpler and earlier forms. Evolution is the term used in a variety of fields, but when we talk of evolution of organisms, the plants and animals, it is called organic evolution. Organic evolution or bio evolution is ‘Descent with modification’ or ‘Continuity of life with constant modifications’. Organic evolution implies that ‘the present complex and highly organized living beings have evolved from simpler and less organized living beings of the past by gradual modification accumulated through successive generations over millions of years.

It suggests that environmental conditions in nature are ever changing. Organisms have an inherent character of changing to the changing environmental conditions. This is called adaptability or adaptations. Such adaptive changes in organisms lead to the ‘Origin of new species’ (Evolution). Since changes in the organisms are due to adaptations, new species are always better adapted and more organized than their ancestors. Different members of a species, on being adapted to different environments, diversify and evolve

* Dr. P. Venkatramana, Faculty of Anthropology, School of Social Sciences, Indira Gandhi National Open University, New Delhi. Prof. A K. Kapoor (Retired), Department of Anthropology, University of Delhi, Delhi. Prof. Jaydip Sen, Department of Anthropology, University of North Bengal, Darjeeling, West Bengal.
along several divergent lines. All the present day species had a common ancestor at some or other time of their evolution. Individuals migrate from their place of origin to varied geographical areas in search of food or because of predators and then gradually adapt to different environmental conditions. This results in the formation of several new species from one ancestral species. Comparative anatomy and morphology shows similarities and differences among organisms of today and those that existed years ago (Mondal, n. d.). Such similarities can be interpreted to understand whether common ancestors were shared or not.

Evolution can be classified into five different patterns: Divergent, Convergent, Coevolution, Parallel evolution and Adaptive Radiation.

- **Divergent Evolution:** It occurs when a population isolated (for a reason) from the rest of the species and becomes exposed to new selective pressures, causing it to evolve into a new species. Homologous structures are evidence of divergent evolution. For example, whales, bats, cheetah and human (all mammals) share similarities in the pattern of bones of forelimbs. Though these forelimbs perform different functions in these animals, they have similar anatomical structure – Hence, in these animals, the same structure developed along different directions due to adaptations to different needs.

- **Convergent Evolution:** When unrelated species occupy the same environment, but they are subjected to similar selective pressures and show similar adaptations. Wings of butterfly and of birds look alike. They are not anatomically similar structures though they perform similar functions. Hence, analogous structures are a result of convergent evolution - different structures evolving for the same function and hence having similarity.

- **Coevolution:** Coevolution is the mutual evolutionary set of adaptations of two interacting species. Pollinator-plant relationships are one example. While feeding on the nectar from a flower, an insect, bird, or bat inadvertently ensures the reproductive success of the flower.

- **Parallel Evolution:** Parallel evolution describes two related species that have made similar evolutionary adaptations after their divergence from a common ancestor. North America and the Tasmanian wolf, a marsupial, of Australia present a notable example. They share a common ancestor and evolved in similar environments, thousands of miles apart.

- **Adaptive Radiation:** Adaptive radiation is the emergence of numerous species from a single common ancestor introduced into an environment. An example of this phenomenon was made famous by Charles Darwin on the Galapagos Islands. Darwin discovered 14 species of finches each filling a different ecological niche. The most striking difference among the species is the variation in their beaks, which are adapted for different diets. They all evolved from a single ancestral species and that radiated to fill 14 different niches (Goldberg and Goldberg, 2009).
Evolution is a very complex and extremely slow process. It is not possible to see one type of animals changing to other, but presence of intergrading organisms supports the concept of evolution.

**Check Your Progress 1**

1) Evolution can be described as:
   a) Process of gradual adaptive changes in organisms
   b) History of races
   c) Variations in races
   d) Change in genetic composition

2) Analogous structures indicate:
   a) Parallel evolution
   b) Convergent evolution
   c) Divergent evolution
   d) Natural evolution

---

### 6.1 THEORIES OF EVOLUTION

Many theories tried to explain the process of evolution, but the important theories that explain the scientific basis of organic evolution are Lamarckism, Darwinism, Mutation Theory and Synthetic Theory of Evolution.

#### 6.1.1 Lamarckism

Jean Baptiste Pierre Antoine de Monet Lamarck (1744-1829) was a French naturalist, well known for his Theory of Evolution. Lamarck’s Theory of Evolution was published in Philosophic Zoologique in 1809 as Lamarckism and as the Theory of Organic Evolution. It is popularly known as ‘Inheritance of Acquired Characters’. It explains the origin of new species.

![Fig. 1: Lamarck (1744-1829)](https://en.wikipedia.org/wiki/Jean-Baptiste_Lamarck)

*Source: https://en.wikipedia.org/wiki/Jean-Baptiste_Lamarck*

Lamarck recognized two principal factors behind the evolution of living forms: the first being an inherent tendency of organic matter to reach new levels of complexity; the second being the modifying capacity of the environment. According to Lamarck, complex living organisms are formed from simple
living organisms. The environment does not remain constant, it changes. The changes in the environment provide new needs for the organisms. In response to the new needs, organisms develop new structures. Variations in organisms arise through the effects of use and disuse. The continuous use makes a structure greatly developed and disuse makes the structure atrophied. The new structures developed by the organisms in response to the environment are called acquired characters. These acquired characters are transmitted generation after generation and by this way a new species is produced (Lamarckism From Oe, n. d.).

Lamarck’s theory has following assumptions and propositions:

6.1.1.1 Assumptions

- “Living organisms and their parts tend to increase in size continuously due to internal urge of life.
- New organs (characters) are developed in order to meet the needs of the new want and are maintained (acquired characters).
- The development of organs and their use are proportional to the activities of these organs. Use and disuse of organs result in variations.

![Basic Idea of Lamarckism](https://www.tutorvista.com)

Fig. 2: Basic idea of Lamarckism

Source: https://www.tutorvista.com

- Every new character that has been acquired in the life of an individual is preserved and transmitted to the next generation by them (inheritance of acquired characters)” (Theories of Evolution, n. d.).

6.1.1.2 Propositions

- **Internal urge:** Living organisms and their parts tend to increase in size continuously due to internal forces of life. Lamarck thought that change of habits may initiate the formation of a new organ or may bring the modification of the existing organ or structure.
- **Inheritance of acquired characters:** “Environmental response leads to development of new adaptive characters in an organism through internal urge or through use and disuse of organs. Such characters
developed during the life time of an organism are called as acquired characters that are not found in its immediate ancestors. The new characters that have been acquired in the life time of an organism are preserved and transmitted to the next generation. In the offspring this modification become more and more pronounced if they are exposed to similar stress of the environment. Acquired characters are thus inherited leading to morphological and anatomical changes in a species.” (Multi Language Document, n. d.).

- **New needs as a reaction to the environment**: New organs (characters) are the result of a new need. Lamarck believed that environment plays an important role in influencing the form of living organisms and their external and internal organs. The influence leads to change in their habits. The change results in unusual activity of an organ or structure. In case of animals, migration from one area to another leads to change in the environment and introduces new needs and requirements. Lamarck demonstrated several cases where individuals of the same species, grown under different environmental conditions, exhibited marked differences.

- **Use and disuse**: The constant use of an organ increases its efficiency and size and leads to its better development. On the contrary if any organ is not used for a long time it leads to the reduction in efficiency and size of the organ and ultimately to its degeneration. In support of his theory, Lamarck cited the examples like long neck of giraffe and limbless in snakes to explain use and disuse of organs. Lamarck explained the long neck of giraffe for use of organs as follows: An original deer-like animal found the supply of trees and herbs inadequate, started to feed on the leaves of trees. In the process of reaching the leaves of higher branches the neck got stretched and the forelegs were raised. This process of stretching the neck was continued for generations to reach the foliage of taller trees and as a result, the neck became longer along with their forelimbs.

**Fig. 3: Long neck of giraffe**

*Source: http://hawaiireedlab.com*
An example for disuse of organs is limblessness in snake. The ancestors of snakes were the four limbed animals. In course time, the snakes adapted to burrowing habit. During this adaptation they gradually lost their limbs. Hence the present day snakes are without limbs.

6.1.1.3 Other examples of Lamarckism

- Development of webbed feet in aquatic birds, like duck is due to developing swimming habit. They are considered to have arisen from the terrestrial ancestors.
- Evolution of flightless birds from their flying ancestors. Flightlessness in kiwi is due to reduction of feathers and wings.
- Biceps in hands in blacksmiths which put their hands constant to heavy hammering.
- Presence of appendix post anal tail and trace of nictitating membrane in man.

6.1.1.4 Criticism of Lamarckism

Lamarckism was exposed to severe criticism as his principles of evolution met with much objection. One of the principles, inheritance of acquired characters has been much disputed. August Weismann (1890), a German biologist with his experiments on mice disproved the inheritance of acquired characters. He cut the tails of white mice for more than 20 generations and observed the length of the tail in the next generation. In all the generations the length of the tail was found to be normal. Hence, he believed that the acquired character was not inherited. Weismann differentiated the protoplasm into somatoplasm and germplasm. Somatoplasm is in the somatic cells while the germplasm is in sex cells. The germplasm play an important role in heredity. Weismann established that the changes that took place in the somatic cells of an organism are not transmitted; only the changes that occur in the germplasm are transmitted. His proposition that the tendency to increase in size, has been noted in many forms but many times evolution shows reduction in size. Moreover, persons constantly busy in reading and writing and using their eyes more than others often develop impaired sight. Why do their eyes not become more efficient? Lamarck’s proposition that new organs develop where the organisms feel their need also faced criticism. If the development of new organ or structure depends upon the desire then why man who has long desired to fly like birds has not developed the wings.

6.1.2 Neo-Lamarckism

Lamarckism is the first scientific assumption that recognised the “adaptation to the environment as a primary product of evolution”. The followers of Lamarck like Cope, Spencer, Packard, Kammerer etc., tried to modify the Lamarckism and made it acceptable. This modified version of Lamarckism is called Neo-Lamarckism. These neo-Lamarckians considered that adaptations are universal. Organisms acquire the new structures due to their adaptations to changed environmental conditions that affect the somatic cells. The variations caused in somatic cells can be inherited in the next generation. The Neo-Lamarckians provided examples in favour of inheritance of acquired characters.
Proteus anguineus, an amphibian lives in caves where there is no light. Hence it is colourless and the eyes are rudimentary. Kammerer, one of the followers of Lamarck brought this animal to day light and observed that the animal gradually developed black skin and normal eyes. These somatic characters were inherited by the next generation.

Yet another experiment conducted by Griffith and Detleofsm on rats by placing them on rotating table for several months, noticed that even after the rotation stopped, the rats showed signs of dizziness and the offspring also exhibited dizziness.

Neo-Lamarckism does not give any importance to factors like internal vital force, appetency and use and disuse of organs. The theory stresses on the direct effect of changed environment on the organisms. It established that only those modifications are transferred to the next generation which influence germ cells or where somatic cells give rise to germ cells.

Lamarckism was incomplete in itself and unable to explain all the cases of evolutionary changes, but holds good to certain extent because the body characters of the organisms are not single attributes but the result of interaction of heritable factors (genes) and the environment conditions.

Check Your Progress 2

3) Lamarck’s theory of evolution is popularly known as:
   a) Struggle for existence
   b) Inheritance of acquired characters
   c) Origin of new species
   d) Natural selection

4) Lamarck’s theory of evolution was published in:
   a) Systema Natuare
   b) Origin of New Species
   c) Philosophic Zoologique
   d) The Descent of Man

5) Who conducted the experiment of removing tails of white mice for many generations to disprove the theory of Lamarck?
   a) Charles Darwin
   b) Herbert Spencer
   c) August Weismann
   d) J. B. S. Haldane

6.1.3 Darwinism

Charles Robert Darwin (1809-1882) was an English naturalist who was appointed as a Naturalist in 1831 upon a world survey-ship of British Government H.M.S. Beagle. During his voyage for five years (1831 to 1836)
he explored the fauna and flora of a number of continents and islands of which Galapagos Islands were the important one. The idea of evolution of new species by natural selection influenced him and based on his observations Darwin published a book titled ‘Origin of Species by Natural Selection’ in the year 1859.

Fig. 4: Charles Darwin (1809-1882)

Source: https://en.wikiquote.org/wiki/Charles_Darwin

Charles Darwin (1809-1882) was an evolutionary biologist. The evolutionary theory proposed by him is called ‘Darwinism’. Darwin was much influenced by three publications namely

- the essay of T.R. Malthus, 1798, titled “On the principles of populations” which states that populations increase geometrically and the food sources increase arithmetically;
- the book written by Sir Charles Lyell entitled “Principles of Geology” which explained the gradualism (earth has changed slowly and gradually through ages) and uniformitarianism (fundamental laws operate today on the earth in the same way as they did in the past) and
- the paper entitled “On the tendency of varieties to depart from original types” sent to him by Alfred Russel Wallace.


Darwin’s theory of natural selection is based on the following principles:

1) **Over Production**: This principle is also called prodigality of over production. Every organism tends to increase their population in a geometric ratio. The organisms produce more number of offspring than will be able to survive and reproduce. “The population of each species remains more or less constant because the offspring die in large number before they become reproductively active. The food and other sources do not increase in the same rate of population increase” (Theories of Evolution, n. d.).

2) **Variations**: Variation is the characteristic feature of all organisms. Variations may be harmful or useful. The useful variations are favourable and inherited to the next generation. Harmful variations make the organism unfit in the struggle for existence. Beneficial variations are favoured by the nature. Such variations become the raw material for evolution and make the organism fit in the struggle for existence and
thus the progeny has better chances of survival (Theories of Evolution, n. d.).

![Fig. 5: Central Theme of Darwinism](https://www.tutorvista.com)

Source: https://www.tutorvista.com

3) **Struggle for existence**: All organisms reproduce in geometric ratio, but the food and space are not increased correspondingly. The organism should face competition for survival. Darwin called it struggle for existence. The struggle is of three types:

- Intraspecific struggle;
- Interspecific struggle and
- Struggle with the environment.

**Intraspecific struggle**: It is the struggle found among the organisms of the same species. This struggle is for food and mating. It is the most severe check on the rate of reproduction.

**Interspecific struggle**: The struggle between individuals of different species is called interspecific struggle. The best example of interspecific struggle is for food.

**Struggle with the environment**: The struggle that the organisms have with the environment for survival is called environmental struggle. Living animals struggle with the environmental factors like food, cold waves, heat waves, earth quake etc.

4) **Natural selection or survival of the fittest**: The organisms with beneficial variations will survive and those with less fit and unfavourable variations will be eliminated. The organisms which are selected by nature are said to be the fittest. This idea of survival of the fittest was proposed by Herbert Spencer. Variations which are useful to the individual in a particular environment would increase that individual’s ability to reproduce and leave fertile offspring.

Less favourable variations would be at disadvantage and organisms possessing them are reproductively less successful. Differential reproductive success exists among organisms. The concept of differential
reproductive success of various forms is more accurate. Over a period of time, the criterion for the success is the reproductive success. The organism that fails to reproduce cannot be represented in future generations however it may be fit in the struggle for existence (Theories of Evolution, n. d.).

5) **Origin of new species:** The over production of animals lead to struggle for existence. The animals survived with favourable variations are better adapted to the environment. All the modifications caused by variations and selected by nature are accumulated from generation to generation till a generation is produced that is more adapted and has more chances of survival (Theories of Evolution, n. d.). Thus a new species originates by gradual accumulation of favourable variations in a number of generations.

Darwin considered that a permanent racial change is the product of fluctuating variations. He also believed that evolution is a gradual, rather than a sudden, biological event. Thus, as per natural selection, new species are evolved due to cumulative effect of fluctuating variations.

### 6.1.3.1 Experimental Verification of Natural Selection – Industrial Melanism

“A classical example of natural selection in the wild is the case of peppered grey moth *Biston Betularia* which was abundant before industrial revolution all over England. These moths showed colouration with two phenotypes, grey and black. The black forms were more and grey forms were less in the industrial period particularly in the industrial cities like Birmingham. Biologists proposed this change in the population of peppered moth was due to the pollution caused by the industrial revolution. Prior to industrial revolution the grey moths succeeded to camouflage the light trunks of the trees. With the industrial revolution more soot was released due to the burning of coal. Tree barks became black. Grey moths were easily identified and were more predated by the birds. Grey moths decreased in number and dark moths increased in the population. Therefore natural selection favoured the melanic moths to reproduce more successfully. Natural selection of darker forms in response to industrial pollution is known as industrial melanism” (Theories of Evolution, n. d.).

**Check Your Progress 3**

6) Who wrote the book “Origin of Species by Natural Selection”?
   a) Charles Darwin  
   b) Jean-Baptiste Lamarck  
   c) Alexander Oparin  
   d) J. B. S. Haldane

7) T.R. Malthus wrote an essay on:
   a) Principles of Geology  
   b) On the principles of populations  
   c) On the tendency of varieties to depart from original types  
   d) Theories of population
8) Natural selection of darker moths in response to industrial pollution is known as:
   a) Industrial pollution
   b) Industrial melanism
   c) Industrial selection
   d) Industrial revolution

6.1.4 The Mutation Theory

Hugo de Vries in the year 1900 proposed a new theory of evolution which is known as the Mutation Theory. This new theory did not consider natural selection as the principle force of evolution; rather it considered mutation as the main proponent of evolution. Mutations are called the spontaneous alteration of genes leading to changes in the organism and this in turn gives rise to new species. The new species originates suddenly and without any visible preparation.

The mutationists were of the opinion that most of the hereditary variables were discontinuous in nature and could be explained by the laws of Mendel. In this case, evolution would be effective if selection is operated on large mutations.

Contrary to the mutationists, the biometricians led by Karl Pearson, supported the view of Darwin and argued that the major cause of evolution was natural selection. They opined that selection acting on small differences was the primary mechanism for evolutionary change. After the acceptance of the Hardy-Weinberg equilibrium (1908), mathematical models began to be developed and a new field called “population genetics” emerged. This field was developed largely due to the efforts of scientists such as Th. Dobzhansky, R. A. Fisher, S. Wright and J.B.S. Haldane.

6.1.5 The Modern Synthetic Theory

As a result of emergence of population genetics, a framework developed for the integration of genetics into natural selection. This subsequently led to the demise of mutationism and the modern synthetic theory was conceived. By the middle of the 20th century, evolutionary biologists universally accepted this integration and the synthetic theory was widely adopted. In contrast to Weismann’s and Wallace’s Neo-Darwinian concept, the Synthetic Theory incorporated facts from fields such as genetics, systematics and paleontology. Hence, the term “Neo-Darwinian theory” should not be confused with the “Synthetic Theory” (or the phrase “Neo-Darwinian synthesis”).

The basic tenets of the Synthetic Theory were Theodosius Dobzhansky (1900-1975), Ernst Mayr (born 1904), Julian Huxley (1887–1975), George G. Simpson (1902–1984), Bernhard Rensch (1900–1990) and G. Ledyard Stebbins (1906–2000).

The proponents of the Modern Synthetic Theory laid emphasis on the population and not on the individual levels. It was observed that natural populations exhibited considerable amount of genetic variation and that selection could act on these variations. Hence, the population had the necessary variability to explain evolutionary genetic change through time and space. Modern Synthetic Theory has considered following aspects:
Mutation forms the base of the Modern Synthetic Theory. These occur in a random fashion and furnish the fuel for evolution by introducing genetic variability.

Migration, founder effect, random genetic drift and hybridization are other factors.

Synthetic theory is the concept of the “biological species” which has been proposed by Mayr in 1942.

Speciation defined by Dobzhansky as a “step of the evolutionary process (at which) forms ... become incapable of interbreeding”. Consequently a number of pre and post-mating isolation mechanisms have also been proposed.

Gradual evolution can be explained in terms of small genetic changes (“mutations”) and recombination and the ordering of this genetic variation by natural selection. The observed evolutionary phenomena, particularly macro-evolutionary processes and speciation, can be explained in a manner that is consistent with the known genetic mechanisms.

Check Your Progress

9) Who proposed the theory of mutation?
   a) Hugo de Vries
   b) Ernst Mayr
   c) Julian Huxley
   d) Bernhard Rensch

10) Gradual evolution can be explained in terms of small genetic changes (“mutations”) and recombination and the ordering of this genetic variation by natural selection. This statement defines:
   a) Neo Lamarckism
   b) Darwinism
   c) Mutation theory
   d) Modern synthetic theory

11) The concept of the “biological species” was proposed by:
   a) Ernst Mayr
   b) Theodosius Dobzhansky
   c) Julian Huxley
   d) Bernhard Rensch

6.2 SUMMARY

The term ‘Evolution’ refers to the development of more complex forms of life from simpler or earlier forms. To understand organic evolution various theories were put forth. But the important theories that explained the organic evolution are: Lamarckism, Darwinism, Mutation theory and Synthetic theory of Evolution. The Lamarckian theory mainly explained the Inheritance of Acquired Characters and Use and Disuse of Organs. The Darwinian Theory
consists of the principles such as, over production, struggle for existence and survival of the fittest. The Mutation Theory did not consider natural selection as the principle force of evolution; rather it considered mutation as the main proponent of evolution. The Synthetic Theory of Evolution is the combination of Darwinian natural selection and Mendelian genetics. Because of the developments in modern genetics, evolution can be studied as changes in gene frequencies between parents and offspring. Hence the Synthetic Theory can be studied with the help of mutation, natural selection and isolation.

6.3 REFERENCES


6.4 ANSWERS/HINTS TO CHECK YOUR PROGRESS

Answers: 1 (a), 2 (b)

Answers: 3 (b), 4 (c), 5 (c)

Answers: 6 (a), 7 (b), 8 (b)

Answers: 9 (a), 10 (c), 11 (a)
UNIT 7 BASIC CONCEPTS OF EVOLUTION*

Contents

7.0 Introduction
7.1 Definition
7.2 Basic Concepts of Evolution
7.3 Speciation
  7.3.1 Allopatric Speciation
  7.3.2 Parapatric Speciation
  7.3.3 Sympatric Speciation
  7.3.4 Quantum Speciation
7.4 Irreversibility
7.5 Parallelism and Convergence
7.6 Adaptive Radiation
7.7 Extinction
7.8 Summary
7.9 References
7.10 Answer/Hints to Check Your Progress

Learning Objectives

After going through this unit, you would be able to understand the basic concepts of evolution, i.e.:
- speciation;
- irreversibility;
- parallelism and convergence;
- adaptive radiation; and
- extinction.

7.0 INTRODUCTION

Physical Anthropology has two principal aspects of study: human evolution and human variation. Human evolution is the evolution of *Homo sapiens* from their ancestors whereas human variation refers to the differences that exist among individual populations. Anthropologists are interested in understanding both cultural and biological variation. Let us first understand what evolution is as the present unit deals with basic concepts of evolution.

All life on earth originated through common descent, from a last universal ancestor that lived approximately 3.5–3.8 billion years ago (Doolittle, 2000; Glansdorff et al., 2008). “Repeated formation of new species (speciation), change within species (anagenesis) and loss of species (extinction) throughout the evolutionary history of life on earth can be inferred from shared sets of morphological and biochemical traits, including shared DNA sequences. These shared traits are more similar among species that share a more recent

---

* Prof. Rashmi Sinha, Faculty of Anthropology, SOSS, IGNOU, New Delhi
common ancestor and can be used to reconstruct a biological “tree of life” based on evolutionary relationships (phylogenetics), using both existing species and the fossil record. Existing patterns of biodiversity have been shaped both by speciation and by extinction” (Evolution, n. d.). Although more than 99 percent of all species that ever lived on the planet are estimated to be extinct (Stearns & Stearns, 2000), there are currently 10–14 million species of life on earth (Miller & Spoolman, 2012).

According to Darwinian Theory of Evolution by Natural Selection organisms become progressively adapted to their environments by accumulating beneficial mutants, immediately strikes our mind. In fact when Darwin originated his theory in the mid 19th century, the mechanism of inheritance and the nature of heritable variations were unidentified; rather he slowly came to acknowledge the Lamarckian view that the inheritance of acquired traits did play some role in evolution. However, Darwin’s Theory of Evolution by Natural Selection as a ground for evolution was accepted into other branches of biology. Huxley, Broca and Duckworth, recognized undoubtedly that, man’s place in nature was amongst primates and held closest proximity to the great apes.

The study of human evolution advanced independently of human genetics owing largely due to the discrepancy in time. 20th century saw the rediscovery of Mendel’s work, explaining the concepts and mechanism of inheritance; thus heralding the landmark Mendelian genetics. Modern Genetic Theory propagates that evolution is result of changes in gene (allele) frequencies between ancestral and descendent populations. Natural selection, mutation, genetic drift and migration are responsible for these changes. Despite the fact that evolution is result of changes in gene, it is practically not viable to measure directly the changes in gene frequencies. Hence, evolution is also essentially viewed as changes in the morphology of organisms through time; and the degree of morphological similarities and differences have always been part of evolutionary studies.

The understanding of human evolution continues and currently the Synthetic Theory of Evolution states that evolution paved way to the fact that functional adaptation of the diverse and variable forms of life, is through the continuous production of variation and the action of natural selection.

7.1 DEFINITION

Evolutionary processes give rise to diversity at every level of biological organisation, including the level of species, individual organisms and at the of molecular level (Hall and Hallgrimsson, 2008). Evolution was first used by Herbert Spencer (1852), an English philosopher, to denote the historical development of life. Evolution is change and the changes within the organism over a period of time is termed ‘micro-evolution’ whereas changes from one being to the other i.e. transformation, is termed as ‘macro-evolution’. Evolution can be defined in numerous ways; there is geological evolution or evolution of planet earth, evolution of solar systems and the evolution of the automobiles, radios and telephones etc, the changes involved in the rise of human civilization or cultural evolution. Likewise ‘organic evolution’ is applied to the changes that have taken place in the living things, viz. plants and animals. Charles Darwin (1859) defined evolution as “descent with modification” i.e., closely related species resembling one another because
of their inheritance; and differing from one another because of the hereditary differences accumulated during the separation of their ancestors. But according to Dodson and Dodson (1976), evolution is the process by which related populations diverge from one another, giving rise to new species (or higher groups) while in 1951 Dobzhansky stated “evolution is the development of dissimilarities between the ancestral and the descendant population”.

### 7.2 BASIC CONCEPTS OF EVOLUTION

Before mid 1800’s it was presumed that the diversity of life on earth was due to God’s grace and perfection and whatever we saw was God’s creation that naturally remain unchanged; this thought lead to the belief that the basis of creation was its genesis only. Nevertheless evolutionary thought did evolve, as fossil discoveries showed that life had changed over time, few scientists considered that life had evolved with time and geological sciences provided evidence that earth was exceedingly old. It was pre-Darwin biologists who proposed mechanisms for evolution and finally Darwin and Wallace (1858; 1859) proposed a mechanism of evolution through their writings. There are various evolutionary principles like speciation, irreversibility, parallelism and convergence, adaptive radiation and extinction which we would be discussing.

### 7.3 SPECIATION

Speciation is the evolutionary process. Among diverse evolutionary principles, speciation by which new biological species arise plays the most important role. Orator F. Cook (1906) was the first to coin the term ‘speciation’ for the splitting of lineages. Mayr (1970) defined speciation as the creation of species. Speciation can also be defined as creation of two or more species from one. Did it strike you that the complete evolution depends on the origin of new populations from their ancestors? It gets very complicated to understand many of them in detail due to lack of sufficient resources because the origin is from their ancestors.

Let us first understand what is species? Species is one of the basic units of biological classification and a taxonomic rank that is often defined as a group of organisms capable of interbreeding and producing fertile offspring. Next, how does the speciation process occur? According to Mayr (1970), true speciation or multiplication of species may occur by the following agencies:

- *Instantaneous speciation* (through individuals) which could be genetical or cytological, in partially or wholly sexual species.
- *Gradual speciation* (through populations) which could be geographical speciation or sympatric speciation.

The course of speciation is achievable by four geographic modes in nature on the basis of the extent to which speciating populations are isolated from one another viz.

- allopatric,
- parapatric,
- sympatric and
- quantum speciation

A brief description of each is given below:
7.3.1 Allopatric Speciation

Allopatric (Greek word *allo* that means other + *patrē* which means fatherland) speciation also referred to as geographic speciation is a common process by which new species arise. The population divides into two geographically isolated populations by a geographic barrier like a mountain range or river for terrestrial organisms, or a land mass for aquatic organisms depending upon the habitat of the animal. These isolated populations then experience genotypic and/or phenotypic deviation because of different selective pressures.

7.3.2 Parapatric Speciation

This mode of speciation is typified when a small population enters into entirely new habitat. But then there is only partial separation of the zones between these two diverging populations and the individuals of each species may come in contact or cross habitats from time to time, but reduced suitability of the heterozygote leads to selection for behaviors or mechanisms that avert their inter-breeding.

7.3.3 Sympatric Speciation

In sympatric speciation, two or more descendant species forms from a single ancestor and occupy the same geographical locality. In this sort of speciation even a small amount of gene flow tends to eradicate genetic differences between parts of a population. There are number of examples of sympatric speciation amongst the invertebrates, predominantly the insects that becomes dependent on diverse host plants in the same area.

7.3.4 Quantum Speciation

Grant (1971) defined quantum speciation as “the budding off a new and very different daughter species from a semi isolated peripheral population of the ancestral species in a cross fertilization organism”. This takes place through adaptive radiation by the discharge of genetic variability surrounded by ecologic islands. Quantum speciation is swift; requiring only few generations, in fact may consist of only one or few individuals. In quantum speciation, genetic drift plays a key role.

Check Your Progress 1

1) What do you understand by evolution?

2) What is Speciation? Describe different mechanisms of speciation with suitable examples.
7.4 IRREVERSIBILITY

Irreversibility is an important principle in the studies of primate evolution. Louis Dollo, a French born Belgian paleontologist proposed in 1893 the Principle of Irreversibility. Dollo’s law of Irreversibility or Dollo’s Law states that an organism is unable to return, even partially to a previous stage, already realized in the ranks of its ancestors. This means that a structure that changes its form in evolution will not revert to its earlier form. So once an animal has passed through a number of stages, a reversion, stage by stage, to the original ancestral condition does not occur. Flying reptiles can be taken as an illustration of this. After these reptiles became extinct, wings and adaptation to an airborne way of life occurred in two other distinct lineages – the birds and mammals.

7.5 PARALLELISM AND CONVERGENCE

Similar structures, similar adaptive relationships, or similar behaviors occurring in dissimilar groups of animals are consequential of similar evolutionary opportunities. The fundamental principle of evolutionary biology is that when there is a close similarity in the total morphological pattern of two organisms, there is a logically close phylogenetic relationship between them. Well, dilemma that erupts with this phenomenon of similarity is whether such similarities are examples of parallelism or convergence or whether they are proof of evolutionary affinity between the organisms. Parallelism and convergence imply that a close phylogenetic relationship does not exist.

- Parallelism is typically limited to the development of similar adaptive features in animals that are related, such as, animals belonging to the same order and also the parallel resemblances are, in all probability the recognition of a genetic potential that is present in the entire group. An example of this may occur when a species colonizes several new areas which are isolated from, but environmentally similar to each other. Similar selective pressures in these environments result in parallel evolution among the traits that confer.

- Convergence on the other hand is the development of similarities in adaptive relationships or structures in two animal species or major groups that are not closely related. The repeated evolution of flying is a typical example of convergent evolution, be it flying insects, birds and bats, all evolved the capacity of flight independently; so what we conclude that they have ‘converged’ on this useful trait. Let us understand this with an example. The eye of the octopus has the same complex structure as the human eye. However, substituting it for human eye study would be very wrong although the two species diverged at the time when animals had evolved into vertebrates and invertebrates.

It is herculean task to classify all cases of similarity as convergent or parallel due to complexity. Let us understand this. There are two types of photoreceptors in the vertebrate eye: rods and cones. Rods are highly sensitive and need very little light to function though have little power of discrimination; on the other side, cones are sensitive to higher intensities of light and have high degree of discrimination of spatial relationships, colors and textures. Rods have been found in the eyes of many nocturnal vertebrates such as owls, bats and lorises and of those that live in dim light such as
whales, cats and some fishes. The difficulty is, in which of these animals are the rods convergent and in which there is parallel development? Therefore, comes the perception of how we define parallel and convergent. As suggestive of the nomenclature, it is convergent when the rods in each of the various animals noted may have evolutionary derivations from different structures and it is parallel if they are derived from the same parts of the basic vertebrate eye. The Old World Monkeys and New World Monkeys present an excellent example of parallelism between groups living today, since they appear to have evolved in parallel from a prosimian ancestor that most likely lived at least 35 million years ago. An example for convergent evolution is the brachiation, locomotion by swinging arm over arm through the trees in some monkeys of both Old World and New World and in certain apes.

The terms homologous and analogous are frequently used to portray particular structures in animals. Homologous structures are those that are related by evolutionary descent and divergence; e.g. the wing of a bat and the forelimb of a monkey are homologous – they are descendent from same ancestral structure, whereas, the wing of a bat and the wing of a butterfly are analogous. Though they may have similar functions and similar forms, but then they are not related by descent from the same ancestral structure. Perhaps thinking of parallelism as homologous evolution and convergence as analogous evolution would help us distinguish the two processes.

7.6 ADAPTIVE RADIATION

In evolutionary biology, adaptive radiation is a process in which organisms diversify rapidly into a multitude of new forms, particularly when a change in the environment makes new resources available, creates new challenges and opens environmental niches (Larsen, 2011; Schulte, 2000). “Four features can be used to identify an adaptive radiation:

- Common ancestry of component species: specifically a recent ancestry. Note that this is not the same as a monophyly in which all descendants of a common ancestor are included.
- A phenotype-environment correlation: A significant association between environments and the morphological and physiological traits used to exploit those environments.
- Trait utility: The performance or fitness advantages of trait values in their corresponding environments.
- Rapid speciation: Presence of one or more bursts in the emergence of new species around the time that ecological and phenotypic divergence is underway.” (Adaptive Radiation, n. d.)

When there is a rapid increase in numbers and kinds of any evolving group of animals facilitated by environmental changes and utilizing a number of new places in the planetary living space because of adaptive radiation, it may result in the evolving group of animals be it at the level of a species, a genus and a super family. These places in the environment are called niches and eco-niches. But, according to Simpson (1953) adaptive radiation is the rapid proliferation of new species from a single ancestral group. In adaptive radiation, species evolves into progressively dissimilar organisms. Sometimes the descendants of a single species evolves to take advantage of many different environments and opportunities, now this rapid change in the external
environment may result in the formation of different animals to grow from a single ancestral form. The evolution of a trait that opens up many new possibilities may also give rise to adaptive radiation. Let us understand this principle of evolution by the history of the mammals.

With the geological revolution that marked the end of the Mesozoic era (the age of the reptiles) and the start of the Tertiary period of the Cenozoic Era, the earlier steady climates became unsettled as a result. Dinosaurs (a varied group of animals from taxonomic, morphological and ecological standpoints) became extinct as they did not adapt themselves to the new environment.

Whereas the mammals evolved in many distinct lines e.g. the rodents specialized for gnawing, the carnivores for hunting, the hoofed animals for grazing, the primates and sloths took to the trees, the whales, seals and sea cows adapted for life in the oceans and the bat took to the air.

Additionally, every mammalian order consecutively gave rise to sub lines that occupied new environments by acquiring new form of life. Many of today’s mammals are distinctly different from their primitive common ancestors to the Paleocene epoch.

The spread of arboreal primates, the old world monkeys, into trees of the tropical forests is an example of an adaptive radiation. Adaptive radiation is said to have occurred when a group of organisms adapt into a planetary living space consequent to the changes in the group’s relationship to environment, which naturally was not possible earlier. These altered relationships can be inferred from the lines of verification such as the morphology of the fossils and comparative studies of the living forms which are in all likelihood descendants of these fossils.

Besides, various orders and sub-orders of mammals have undergone more differentiation, dividing or ‘radiating’ into types adapted to different habitats. Hence, all the main groups of primates today embrace species with distinct dietary habits. Therefore, insect eating, seed eating, leaf eating and more or less omnivorous genera reappear in different branches of the primates as these branches diverge more or less from the ancestral line. This adaptive radiation within the branches is thus accompanied by parallelism between the branches and by convergence of adaptations towards those of some non primate lines.

Darwin’s finches are the famous example where adaptive radiation is seen. Patchy land is time and again a prime location for adaptive radiation to occur, is argued by the evolutionary biologists. The differences in geography all through disjointed landscapes are thought to promote such diversification in species. Darwin’s finches also inhabit the patchy or fragmented land of the Galapagos Islands and are diversified into many different species which differ in ecology and morphology, specifically the size and shapes of their beaks.
Fig. 1: Adaptive radiation in Galapagos finches

Source: https://www.britannica.com/science/speciation

It was adaptive radiation that paved way for the evolution of different beaks which facilitated the access to appropriate, different food and resources. Depending upon their beak would be their food e.g. those with short beaks are better adapted to eating seeds on the ground, those with thin, sharp beaks eat insects and those with long beaks use their beaks to probe for food inside cacti. Accordingly with such specializations in the beaks, seven or more species of finches are able to inhabit the same environments without competition or lack of resources killing several off. Consequently, these morphological differences in beak size and shape brought about by adaptive radiation allow the island diversification to continue.

7.7 EXTINCTION

Extinction is when an organism or of a group of organisms, that is, a species ceases to exist. It is through evolution that a new species is formed by the process of speciation. The relationship between animals and their ecological niches has been firmly established (Sahney et al., 2010). Extinction is the disappearance of an animal group, such as species, from the evolutionary record due to the death of the last individual of that species. It is not a bizarre occurrence, because species are produced by speciation when new organism evolve and increase when they find suitable ecological niche and when they are no longer able to cope with the new changing conditions, they disappear through extinction. Practically all animal and plant species that have lived on earth are now extinct and extinction appears to be the eventual destiny of all species. Hence, when there are no existing individuals to reproduce and carry on next generation extinction then becomes inevitable. The species also become functionally extinct when very few
individuals who are unable to reproduce that may be due to age, poor health, large distant or even lack of individuals of both the sexes, survive. The extinctions are constant all through the history of life, even if the rate of extinction elevates in occasional mass extinction events. Extinction of species may be due to the negative role of environmental selection in evolution wherein the species may develop a way of life such that a change in the environment is unable to support its survival or one species may become extinct when it is changed into another, resulting in species being a segment of a continuous, progressive evolutionary lineage. Therefore, the species of one time period in which this lineage exists is the ancestor of the subsequent species in the next time period and the ancestral species become extinct through the course by which it is transformed into its descendants. The early Pleistocene hominids, australopithecines are extinct; nevertheless it is probable that some direct descendants of australopithecine genetic material exist in modern Homo sapiens. The Cretaceous–Tertiary extinction event, during which the non-avian dinosaurs went extinct, is the most well-known, but the earlier Permian–Triassic extinction event was even more severe, with approximately 96 percent of species driven to extinction. The Holocene extinction event is an ongoing mass extinction coupled with humanity’s expansion across the globe over the past few thousand years. Human activities are now the crucial cause of the continuing extinction event; global warming may additionally hasten it in the future. The position of extinction in evolution is not very well understood and may depend on which type of extinction is considered. The foundation of the incessant “low-level” extinction events, which constitute the greater part of extinctions, may be the result of competition between species for limited resources. If one species can out-compete another, this could generate species selection, with the fitter species surviving and the other species driven to extinction. The sporadic mass extinctions are also important, but instead of acting as a selective force, they radically reduce diversity in a non-specific manner and promote bursts of rapid evolution and speciation in survivors.

7.7.1 Pseudoextinction

Extinction of a parent species where daughter species or subspecies are still alive is also called pseudoextinction. In other cases, species have produced no new variants, or none that are able to survive the parent species’ extinction. Many of prehistoric extinct species have evolved into new species; for example the extinct Eohippus (an ancient horse like animal) was the ancestor of several existing species including the horse, the zebra and the donkey. The Eohippus itself is no more, but its descendants live on. It is therefore said to be pseudoextinct.

Check Your Progress 2

3) Write a short note on irreversibility, parallelism and convergence and adaptive radiation.
4) What is extinction? Critically discuss this evolutionary process with examples.

7.8 SUMMARY

Evolution simply means change. Organic evolution is the study of changes that have taken place in living things i.e., plants and animals. According to the progress of modern genetic theory, evolution is now considered as changes in gene (allele) frequencies between ancestral and decedent populations. But then it is practically unattainable task to measure directly the changes in gene frequencies. Hence, evolution is also essentially viewed as changes in the morphology of organisms through time. Analyses of degrees of morphological similarities and differences have always been focus of evolutionary studies. The origin of discontinuities between animal populations, that is speciation, is a foremost issue of biologists. After the foundation of the development of genetic concepts, today we are possessors of the Synthetic Theory of Evolution, which states that evolution led to the functional adaptation of the diverse and variable forms of life through the continuous production of variation and the action of natural selection. While understanding the evolution, the basic concepts of evolution like speciation, irreversibility, parallelism and convergence, adaptive radiation and extinction are important.

7.9 REFERENCES


7.10 ANSWER/HINTS TO CHECK YOUR PROGRESS

1) Evolution, also known as descent with modification, is the change in heritable phenotype traits of biological populations over successive generations. (Refer to the section 7.1).

2) Speciation is the evolutionary process and whether genetic drift is a minor or major contributor to speciation is the subject matter of much ongoing debate. Among diverse evolutionary principles, speciation by which new biological species arise plays a most important role.

There are two mechanism of speciation: Instantaneous speciation and Gradual speciation (Refer to the section 7.3).

3) Irreversibility

Irreversibility is an important principle in the studies of primate evolution. Dollo’s law of Irreversibility or Dollos Law states that an organism is unable to return, even partially, to a previous stage already realized in the ranks of its ancestors. This means that a structure that changes its form in evolution will not revert to its earlier form.

Parallelism and Convergence

Parallelism and convergence imply that a close phylogenetic relationship does not exist. Parallelism is typically limited to the development of similar adaptive features in animals that are related, such as animals belonging to the same order and also the parallel resemblances are in all probability the recognition of a genetic potential that is present
in the entire group. Convergence on the other hand is the development of similarities in adaptive relationships or structures in two animal species or major groups that are not closely related.

Adaptive Radiation

In evolutionary biology, adaptive radiation is a process in which organisms diversify rapidly into a multitude of new forms, particularly when a change in the environment makes new resources available, creates new challenges and opens environmental niches.

4) Extinction

Extinction is when an organism or of a group of organism that is species ceases to exist. It is through evolution that a new species is formed by the process of speciation. Extinction is the disappearance of an animal group, such as species, from the evolutionary record due to the death of the last individual of that species. (For further refer to section 7.7).
UNIT 8  DEFINING “RACE” AND MAJOR “RACES” OF THE WORLD*

Contents

8.0  Introduction

8.1  Classifications of Major Races
  8.1.1  Negroid Group
  8.1.2  Caucasoid Group
  8.1.3  Mongoloid Group

8.2  Criticism of Various Classifications of Races

8.3  Summary

8.4  References

8.5  Answer/Hints to Check Your Progress

Learning Objectives

After going through this unit you will know the:

➢ different races and other racial sub-groups of mankind; and

➢ detailed information of all the three major groups of mankind known as the Negroid, Caucasoid and Mongoloid.

8.0  INTRODUCTION

It is a general observation that human beings differ from each other physically and also in morphological features. The anthropologists have tried to categorize groups on the basis of some common physical features. In biology, a “race” has been customarily defined as a subdivision of a species that inherits physical characteristics distinguishing it from other populations of the species (Montagu, 2001). These features include the pigmentation of the skin, hair colour, its form and quantity, shape of the nose, head and face, eyes, stature, finger and palm prints. It was a natural curiosity of the anthropologists to club the overall diversity of the mankind in certain groups so that it becomes easier to describe them.

There is a lot of overlapping of characters and mixing of features among the races. The system of classification of races is inadequate; it is hypothesized that the physical features of the different people have originated because of adaptation to different types of ecological zones in which they have lived for centuries together. In this unit, you will get information about the different racial groups of the mankind classified by the anthropologists. It must be understood that the classifications offered by different anthropologists are arbitrary as they are based mainly on the physical features of the body.

*  Prof. S. P. Singh, Retired, Human Genetics Department, Punjabi University, Patiala.
Among anthropologists and biologists, race has historically been an idea about the geographic patterning of human biological variations. The term race is never used by modern anthropologists to refer to religious groups, linguistic groups, or nationalities. There are many anatomical or morphological differences between people and populations that reflect underlying biological differences. Some morphological differences are visible to the naked eye, including skin, eye and hair color and body size and shape. Some other biological differences are just as real but are not as easily seen; these include blood type, fingerprint patterns, and disease susceptibilities. Considering all of these traits that differ among members of our species, there is no doubt that Homo sapiens is a species with considerable biological differences. This kind of geographically patterned biological variation is the traditional raw material of racial classification. We can define race, then, as the geographic pattern of variation in some biological traits that distinguish different human populations (Anemone, 2011).

8.1 CLASSIFICATION OF MAJOR RACES

The variety of mankind has been described by the anthropologists in three major groups or races. These are known as the Negroid, Caucasoid and Mongoloid.

8.1.1 Negroid Group

Negroid race is mainly distributed in Sub-Saharan Africa. They possess very unique facial characteristics. Negroid group is mainly represented by the African people. The distinguishing characteristics of the Negroid group are:

- Skin colour is dark brown to black
- Head hair is woolly and tightly curly
- Head form is more elongated but less broad
- Nose is broad and flat in shape
- Lips are thick and everted
- Body hair is sparsely distributed

There are different sub groups of the Negroid group and these have been described below:

a) The True Negroes

The True Negroes are those who possess almost all the features of the Negroes. They live in West Africa and inhabit areas from the Senegal River to the eastern border of Nigeria. They have an average height of five feet and eight inches. Their arms and legs are long and they are sturdily built. The skin colour is black. Heads are elongated with conspicuous prognathism. The shape of the nose is broad and flat.

b) The Forest Negroes

The Forest Negroes live in Sudan, Uganda and neighboring areas of Africa. They have long arms but short legs. Their chests are barrel shaped and
they have elongated heads. Their lips are everted. Body build of these people is muscular. Forehead is sloping and lower face is protruding.

c) **Nilotic Negroes**

They are the inhabitants of Sudan and upper Nile valley along the great Nile River. The Nilotic Negroes are tall and very slim in body built and have dark skin colour. They have long heads but their face is not protruding. The average height is five feet and ten inches.

d) **Half Hamites**

They inhabit different areas of Kenya, Uganda and Sudan. They have a variety of brown skin colour. The head hair is woolly. Nose is broad and flat and their average height is five feet and eight inches. Their head is long.

e) **Bantu speaking Negroes**

These people are found in a great majority living in Central and Southern Africa. The skin colour varies from yellow to dark brown. The average height of these people is five feet and six inches.

f) **Bushman**

They inhabit southern Angola and parts of Kalahari Desert. In earlier times, they inhabited whole South Africa and tropical areas of central Africa. But now their number has greatly decreased and they have been pushed only to small areas of Africa. The Bushman are typical in appearance and are different from other Negro sub groups. The majority of the Bushman are very small in height and look like pygmies but some of them are also tall. They have an average height of five feet and two inches. They have medium-shaped heads which are neither elongated nor broad. Their hands and feet are small, body build is lean, arms and legs are longer as compared to the trunk. The head hair are tightly rolled in coils and are called “peppercorn”. Body hair is lacking and sparse growth of facial hair can be seen. They have short, small and broadened nose. The chin is generally pointed and ears are small without the earlobes.

g) **Hottentots**

The Hottentots are generally distributed in the western part of West Africa. The Bushman and Hottentots are very much similar to each other. The Hottentots have elongated heads as compared to those of the Bushman and are also taller than them.

h) **Pygmies**

The early anthropologists considered the Pygmies as the most primitive people. They are characterized by very small stature. The average height of the Pygmies is 4 feet and 8 inches. They have woolly type of head hair and the colour of their skin varies from yellowish brown to black. The shape of the nose is broad and flat. The lips and the eyes are large. The shape of the head is medium to broad. Prognathism is generally seen. The geographical distribution of the Pygmies extends from Congo region in Africa to Malay and East Sumatra, Andaman Islands and the Philippine islands. On the basis of the geographical distribution and physical
characteristics, the Pygmies are further divided into three distinct groups, viz., the African Pygmies, Asiatic Pygmies and Oceanic Pygmies.

j) The Veddas

The Veddas of Ceylon have an average height of about five feet. They have wavy or slightly curled head hair which are generally black. Facial hair are sparse on the chin and the body hair are generally lacking. The size of the head is small and its shape is elongated.

j) The Pre-Dravidians

They occupy parts of Central and Southern India and are considered to be the oldest inhabitants of these regions. It is argued that formerly they inhabited larger parts of India but now they live in the jungles. Prominent among them are the Bhil, Gond, Oraon, Kadar, Kurumba, Paniyan, etc. They have an average height of five feet and two inches (157 cm). The skin colour is black and the shape of the head is dolichocephalic. Forehead is slightly receding. Brow ridges show moderate development.

k) Ainu

The Ainu are considered to be the original inhabitants of Japan who were forced to migrate to the northern regions. Presently they inhabit Hokkaido and Sakhalin islands of northern Japan.

The Ainu people show a very prominent growth of facial and head hair seen in any group of the humans. They show a range of skin colour from brown to white. They have an average height of five feet and two inches and are stockily built. The shape of the head is mesocephalic.

The first classification based on cranial morphology is attributed to the Professor of Anatomy Anders Retzius (1840). Retzius described as gentes dolichocephalae those individuals who had an elongated skull shape, and gentes brachycephalae those whose skulls were short. However, he assigned no numerical values to set the boundaries between individual types in both groups and neither did he use the intermediate term mesocephalae, which was introduced at a later time. The measures used by Retzius—when applied to living individuals are known as cephalic index, and when referring to dry skulls, cranial index. These indices are calculated by determining the ratio between maximum width and maximum length of the head. The concept was subsequently enhanced with the definition of intermediate values, which provide a classification system and reflect more accurately the diversity found in human facial morphology. Both the cephalic and cranial indices are therefore measures related to the shape of the skull. The index used in anthropometry to describe the face proportions is the facial index, a product of morphological facial height, measured from the Nasion (N) to Gnathion (Gn) anatomical landmarks, divided by the bizygomatic width, measured from the right to the left Zygon (Zyr-Zyl). Semantically, the terms used in the facial index are derived from Greek, where the word for face is prosopon. According to this classification system, numerical values are assigned which establish the euryprosopic, mesoprosopic and leptoprosopic categories (Franco et al., 2013).
Human Evolution and Variation

Cranial Index

<table>
<thead>
<tr>
<th>Cranial Index</th>
<th>Maximum skull width x 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum skull length</td>
</tr>
</tbody>
</table>

**Table 1: Head classification according to the cephalic index**

- Ultradolichocephalic: \(x - 64.9\)
- Hyperdolichocephalic: \(65.0-69.9\)
- Dolichocephalic: \(70.0 - 74.9\)
- Mesocephalic: \(75.0 - 79.9\)
- Brachycephalic: \(80.0 - 84.9\)
- Hyperbrachycephalic: \(85.0 - 89.9\)
- Ultrabrachycephalic: \(90.0 - x\)

- Facial index
  - Morphological facial height: \(x \times 100\)
  - Bizeygomatic width

**Table 2: Face classification according to facial index**

- Hypereuryprosopic: \(x - 79.9\)
- Euryprosopic: \(80.0 - 84.9\)
- Mesoprospic: \(85.0 - 89.9\)
- Leptoprospic: \(90.0 - 94.9\)
- Hyperleptoprospic: \(95.0 - x\)

**8.1.2 Caucasoid Group**

The Caucasoid are generally referred to as the ‘White’ people. However, the term seems to be a misnomer as this group includes many people with dark skin colour too. The major characteristics of this group include:

- Head hair is generally wavy but may be straight or somewhat curly
- Skin colour may range from white to brown
- Shape of the head shows a large variety from narrow headed to broad headed
- Narrow and pointed nose
- Face is straight and does not show prognathism
- Cheek bones are not prominent
- Lips are generally thin
- Forehead and chin are relatively prominent

The Caucasoid include the following sub groups:

**a) Mediterranean**

This is a large group of different populations which inhabit the areas spreading out in every direction from the Mediterranean Sea and extending up to the Northern India. These include the Portuguese, Italians, Spaniards, Frenchmen, Turks, Greeks, Iranians, Indians, Afghans and North Africans, among others. Their skin colour varies from tanned white to brown. The hair is generally black. The head is dolichocephalic. The average height is five feet and four inches. The face does not show prognathism. The lips are full.

Three distinct types can be found in this sub groups which are recognized as the Basic Mediterranean, Atlanto Mediterranean an Irano Afghan Mediterranean.
b) **The Nordic**

The Nordic people live in the Scandinavian countries viz., Iceland, Netherlands, Belgium, Germany, Poland and Western Russia. The hair colour is from blonde to other light colours. The skin colour is white or slightly pinkish. The eyes are either blue or grey. The head is either elongated or of medium breadth. The nose is prominent, long and pointed. The average height is five feet and eight inches (172 cm).

c) **Alpine**

The Alpine people inhabit along all areas of the Alps Mountains of Europe, France, Russia and Siberia. The Alpine people have broad heads with strongly developed brow ridges. The hair colour is blonde or black-brown. The average height is five feet and five inches (165 cm). The nose is prominent at the tip. They are strongly built.

d) **Dinaric**

The area of Switzerland, Slovakia and Albania is the home of the Dinarics. The head form ranges from mesocephaly to brachycephaly. The forehead is generally vertical. The hair colour varies from black to brown whereas the shape of the head hair is straight or wavy. They have full lips and chin is strongly developed. The nose is generally curved with fleshy tips. They have an average height of five feet and eight inches (172 cm).

e) **Armenoid**

The geographic distribution of these people is towards the eastern side of the Black Sea, Armenia and Turkey. They have a good resemblance with the Dinaric people. They have curved and fleshy noses which are prominent at the tips. The head shape ranges from mesocephaly to brachycephaly. The hair colour is dark brown to black. The mean height of Armenoids is five feet and six inches (167 cm).

f) **Hamites**

The Hamites occupy vast areas of East and North Africa. They show a great range of skin colour from white to black. The head hair also shows large variations from straight to frizzy. They have very little body hair. The shape of the head is dolichocephalic. They have elongated face with pointed chin. Their body build is lean and they are of average height of five feet and five inches (165 cm).

g) **East Baltic**

The Baltic group is native to Germany, Poland, Finland and other Baltic areas. They have very little pigmentation of the hair, skin and eyes and hence they are generally blonde, have white skin colour with very light coloured eyes. The head is broad which means they are brachycephalic. They are called square headed people as the head is evenly and proportionately developed in all areas. The average height is five feet and four inches (164 cm).

h) **The Lapp**

The Lapps inhabit areas of Sweden, Norway, Finland and some parts of Russia. They used to live around coastal area, forests and rivers in very harsh snowy conditions. They have broad head (brachycephaly) and the forehead is steep but narrow. The skin colour is yellowish to brown whereas the hair color is brown and black. The texture of hair is straight or wavy. The average height is five feet and three inches (159 cm).
j) **Indo-Dravidian**

The Indo-Dravidians inhabit most parts of India and Ceylon (Sri Lanka). The shape of the head varies largely from dolichocephalic to brachycephalic. The faces are narrow and small and without any prognathism. The skin colour is dark brown and the hairs are generally black. They have full lips and prominent noses and have an average height of five feet and four inches (164 cm).

j) **Polynesians**

The Polynesians inhabit a geographical area spreading from Hawaii Islands to Fiji Islands and New Zealand. They are very strongly built. Their head shape is broad (brachycephalic) and the cheek bones are prominent. They have broad faces with well developed chins. The skin colour is light brown whereas hair colour varies from black to dark brown. The hair form is generally straight or wavy. The average height is five feet and eight inches (172 cm).

### 8.1.3 Mongoloid Group

Mongoloids have probably originated in Central Asia and moved to different directions. This group has vast and diverse geographical distribution. People of China and Japan are key representatives of this group. The Mongoloid group is characterized as follows:

- Skin colour varies from yellowish to yellowish brown.
- Head form is broad (brachycephalic).
- Hair colour is black and texture of hair is generally straight.
- Cheek bones are very prominent.
- Upper eyelid has a fold of the skin known as the epicanthic fold.
- Hair density per unit of body surface area is very less.

There are four major sub-groups of the Mongoloid group, viz., the Central or Classical Mongoloids, Arctic Mongoloids or Eskimoids, American Indians or Amerindians and Indonesian Malays.

a) **Central or Classical Mongoloids**

Almost all of the characteristics of the Mongoloids are present in this group. The regions inhabited by this group include areas of the Northern China, Tibet and Mongolia. Their head form is broad and epicanthic eye folds are always present. They have prominent cheek bones and flattened faces.

b) **The Arctic Mongoloids or Eskimoids**

The areas of Greenland, Alaska, Arctic coast of North America, Northeast Asia constitute the home of the Arctic Mongoloids or Eskimoids. This group shows typical epicanthic eye fold, prominent cheek bones, black and straight hair, large torso and small extremities.

c) **The American Indians or Amerindians**

The original Indians of the North, Middle and South America fall in this group of Mongolid people. The skin colour varies from yellow brown to red brown. The hair are generally straight or wavy and black in colour. The body and facial hair growth is very sparse. The internal epicanthic
eye fold is present but the external epicanthic eye fold is not always present. The face is broad with large cheek bones.

d) **Indonesian-Malays**

The Indonesian-Malays are a little shorter (average height five feet and one inch) than the Malay people (average height five feet and two inches); while the former is long-headed the latter is broad-headed. The other features of the Mongoloid group are more prominent in the Malay group than in the Indonesian group. The Indonesian-Malays inhabit different areas of the South China, Burma and Thailand. This group belongs to the Malay Peninsula, Philippines and Japan.

**Check Your Progress 1**

1) Describe the major features of the Negroid group.

2) Draw a comparison between the Negroid and Mongoloid groups.

3) Describe the important features which form the basis of racial classifications.

4) What is geographic distribution of the Mongoloid people?

---

**8.2 CRITICISM OF VARIOUS CLASSIFICATIONS OF RACES**

All human beings inhabiting this world belong to a single species of *Homo sapiens*. Yet by virtue of the external appearance they look very different from each other. May be it is the skin colour, the shape of the nose, the colour of the eyes, the shape of the head or the hair form and colour. The above classification of the mankind into three major groups and numerous sub groups can be considered to be basic but is often termed as flawed because of numerous drawbacks some of which have been listed and described below:

1) **Arbitrary and crude**

The classification of the mankind can be referred to as arbitrary and crude simply because of the fact that it is based on visibly distinguishing features. These features include the skin color, shape of the head, nose and hair etc. The underlying genetic relationships have not been considered and thus
do not form the basis of this classification. The humans have always been on the move in search of food and security. Racial admixture has been happening along with confrontation amongst different groups, probably led to the change in gene pools and gene frequencies. The human groups are dynamic and keep on changing their habitat. The racial admixture may have led to the formation of different groups. In short, it is logical to conclude that the criteria on the basis of which the present classification has been made is arbitrary.

2) *Geographic distribution as a limiting factor*

The continuity of geographical areas in describing various groups of the mankind has been the mainstay of this classification. However, people with many similar characteristics may be seen in many areas far flung from each other. But these may not have been included in that group on the basis of geographic discontinuity.

3) *Overlapping of characteristics*

The characteristics used for racial classification show continuity and hence pose a real difficulty of the cut-off limits for each trait. Within group variations for a characteristic should be much smaller compared to between group variations for it to qualify as a classifying trait. But the numerous examples of this not happening are available hence, compromise on the accuracy of the racial classification. Had there been no continuity in the characteristics, the issue of racial classification would have been resolved very easily, but then it is not the case.

4) *No genetic basis*

The present classification does not take into consideration the genetic basis of the differences in different groups. Of course, the anthropologists have studied the genetic structure of different populations and obtained the gene (allele) frequencies of different genetic traits. The best way would have been to consider numerous genetic traits to find out commonality amongst the members of a specific group to name it as a separate group. Most of the characteristics studied and included in the classification may be genetically determined and modifiable under environmental conditions but they are not exclusively determined by genetics such as various blood groups.

**Check Your Progress 2**

5) Describe why the present classification of the mankind into three major groups is arbitrary.

6) Why genetic traits should be preferred for classification of the mankind?
8.3 SUMMARY

Race is defined as the geographic pattern of variation in some biological traits that distinguishes different human populations. A belief in the existence of biological race within the human species is usually associated with the attempt to classify all human populations into a finite number of races based on some set of features. The mankind has been classified into three major groups, viz., the Negroid, Caucasoid and Mongoloid. It is based on the morphological characteristics such as the pigmentation of the skin, hair colour, hair form and quantity, shapes of the nose, head and face, eyes, stature, finger and palm prints, etc. The Negroid group inhabits various parts of Africa and some other regions of the world. Their skin colour ranges from dark brown to black, the head hair are woolly and tightly curly, head form is more elongated but less broad, nose is broad and flat in shape, lips are thick and everted and body hair is sparsely distributed. The Caucasoid group inhabits areas of the Europe and Central Asia and the Middle East. The head hair are generally wavy but may be straight or somewhat curled, the skin colour may range from white to brown, the shape of the head shows a large variety from narrow headed to broad headed, narrow and pointed nose, the face is straight and does not show prognathism, the cheek bones are not prominent, the lips are generally thin, and the forehead and chin are relatively prominent. The Mongoloid group inhabits areas of the East Asia, Japan, and South East Asia. The skin colour varies from yellowish to yellowish brown, the head form is broad (brachycephalic), hair colour is black and hair are generally straight, the cheek bones are very prominent, upper eyelid has a fold of skin known as the epicanthic fold, hair density per unit of body surface area is very less.

However, this classification of the mankind suffers from the arbitrariness of features, genetic basis being doubtful, geographical distributions being a limiting factor and there being overlapping of the characteristics among different groups.

8.4 REFERENCES


### 8.5 ANSWERS/HINTS TO CHECK YOUR PROGRESS

1) The following are the most important distinguishing characteristics of Negroid Group:
   - Skin colour is dark brown to black
   - Head hair are wooly and tightly curly
   - Head form is more elongated but less broad
   - Nose is broad and flat in shape
   - Lips are thick and everted
   - Body hair is sparsely distributed (Refer section 8.1.1).

2) The skin of Negroid group is black whereas that of Mongolid is Yellow. The former have thick everted lips while the latter have epicanthic eye folds. Negroid have wooly or tightly curled hair whereas Mongolid have smooth hair form (Refer section 8.1.1 and 8.1.3).

3) All human beings inhabiting this world belong to a single species of *Homo sapiens*. Yet by virtue of external appearance we look very different from each other. May be it is the skin color, the shape of the nose, the color of the eyes, the shape of the head or the hair form and color. The above classification of mankind into three major groups and numerous sub-groups can be considered to be basic but is often termed as flawed because of numerous drawbacks (Refer section 8.0).

4) Mongolid people inhabit the following geographic regions of the world mainly Asia Pacific: China and Japan (Refer section 8.1.3).

5) The above classification of mankind can be referred to as arbitrary and crude simply because of the fact that it is based on visibly distinguishing features. These features include skin color, shape of the head, nose, hair etc., which have already been described. The underlying genetic relationships have not been considered and thus do not form the basis of this classification. The humans have always been on the move in search of food and security. Racial admixture has been happening along with confrontation amongst different groups. This may have lead to the change in gene pools and gene frequencies. The human groups are dynamic and keep on changing their habitats. Racial admixture may have led to the formation of different groups. In a nutshell, it is logical to conclude that
the criteria on the basis of which the present classification has been made is arbitrary. (Refer section 8.2).

6) The present classification does not take into consideration the genetic basis of the differences in different groups. Of course, the anthropologists gave studied the genetic structure of different populations and obtained the gene frequencies of different genetic traits. The best way would have been to consider numerous genetic traits to find out commonality amongst the members of a specific group to name it as a separate group. Most of the characteristics studied and included in the classification may be genetically determined and modifiable under environmental conditions but they are not exclusively determined by heredity such as blood groups (Refer section 8.2).

7) The continuity of geographical areas in describing various groups of mankind has been the mainstay of this classification. However, people with many similar characteristics may be seen in many areas far flung from each other. But these may not have been included in that group on the basis of geographic discontinuity (Refer section 8.2).
UNIT 9 CRITERIA AND CLASSIFICATION OF “RACES”*

Contents

9.0 Introduction

9.1 Morphological Criteria of Racial Classification
   9.1.1 Pigmentation of the Skin (skin colour)
   9.1.2 Hair Colour and Form
   9.1.3 Head Form
   9.1.4 Facial Features
   9.1.5 Nose
   9.1.6 Eyes
   9.1.7 Stature
   9.1.8 Dermatoglyphics

9.2 Serological and Genetic Criteria of Racial Classification
   9.2.1 ABO Blood Group System
   9.2.2 MN Blood Group System
   9.2.3 Rh Blood Group System
   9.2.4 ABH Secretion System
   9.2.5 PTC Tasting Ability
   9.2.6 Other Genetic Markers

9.3 Summary

9.4 Glossary

9.5 References

9.6 Answer/Hints to Check Your Progress

Learning Objectives

The human diversity is unique in many ways, especially that which is visible to the naked eye. After reading this unit you will get an insight into the:

- the physical diversity and various characteristics used for classification of this diversity;
- the morphology of the body which includes the shape, size, colour and composition an important tool for classification; and
- the blood genetic markers, including various blood group systems, biochemical polymorphisms and PTC tasting ability etc. that have been used for racial classification.

9.0 INTRODUCTION

In this unit, we are going to have introductory information about the different criteria used by anthropologists to classify human races. The morphological classification of human species takes into consideration the features which are easily observable. These features include the pigmentation of the skin, hair colour and its form and quantity, shape of the nose, head and face, eye, stature, finger and palm prints. In order to understand the biological diversity in humans from the view point of serological and biochemical genetic characteristics,

* Prof. Rajan Gaur, Department of Anthropology, Panjab University, Chandigarh
the blood groups types, red cell enzyme/plasma protein polymorphisms and haemoglobin variants are important. Many scientists have studied different blood group systems in almost all ethnic groups and have found large variations in their phenotypes and allele frequencies. All these criteria have collectively been used for the classification of human races. There is a general consensus among the scientists that all living human beings today belong to a single species — *Homo sapiens*; all of us have diverged from a common ancestor. There are however differences in opinion as to the mode and time of divergence of different human groups. The anthropologists consider the concept of race as a classifying device to further study the human evolutionary perspective and in the context of the animal kingdom. The concept of race should be used to classify human groups on the basis of distinct heritable physical characteristics. It is pertinent to understand the formal definition of a biological population as given by Dobzhansky (1958) “A Mendelian population is a reproductive community of sexual cross-fertilized individuals among whom mating regularly occur who, consequently, have a common gene pool.”

9.1 MORPHOLOGICAL CRITERIA OF RACIAL CLASSIFICATION

Human races are classified on the basis of various morphological parameters such as Skin colour, Hair colour and form, Head form, Facial features, Nose, Eyes, Stature, Dermatoglyphics etc. A brief description of these parameters is given below:

9.1.1 Pigmentation of the Skin (Skin Colour)

You may have seen people around you with different skin colours. These people belong to different races. Prominent colours of human skin are the white, black and yellow. However, there are immense shades of the skin colour among humanity. This variety is similar to the shades of clothes stacked up in the racks of the textile retailer where we go for colour matching of our clothes.

Pigmentation is the most prominent criteria on the basis of which the three major races were differentiated which have been described as follows:

- People who have the white skin colour are called the Caucasoid (Leucoderms)
- People who have the yellow skin colour are called the Mongoloid (Canthoderms)
- People who have the black skin colour are called the Negroid (Melanoderms)

The colour of the skin is primarily due to the presence of a pigment called melanin. All shades of skin colour have this pigment; however, there are two forms of this pigment, viz., pheomelanin which is red to yellow in colour and eumelanin which is dark brown to black. Melanin is present in the outer layers of the skin and is produced by the specialized cells known as melanocytes situated at the base of the epidermis. The dark skin colour is an adaptation to sunlight. The greater the sunlight the darker the skin colour. It has been noticed that generally the populations living around the equator have dark skins. Natural selection helps people with dark skins in the tropics where the direct sunlight exposes the people to greater amounts of ultraviolet radiation and greater amounts of melanin acts as a protective shield against the ultraviolet radiation.
Thus it helps in preventing the sunburns which may cause the DNA damage. Overexposure to sunlight and sunburns may result in melanoma whose incidence is very rare in people with the dark skin but is comparatively higher in the Europeans and Americans who have the white skin.

### 9.1.2 Hair Colour and Form

The human hair can be categorized into three groups: Straight or Sleek (Lissotrichous), wavy (Cymatotrichous) and frizzly/woolly (Ulotrichous). The smooth hair is usually straight and may be a little flat and wavy. They can further be thin or coarse. Mongoloid race has smooth hair. There can be three forms of wavy hair: broad wavy hair has broad waves, narrow wavy hairs have strongly curved waves and curly hairs have large spirals. The European and north east African people have such types of wavy hair form. The last category is that of the woolly hair which may be closer-knit or wider knit or pepper-corn or spiral. Such type of hair form is observed in the Negroes, Melanesians and Bushman.

The hair colour of the populations living in the tropical countries is black or dark brown. In case of populations of the Europe, the hair colour ranges from black to blonde and from brown to even red colour.

The texture of the hair may give a smooth finish or a coarse look and the thickness of the hair may also vary. The hair is termed as fine if its thickness is up to 56 microns, it is called medium if the thickness is between 57 and 84 microns and coarse when the thickness increases beyond 84 microns. The quantity of hair can be scanty, medium or rich or luxuriant. There are groups in whom the hair growth is found all over the body whereas there are other groups in which the body hair growth is very scantly.

### 9.1.3 Head Form

The head form can be easily determined with the help of its measurements using which the Cephalic (scientific name of the head) Index often been used to classify races is calculated as follows.

Cephalic Index (C.I.) = \((\text{Head Breadth}/\text{Head Length}) \times 100\)

Thus, if the head length is 25 cm and head breadth is 18 cm in a human male, Cephalic Index = \((18/25) \times 100 = 72\)

With a Cephalic Index of 72 this male falls in the category of dolichocephalic which means he has a long and narrow head. Table 1 shows various categories of the head form along with the range of the Cephalic Index, separately for the male and female.

<table>
<thead>
<tr>
<th>Category</th>
<th>Range of the Cephalic Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Dolichocephalic</td>
<td>71.0-75.9</td>
</tr>
<tr>
<td>Mesocephalic</td>
<td>76-80.9</td>
</tr>
<tr>
<td>Brachycephalic</td>
<td>81.0-85.4</td>
</tr>
</tbody>
</table>
Various races of mankind have different forms of heads. The dolichocephals are long and narrow heads whereas the brachycephals are short and broad heads. Dolichocephaly is rare in the Mongoloids whereas brachycephaly is relatively rare in the Negroses. The Caucasoids seem to have all types of head shapes.

### 9.1.4 Facial Features

The facial features are the most prominent of all the characteristics which come to our notice immediately. We identify people on the basis of the facial features and most often everywhere there is a need of identity and the photograph of the face is required. The shape of the face may be broad, narrow, square or oval. The shape of the face can be calculated with the help of two anthropometric measurements of the face, viz., the Morphological Facial Length and Bizygomatic Breadth. The Morphological Facial Length is the straight distance between the landmarks nasion (where the upper end of internasal suture meets the frontal bone) and gnathion (lowest point on the mandible in the mid-sagittal plane). The Bizygomatic Breadth is the maximum distance across the zygomatic arches of the face beyond the eyes. The Morphological Facial Index is represented as follows:

\[
\text{Morphological Facial Index} = \left( \frac{\text{Morphological Facial Length}}{\text{Bizygomatic Breadth}} \right) \times 100
\]

The human face when viewed from the side or in profile view may show various degrees of prognathism (protrusion of the jaws). When the jaws are in vertical line of the face as seen in the side view, this is called orthognathism.

The mouth and lips perform functions of eating food and speech. The lips in case of man are exposed to outside unlike animals who do not have them like the humans. The mucous membrane is exposed to the outside in humans and the degree with which it is turned outside is called lip eversion. The maximum lip eversion has been seen along with thick lips in case of the Negroses. The minimum lip eversion occurs in the Caucasoids.

### 9.1.5 Nose

The portion of the nose which is bony has a *root* which lies between the eyes. The portion of the nose projecting downwards from root is bony and cartilaginous and is called the *bridge*. The Lowest most part of the nose is the *tip* and the sides of nose are called *alar* which cover the nostrils. The roots of the nose are sharp edged and projecting in case of the Caucasians. The East Asian people have nasal roots which are very low and if viewed from the side one can perhaps see the other eyeball across the nasal root. The Africans exhibit a smooth curve from one side to another. The nasal bridge seen from the side may be straight and pointed or curved forward like a hump. The bridge is often wider than the root. The alare may vary in size. Combined together the *root*, *bridge* and the *tip* of the nose make innumerable shapes of the nose and thus representing a huge variety among different races.

The shape of the nose can be estimated by using an index of the Nasal Breadth and Nasal Height as follows:

\[
\text{Nasal Index (N.I.)} = \left( \frac{\text{Nasal Breadth}}{\text{Nasal Height}} \right) \times 100
\]
The scientists have tried to give explanation for the shape of the nose in terms of the ecological adaptations. The lowly projecting nose of the people of Central Asia has been considered as an adaptation to cold environment. Coon et al. (1950) suggested that any projection of the body in a cold climate would lose body heat much faster than any other part of the body. The ears and noses by virtue of their large surface areas have this disadvantage and races well adapted to these climates would show less protruding body parts. Very large protruding human noses have been found in tropical areas. However, the exact mechanisms of adaptations of the shape of nose to environment are still eluding.

### 9.1.6 Eyes

The eyes of the Mongoloid race have fold of the skin over the inner corner of eyes. This fold of the skin and subcutaneous tissue is also called epicanthic fold or the Mongoloid fold. In most other races of the mankind, there is no such fold. Inner corner of the eye has a small bump which is usually covered by the eye fold in case of the Mongoloid race. The eye fold may look fleshy or plump because of the presence of fatty tissue in it. This epicanthic eye fold may cover a small area on the inner side of the eyelid, or cover up to the middle of the upper eyelid or may cover it completely. In some persons the eye fold may have very little amounts of fat and in them the contours of the eyeball may be seen through the eye fold. Most of us who have seen the Mongoloid people are of the opinion that they have slanted eyes. But in reality their eyes are not slanted and it is only an optical illusion. When we see such a person, we cannot see the actual inner corner of the eye which is covered with the fold but can only see the lower edge of the fold on the inner side of the eye which is located downwards and is drooping over the corner of the eye. The other corner of the eye is generally not covered with the epicanthic eye fold and therefore we can see that corner easily and hence the eyes look slanted. The Chinese and the Japanese have these prominent eyefolds.

Another feature of the eye is the iris which gives the eye its distinctive colour. The iris is pigmented and opaque and contains circular and radial muscles which change the size of the pupil of the eye. The colour of the iris may be black, brown, green, blue or variations of all these colours. The Mongoloids and Negroids have iris colour between black and brown. The Caucasoids have a large range of the colour of their eyes.

### 9.1.7 Stature

The human stature has become a symbol of social prestige and during childhood almost all of you must have envied the tallest boys and the girls and longed to be like them. Not only has the variation in stature existed across different groups but also within a group as well. Children in a family also differ in size. Although there seems to be social bias in favour of taller individuals yet it is not very clearly known whether taller height has some biological advantage.

During the course of evolution the tallest animals became the focus of extinction. The larger individual has greater calorie needs during the growing period as well as during its life time. In the past when food was scarce, animals with smaller bodies would have been at a biological advantage. The natural selection may act against individuals who have a genetic potential for larger body size, especially in times of scarcity of food. Many studies have shown that immigrants
to the United States from other countries increased in their height. Historically speaking, the human populations have been increasing in stature over the past one hundred and fifty years. The Europeans, especially the Dutch are one of the tallest populations with an average stature of more than six feet whereas the Pygmies of the Congo basin have the shortest stature which is around four feet. Availability of food in the past seems to have played a significant role in the development of stature.

9.1.8 Dermatoglyphics

The dermatoglyphics (derma means skin and glyphics means to carve) is the study of the patterns of the ridges on the hands, fingers and soles. These ridges provide roughness and are useful for a strong grip. One thing important about the dermatoglyphic patterns is that these do not change with age and are unique in a way that no two individuals have same dermatoglyphic patterns. This characteristic of the finger prints has made them unique for personal identification to the extent that they act as a person’s signature and are almost fool proof evidence against suspects in a crime from where these evidences are collected. The dermatoglyphic patterns prove useful in classifying different populations.

A triradius is a centre of the delta shaped (deltoid) junction of three regions each containing curved streams of parallel ridges i.e. a three ridge system. Depending on the number of triradii present, the patterns of the ridges on the human finger tip are mainly classified into the following types.

* Whorl (W): it possesses two triradii. A triradius is a point from where ridges in three directions seem to emerge.

* Loop Radial (L'): it possesses one triradius and the loop opens towards the radial (thumb) side.

* Loop Ulnar (L^): it also possesses one triradius and the loop opens towards the ulnar side.

* Arch (A): it is pattern which does not have any triradius.

Check Your Progress

1) Describe different types of racial groups on the basis of pigmentation of the skin.

---------------------------------------------------------------------------------------------------------------------------------------------------------------

---------------------------------------------------------------------------------------------------------------------------------------------------------------

---------------------------------------------------------------------------------------------------------------------------------------------------------------

---------------------------------------------------------------------------------------------------------------------------------------------------------------

2) Which different types are made on the basis of head form?

---------------------------------------------------------------------------------------------------------------------------------------------------------------

---------------------------------------------------------------------------------------------------------------------------------------------------------------

---------------------------------------------------------------------------------------------------------------------------------------------------------------

---------------------------------------------------------------------------------------------------------------------------------------------------------------
3) Describe the nasal index and the shape of the nose as an adaptation to environment.

4) What is the importance of hair form and hair colour in racial differentiation?

---

9.2 SEROLOGICAL AND GENETIC CRITERIA OF RACIAL CLASSIFICATION

Racial classification is also made on the basis of certain serological and genetic criteria. Such types of traits include ABO, MN and Rh blood group systems, ABH secretion system, PTC (Phenythiothiocarbamide) tasting ability and other genetic markers. A brief description of each is given:

9.2.1 ABO Blood Group System

The phenomenon of the occurrence of two or more clearly different classes of the phenotypes with appreciable (>1%) frequencies in the same population is referred to as polymorphism. Different blood group systems, serum protein and red cell enzyme polymorphisms, haemoglobin variants and numerous other genetic traits are examples of the genetic polymorphisms.

The blood groups are valuable anthropological characters, since most of them occur in different proportions in different parts of the world. One of the most widely used blood group system for studying variation among various ethnic groups is the ABO system. The membrane of the red blood cells (erythrocytes) of human beings has a large variety of blood group antigens (agglutinogens) and in the ABO system the antigens involved are known as A and B. An antigen is basically a molecule which would initiate the production of the corresponding antibodies (agglutinins) in the immune system which in turn would neutralize (agglutinate) the antigen which is acknowledged by the body as something foreign and potentially dangerous. The term ANTIGEN has been derived from the fact that it is ANTibody GENerator.

The blood groups are characterized by the antigens which the red blood cells carry on their membranes. If in a person the red blood cells have A antigens on their surface, the blood group of that individual will be referred to as A; if one carries the B antigens, the blood group is referred to as B, if one carries both A and B antigens then the blood group is referred to as AB and if there is no antigen present on the red blood cells, the blood group is known as O. The plasma or serum of different individuals contains naturally occurring ABO blood group antibodies, except AB blood group persons as given in Table 2.
### Table 2: The ABO blood group antigens and antibodies

<table>
<thead>
<tr>
<th>Blood group</th>
<th>Antigen (agglutinogen) on RBCs</th>
<th>Antibody (agglutinin) in plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>anti-B</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>anti-A</td>
</tr>
<tr>
<td>AB</td>
<td>A and B</td>
<td>none</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
<td>anti-A and anti-B</td>
</tr>
</tbody>
</table>

The frequencies of the ABO blood groups can also help in tracing the origin of the racial groups. Thus, for example, it has been found that one of the colonies of the Gypsies in Hungary had ABO blood group frequencies similar to those of the Hindus of North India rather than those of the Hungarians. The linguists found commonality in the language between the Gypsies of Hungary and the Hindus of North India and suggested that the former might have migrated from India to Hungary around 500 years back. There have been numerous such instances where on the basis of blood group frequencies, information about the migration of the population groups has been generated.

#### 9.2.2 MN Blood Group System

In the MN blood group system, there are three distinct blood group types (phenotypes) viz., M, N and MN, controlled by two codominant autosomal alleles - MN*M and MN*N. The red blood cell membranes therefore can carry two different types of antigens (agglutinogens) namely M and N on their surfaces, either singularly (in homozygotes) or both (in heterozygote). The persons carrying M antigen on the surface of their red blood cells are called type M, those carrying N antigen are called type N and those carrying both the antigens are called MN. The naturally occurring corresponding antibodies (agglutinins) are very rare in the MN blood group system. It means that, unlike the ABO blood group system, in the MN blood group system, no naturally occurring anti-M and anti-N antibodies are present in the serum of the individuals.

The M blood group, frequency has been reported highest in the Eskimos (83.5%), followed by the Mexican Indians (61.2%). At the lowest end of the frequencies of the M type are the Australian aborigines and Papuans. On the other hand, the N blood group shows the highest frequency in the Australian aborigines and Papuans (67.4% and 69%, respectively) whereas the Eskimos and the Mexican Indians show the lowest frequencies (0.8% and 3.1%, respectively). The Papua New Guinea and Australian islands are separated from each other but there is strong resemblance among the inhabitants of these two islands who share a similar picture of the distribution of the MN blood groups.

It is worthwhile to explore the reasons for this affinity in the blood group frequencies between the Papuans and the Australian aborigines. One of the striking similarities in the MN blood groups is between the American Negroes and the Pygmies of the Africa.

#### 9.2.3 RH Blood Group System

Experiments were conducted in which the blood of the monkey Macacus rhesus was transfused into the rabbits and guinea-pigs to immunize them to produce antibodies. The resulting antibodies agglutinated not only the monkey red cells but also the red cells of about 85% of the individuals of the White race in
spite of the fact that they had different ABO blood group types. Such individuals possessed an Rh factor (antigen) and hence were designated as Rh positive whereas the remaining 15% who did not show any agglutinating reaction with the rabbit anti-rhesus serum were designated as Rh negative.

There are mainly three factors (antigens) of the Rh blood group system, viz., C, D, and E, and out of these the factor D (antigen D) is the most powerful and elicits the greatest agglutinating reaction. The other two factors (C and E) give very weak agglutinating reactions and hence can be ignored for the clinical (transfusion) purposes but anthropologically they are extremely useful.

The Rh blood group system is controlled by three closely linked loci and they can be present in an individual either of the two alleles viz., C or c; D or d; E or e at these loci. An Rh gene complex could therefore be assembled in eight different ways: CDe, cDe, cde, cDe, CDe, CDe and Cde. Seven of these assemblages could be identified in the alleles already known; the eighth, Cde, remained to be found.

The Rh negative refers to all those assemblages/ gene complexes which contain d instead of D. So, out of the possible eight gene complexes mentioned above, the four - Cde, Cde, cde and cde lead to a Rh negative blood. The cde is the most commonly found Rh negative gene complex and has a frequency of about 20 - 50% in the Europeans and Asians, about 20% in some African populations and about 10% in the American Indians. This complex is rare in rest of the world. The Cde gene complex has been observed in about 13% of the Australians and about 7% of South African populations. Of the remaining Rh negative gene complexes, cDe has been found in very small proportions while Cde has not been detected in any world population. The most abundantly found Rh gene complex is the CDe for which the Asians and Melanasians have the highest frequency (range 75 - 80%), followed by the Europeans (around 50%) while in the African populations, this Rh complex, if found, has the lowest frequency (around 10%).

9.2.4 ABH Secretion System

The ABH antigens present on the red cell surface (in alcohol soluble form) can also exist in a water soluble form in the body fluids. Thus some individuals may demonstrate the presence of the blood group factors corresponding to their own ABO blood group status in their body fluids such as the saliva, urine, gastric juices and mucous secretions. Such persons are known as the ‘secretors’. The others who do not secrete in their body fluids any blood group factor corresponding to their ABO blood group status are known as the ‘non-secretors’. The ability to secrete the A, B or H substances in the saliva is inherited as a Mendelian dominant character. There are two genes (alleles) responsible for the control and inheritance of the ABH secretion, viz., a dominant secretor gene Se and a recessive non-secretor gene se. These are not linked to the ABO blood group genes.

Studies have shown a high frequency of the secretors in the New York Whites (85%) and German Whites (78%) whereas the incidence of the trait was found to be comparatively lower in the American Negroes (61%). The secretor locus Se is withdrawn and renamed FUT 2 (fucosyl transferase 2) The alleles Se and se are renamed FUT2*SEC and FUT2*QO, respectively and the secretors and non-secretors are renamed FUT 2 SEC and FUT 2 NON SEC, respectively.
9.2.5 PTC Tasting Ability

A chemical substance known as phenylthiocarbamide (PTC) has a very bitter taste for most people, but there are some others who cannot taste this substance. Thus people can be divided into two categories on the basis of their ability to taste PTC; the tasters and non-tasters. The trait is controlled by a pair of autosomal genes (alleles) - the dominant taster allele \( T \) and the recessive non-taster allele \( t \). The ability to taste PTC is dependent on the presence of the dominant gene \( T \). The world populations have shown different frequencies of the PTC tasters. The American Indians and African Negroes have more than 95% of the population as the tasters of PTC while the Australian aborigines have the lowest frequency of the tasters (27 - 50%). An experiment on the chimpanzees revealed that about 74% of them were PTC tasters thus showing similarity to the humans in their frequency of this genetic trait which may be taken as an evolutionary affinity to the humans.

9.2.6 Other Genetic Markers

**Haemoglobin**

Haemoglobin (Hb), also known as blood globin or blood protein, is a ferroprotein comprised of globin and haem molecules and occurs in three different normal forms in man viz., Hb A Hb A2 and Hb F. The normal hemoglobin A (Hb A) is comprised of two chains of the alpha globin polypeptides and two chains of the beta globin polypeptides. In the fetus, instead of the two beta globin chains two gamma globin chains are present, resulting in the formation of foetal haemoglobin F (Hb F).

An example of an abnormal haemoglobin variant of the beta chain, designated as sickle cell haemoglobin S (Hb S), present in abnormal red cells of the shape of a sickle which resulted in sickle cell anaemia, has been discovered. It was later on found that many populations in Africa had sickle cell haemoglobin. The persons with HBB S were found protected against the malaria and hence the frequency of such persons was found quite high (10 - 40%) in some African populations. It was further noticed that the heterozygote (Hb AS) individuals were more resistant to the malaria than the homozygote (Hb SS) individuals. A large number of other haemoglobin variants, mostly of the beta chain, have been reported in the world populations and represent the structural examples of the human haemoglobinopathies. In the Indian populations, the most frequently encountered haemoglobin variants include Hb AS, Hb AD and Hb AE, among others.

**Thalassaemia**

The thalassaemia, often called the Cooley’s anaemia, represent another type of the hereditary human haemoglobinopathies in which the rate of synthesis of one of the globin chain (alpha or beta) is altered. It results in severe haemolytic disease in which the red cells are destroyed and is quite prevalent in the countries around the Mediterranean Sea. In the areas of the world where malaria is endemic, thalassaemia is quite high which raises the issue about its possible heterozygote advantage to the carrier under the malarial conditions.
Glucose - 6 - phosphate dehydrogenase (G6PD) deficiency

Glucose-6-phosphate dehydrogenase is an enzyme in the human red cells (erythrocytes) which catalyzes the oxidation of glucose-6-phosphate to 6-phosphogluconate in the glucose metabolism. Some individuals are deficient in this enzyme and hence are called the G6PD deficiency disease patients. This disease is found in the Mediterranean area (Sardinia, Greece and Israel), Africa (East and West Africa, Congo) and India. In the tropical countries with high incidence of the falciparum malaria, the G6PD deficiency individuals are found in good numbers. A large number of the variants with the deficiency of the G6PD enzyme activity have been detected in different world populations. It has been hypothesized that patients with the G6PD deficiency are better protected against malaria. The G6PD deficiency is inherited as an X-linked genetic trait.

Haptoglobin

Haptoglobin is a glycoprotein globin present in the human serum that combines with the free haemoglobin from the lysed red cells and thereby preventing its excretion by the kidneys. Human haptoglobin is polymorphic with three phenotypes viz., HP 1, HP 1,2 and HP 2, detectable by the biochemical technique of gel electrophoresis. These are controlled by a pair of codominant autosomal alleles HP*1 and HP*2. In some African populations living in the malarial areas, the serum haptoglobins are totally absent (phenotype HP 0) and the condition is called ahaphtoglobinaemia or hypohaptoglobinaemia. Such type of cases has not been found in the European populations. The frequency of HP*1 allele is very high in populations of the African continent, suggesting some selective advantage.

Check Your Progress

5) What different types of antigens are present in Rh blood group system and which Rh gene complexes are Rh negative?

6) Describe the MN blood group system.

7) Explain the ABH secretion system in man.

8) What is the significance of the tasters and non-tasters of PTC?

118
9.3 SUMMARY

The human populations are distinct from each other because of the reason that they inhabit different geographic and climatic regions of the world and have got adapted to these environments. The classification of different human races of the mankind should be strictly made on the basis of characteristics which are strongly determined by genetics and in which the environment plays very small role in modifying them, if at all. The pigmentation of the skin, shape of the head, nose and face, colour of the eyes and hair, stature and dermatoglyphic features form important morphological traits for the classification of the mankind into races. Several blood group polymorphisms of the ABO, MN and Rh systems, among others, play a crucial role in race classification as the frequencies of the genes (alleles) controlling these serological markers vary greatly in the world populations and therefore the blood group systems form an important genetic criteria. The ability or inability of tasting phenylthiocarbamide (PTC), and the ABH secretion or non-secretion in various body fluids provide additional genetic criteria for the human racial classification. Similarly, the electrophoretically detectable biochemical polymorphisms of the blood protein haemoglobin, serum protein haptoglobin and red cell enzyme G-6-PD, among others, also act as good genetic markers for the racial classification.

9.4 GLOSSARY

- Antigen is basically a molecule which would initiate the production of antibodies (agglutinins) in the host immune system which in turn would either kill or neutralize the antigen which is acknowledged by the body as something foreign and potentially dangerous. The term ANTIGEN has been derived from the fact that it is an ANTIbody GENERator.

- Antibody is an immunoglobulin, a specialized immune protein, produced because of the introduction of an antigen into the body, and possesses the remarkable ability to combine with the very antigen that triggered its production.

- Polymorphism is a situation when two or more clearly different phenotypes or genes/alleles exist in the same population at the same time. For example the ABO blood groups and haemoglobin types. The balanced polymorphism is an equilibrium mixture of homozygotes and heterozygotes in a genetic system maintained by the natural selection against both the homozygotes.

9.5 REFERENCES


9.6 ANSWERS/HINTS TO CHECK YOUR PROGRESS

1) The colour of the skin is due primarily to the presence of a pigment called melanin which is the most prominent criterion for racial classification as: People who have white skin colour are called Caucasoid (Leucoderms) People who have yellow skin colour are called Mongoloid (Canthoderms) People who have black skin colour are called Negroid (Melanoderms) For further details refer section 9.1.1

2) Head form can be judged from Cephalic index which can be calculated as follows:

\[
\text{Cephalic index} = \left(\frac{\text{head breadth}}{\text{head length}}\right) \times 100
\]

The dolichocephal are long and narrow heads whereas brachycephals are short and broad heads. All the races of mankind have different forms of heads. Dolichocephaly is very rare in Mongoloids whereas brachycephaly is relatively rare in Negros. Caucasoids seem to have all types of head shapes. For further details refer Table 1 and section 9.1.3

3) The shape of the nose can be estimated by using an index of the nasal length and nasal breadth as follows: Nasal Index = (nasal breadth/nasal length) × 100

Explanations to the shape of the nose in terms of ecological adaptations have been put forth. Lowly projecting nose of the people of Central Asia has been considered as an adaptation to cold environment. For further details refer to section 9.1.5

4) Human hair can be categorized into three groups: smooth, wavy and wooly. The smooth hair is usually straight and may be a little flat and wavy. They can further be thin or coarse. Mongoloid race has smooth hair. There can be three forms of wavy hair: broad wavy hair have broad waves, narrow wavy hair have strongly curved waves and curly hair have large spirals. European and north east African people have such types of wavy hair form. The last category is that of the wooly hair which may show short and deep waves. Such type of hair form is observed in Negros, Melanesians and Bushman. For further details refer to section 9.1.2

5) There are mainly three factors and out of all the three factors (antigens), viz., C,D, and E, factor D (antigen D) is the most powerful and elicits the greatest reaction. The other two factors (C and E) give very weak agglutinating reactions and hence can be ignored for transfusion purposes. For further details refer to section 9.2.3.

6) There are three distinct blood group types, viz., M, N and MN in the
M-N system. The red cell membranes contain two different types of agglutinogens namely M and N. The persons carrying M antigen on the surface of their red cells are called type M, those carrying N antigen are called type N and those carrying both the antigens are called MN. For further details refer section 9.2.2

7) Some persons may also demonstrate blood group factors in their body fluids such as saliva, urine, gastric juices and mucous secretions. These persons are known as ‘secretors’. The other persons whose body fluids do not secrete the blood group factors are known as ‘non-secretors’. There are two genes responsible for the inheritance of secretor factor, viz., a dominant gene “S” and the recessive gene “s.” For further details refer Section 9.2.4

8) A chemical substance known as Phenyl-Thio-Carbamide (PTC) has a very bitter taste, however, there are some people who cannot tell the taste of this substance. Hence people can be divided into two groups on the basis of this substance (PTC); tasters and non-tasters. This trait is inherited as a dominant one and has two genes, T the dominant gene and t the recessive gene. For further details refer section 9.2.5.