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MANI-002
PHYSICAL ANTHROPOLOGY

Block

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ECOLOGICAL ANTHROPOLOGY

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BLOCK 7 ECOLOGICAL ANTHROPOLOGY

Introduction

Since the first appearance of genus *Homo* to the emergence of the species *sapiens*, human populations have expanded and diversified to occupy a wide range of habitats. They use a variety of survival strategies to exploit an exceptionally broad range of eco-regions and dietary components. Such diversity bears authentication to our adaptability to an array of environmental conditions. Human as an individual, respond to environmental stress with physiological and growth adjustments which enhance their survivability. These aspects of human-environment interaction change dramatically during evolution, giving rise to new selective pressures. Thus, ecology is founded on the notion of organisms adapting to a selecting environment. Evolutionary trends in human body form provide important context for interpreting variation among modern populations. In a given region, the interaction of biotic assemblage of the organism with its physical environment leads to defined tropic structure and biodiversity in an ecosystem.

The term 'adaptability' is often interpreted to encompass only the responses in the phenotype, emerging by the action of environment upon a given genotype. It distinguishes genetic adaptation as specific inheritable characteristic which favors tolerance and survival of the organisms in a particular environment. At the same time, 'human adaptability' is applied to response which improves functioning of an individual or population in an environment. The study of human adaptability involves biological response, which include physiological, biochemical and structural components. Thus, specific genetic trait which adapts a population to its environmental niche must be distinguished from general genetic structure of the species which allow all populations to adjust to a variety of environments. The respective input of genetic and environmental factors differ with the developmental stage of the organism – the earlier the stage, the larger the influence of the environment and greater the plasticity of organism.

Adaptation to climate does not take place in seclusion from the influence of other "non-environmental" forces, instead, in the midst of a multifaceted set, of economic, social, and institutional situations which ascertain a location-specific perspective for human-environment interactions. It is significant to both long term global climate change and to current changeability in climatic conditions. The competence for adaptation to environmental stress varies between population and even between individuals.

Beyond adaptability, human survivability is influenced by dietary in-adequacies or nutritional stress and diseases also. Populations have differential nutritional requirements depending on the climate where humans reside. When less severe, it retards physical development, reduces vitality, and increases susceptibility to most infectious diseases. The common infectious and parasitic diseases such as malaria and the HIV/AIDS pandemic remain major unresolved health problems in many countries. The emerging non-communicable diseases relating to changing diet and lifestyle have been increasing over the last two decades, thus creating a double burden of disease especially in developed and underdeveloped countries. For many populations, shifts in nutritional status signal variability in access to resources at different life stages. Though epidemiological studies reveal the distribution and determinants of disease, these cannot provide the necessary components for comprehension and explanation of causes that maintain the endemic levels. The socio-cultural structure often governs the spread of disease and the attitude of a population to health. Thus, epidemiological and anthropological interaction elucidate the interaction of biological and the social-cultural aspect influencing the health/ disease process, eliminating the impediment (obstruction) which limit the intervention aimed at control of disease.

The units in this block will emphasise on ecological principles as applied to human populations, the emergence of adaptations during the process of gene–environment interaction, spatial distribution of diseases and impact of nutritional stress and the interplay of cultural and biological factors in human behaviour.

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UNIT 1 FUNDAMENTALS OF ECOLOGY

Contents

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Learning Objectives

Once you have studied this unit, you should be able to:

- define human ecology;
- explain the concepts and methods of studying ecology;
- describe the different ecosystems; and
- indicate the different acclamatory adjustments.

1.1 INTRODUCTION

Ecology is the scientific study of the relationships between living organisms and their environment. General ecology contains a set of concepts and principles derived from evolutionary theory that are used to explain the adaptation and evolution of animal and plant populations and communities in response to the varying conditions of resource availability presented by diverse, dynamic and changing environments. These concepts and principles pertain to other aspects such as energy flow, feeding relations, resource attainment, behaviours, materials cycles, population dynamics, ecosystem properties, population interactions and community organisation (Abruzzi, 2003).

1.2 BASIC CONCEPTS OF ECOLOGY

- Diversity of Living Things: Plants and animals exist in great variety of forms and can be classified by their structure and behaviour.
- Interdependency of Living Things: All living things rely on and are affected by other living organisms and non-living components of their environments.
- Resource and Energy Cycles: The interactions among the members of an ecological community involve the exchange of energy and resources in continual cycles.
- Nested Systems: Networks of interdependent organisms exist within other larger networks (community to bio-sphere).
- Dynamic Balance: Each ecological network regulates and organises itself by maintaining a state of dynamic balance characterised by continual fluctuations.

1.3 DEVELOPMENT OF HUMAN ECOLOGY

Human ecology is the systematic application of ecological concepts, principles, theory and research methods to study the human populations and communities. Human ecology examines the way human-resource relationships affect the human adaptation to diverse type of ecosystem such as desert, arctic, forest and others (Abruzzi, 2003). It also scrutinises the role that resource requirements needed to withstand a population play in shaping local differences in behaviour, residential distribution, household composition and structure, community, social and political organisations, inter-population relationships and other social behaviour. Human ecology also examines contemporary ecological concerns that results from population growth and industrial development (Abruzzi, 2003).

It has been known for a long time that human survivability is determined by environment. Several attempts made to understand responses of organism to critical environment can be traced back to antiquity. But the idea of contemporary human ecology has been expressed since the 18th century by Adam Smith, Malthus, Darwin and Hoppes. It is believed that the term Human Ecology was first used in geography by Huntington (1916) and later it was adopted in Sociology (1921). The history of human ecology in sociology is complex. In fact concepts of human ecology in sociology evolved from the classical concepts of competition. The social area analysis focused on the population structure (organisation) in relation to the total environment. In other words, it is the ecological analysis of social organisation. Since human ecology deals with the role of the environment in the origin and existence of man, it has engrossed many other disciplines including anthropology and medicine.

> Thus human ecology can be defined as the study of spatial and temporal relations of human beings affected by selective, distributive and accommodating forces of the environment. The definition is well adapted in sociology and other sciences.

The anthropological perspective of human ecology deals with the question "how man copes with his environment". Since human relations are not mainly biological therefore the development of culture context is necessary. Culture cannot be understood in isolation from the environment in which it evolved. Contemporarily, social anthropology concern with the issues related to the exploitation of the environment, utilisation of resources and energy transformation in a cultural setting.

On the other hand economists view ecology as subset of economy. The economy is disrupting and destroying earth's natural system. An environmentally sustainable economy requires that the principles of ecology establish the framework for the formulation of economic policy (Brown, 2001).

It was on the basis of Malthus's concept that Darwin thought of 'struggle for existence' which result into balance between the environmental state and social activity of humans. It emphasizes on the importance of exchange system among individuals, populations and species. Theoretically, succession corresponds to accumulative increase in the human population. Practically the problem of limited natural resources is the real connecting link. This would lead to minimize consumption by consumers and to maximize the benefits by producers. It may lead to a state of balance through mutual succession. However, it has been shown that neglecting ecological and economical laws along with lack of coordination of activities, results in the destruction of natural environment and deterioration of living conditions for humans. All these ideas are typical of the initial stage of human ecology which dominated for about half century.

Human ecology in the beginning had a monodisciplinary approach. A review of the trends in human ecology defines the scope of ecological concepts which includes basic processes like the kind of interaction between living organisms, levels of integration and functional relationship. Human ecology distinctly focuses on the interactions because organisms cannot live in isolation. Such interactions have its own dynamic structural and functional dimension. It determines the role of Homo sapiens with his own and other species. Thus the subject matter of human ecology includes systems of interactions among individuals and interrelations with the environment, niche, habitat and the ecosystem. Environment may act at three level of biological organisation: individual, population and community. Population refers to group of individuals of same species living in a given territory and is integrated by common culture. In other words human ecology deals with the matrix of nature in which each object has its own place and function.

1.4 METHODS OF STUDYING HUMAN ECOLOGY

Human ecology utilises various methods acquired from other classical disciplines that it synthesizes and incorporates. However, the methodology of human ecology is neither exclusively an analysis of individual objects nor synthesis of the problems.

The basic methods are the observation and recording of the state of nature and society which instinctively recognises the interrelationships between organisms and their environment. Monitoring is carried out at the level of the organisms, populations and environment. For instance, the inferences in epidemiology when implicit as a part of human ecology are based on healthy people rather than unhealthy people, and on populations rather than individuals. The characterisation of an event in the context of the environmental conditions provides opportunity for estimating what is the average, normal and regular.

In Anthropology, monitoring consists of recording individual responses to similar environmental conditions and intra population differences. Thus the specific response of different races or ethnic groups remains in the field of classical anthropology and the old approaches have been modernised in the light of the concepts of major genes or complex linked genes or populations.

The monitoring of the state of the environment is extremely complex, as the number of environmental factors affecting humans is almost unlimited. The physical factors include climate, nutrition, pollution of air, water, food and noise. In addition, social and economic factors indicating living conditions are also considered.

1.5 OCCURRENCE OF ADAPTATION AT DIFFERENT LEVELS

- Genetic adaptation, the evolution of advantageous characteristics,
- Developmental adaptation (plasticity),
- Long term acclimatisation acquired over the years but reversible under environmental change,
- Seasonal acclimatisation, which reverses itself during the annual cycle, and
- Short term acclimatisation, it manifests in daily or irregular responses to conditions.

1.6 DIFFERENT ECO SYSTEMS

- Deserts and dry lands
- Tropical forests
- Tropical scrubs
- Tropical grass land (Savanna)
- Temperate forests
- Mediterranean scrubs
- Temperate grass lands – short grass
- Boreal lands – coniferous forests
- Polar lands and Tundra
- Mountain habitats

1.7 HUMAN ADAPTABILITY: ADJUSTMENTS TO DIFFERENT ECO SYSTEMS

Human populations occupy a wide range of habitats, from the icy wastelands of the Arctic to the equatorial deserts of North Africa. While most animal species have become adapted to relatively narrow niches, humans have survived in far-ranging and highly diverse niches.

For the sake of discussion, two mechanisms of human adaptability may be differentiated: adaptation and adjustment. Adaptation refers to changes in gene frequencies resulting from selective pressures exerted by environmental factors on a population. Human species is able to adjust to a wide variety of environmental conditions without undergoing major micro evolutionary changes. Such changes are termed adjustments.

However, it must be emphasised that the potentials for such non genetic adjustments are the end products of the evolutionary process. One of the major problems faced by researchers in this area is the determination of the relative importance of genetic and non genetic forms of adaptability, which we have termed here adaptation and adjustment, respectively. In fact, in most situations, both probably operate together.

1.8 BEHAVIOURAL ADJUSTMENTS

Humans are biologically tropical, better equipped to survive in hot rather than cold climate. They do not possess thick layers of subcutaneous fat or thick fur which otherwise provide insulation to body against cold. Thus, a substantial portion of cold adaptation in this hostile climate is behavioural. Behavioural adjustments are cultural responses of humans to cope with environmental stresses. These adjustments are not inherited from one generation to the other. Hence, behavioural adjustment must be made by each generation as newborn infants learn their culture. It includes seeking shelter, using protective clothing, improving housing and other technologies.

1.9 HUMAN HOUSING

A clear example of how culture permits people to survive in stressful habitats is housing. The oldest known human habitation structure was discovered at Olduvai Gorge, a site in east Africa that has yielded important fossil and archaeological evidence of human evolution. This structure, almost 2 million years old, consists of stones arranged in a rough circle about 360 to 420 centimeters (12 to 14 feet) in diameter. These stones most likely supported a brush structure similar to those still being built in the same area now-a-days.

Today, we are impressed by the tremendous variety of habitation structures. House form is a reflection of many variables, including the size of the household unit and availability of raw materials. It also reflects socio-cultural features such as religious beliefs, family and clan structure, social organisation, way of gaining a livelihood and social relations between individuals.

Environment plays a major role in the development of house type; its significance lies in areas under environmental stress, e.g. Igloo of the Eskimo. The igloo consists of a dome-shaped structure (Romans and Etruscans were not the only people to develop the arch) connected to the outside by a tunnel. It is made up of snow, which is an excellent insulator as it traps the air within itself. Heat is produced by a small seal-oil lamp within the structure. This melts the snow slightly during the day and refreezes at night, forming an icy reflective layer on the inner side. The reflective layers accompanied with the dome structure serve to reflect the heat throughout the igloo. Relatively little heat is lost to the outside since the dome shape minimizes the surface area from which heat can radiate. A long tunnel way helps to warm the air gradually as one enters the structure, and also block the entry of wind into the habitation area.

Habitation structure is one aspect of a human technology. There are other aspects of technology also which enable human to survive in stressful environments including, for short periods of time, outer space.

1.10 SOCIAL RESPONSE TO HARSH ENVIRONMENTS

In addition behavioural adaptation humans adjust their social organisation to their environments. For instance, Eskimos, living in extremely harsh environments use a number of strategies to reduce environmental stress. Anthropologist Knud Rasmussen during a trip to King William Island discovered that in a sample of eighteen marriages, 38 out of 96 female infants born were put to death. This strategy of female infanticide is practiced by the Netsilik Eskimos to increase the ratio of males to females. Such numerical balance between the sexes reduces stress of male hunters to support unproductive members of society. Also, in the harsh northern environments females are considered to have less survivability than males. People in these habitats also practice suicide, invalidicide, and senilicide in crisis situations. Infanticide is usually an extreme response to extreme conditions, although it has been practiced in a wide variety of human societies. All human societies in some way adjust economic, political, social, religious, and other aspects of their social systems to the environmental conditions. This socio-cultural flexibility, in part, allows humans to exist in so many habitats.

1.11 ACCLAMATORY ADJUSTMENTS

Acclamatory refers to reversible physiological adjustments to environmental stress. Instances of acclimatisation have been observed in three environments: the arctic, the desert, and high altitudes.

The Arctic, is perhaps one of the more stressful habitats occupied by humans. It was inhabited relatively late in human prehistory, and gradually human became acclimatised to the climate.

The primary environmental stress in the arctic is very low temperatures. Normal human core body temperature is 37^0C (98.6^0F). When the core temperature falls below 34.4^0C (94^0F), hypothermia occurs and at 29.4^0C (85^0F), temperature regulating ability of the hypothalamus in the brain is impaired resulting in death. Cold exposure which leads to freezing of the tissues causes frostbite. It usually occurs in exposed area of the body parts such as fingers, toes, and earlobes.

Perhaps the most important acclamatory adjustment is increase in the basal metabolic rate. The basal metabolic rate refers to minimum amount of energy required by the body to maintain body processes necessary for life and is measured as the amount of heat produced by the body per unit time at rest. This increase can be as much as 25 per cent in adults and 170 per cent in infants. The increased basal metabolic rate results in the production of additional body heat but it requires that individuals' consumption of food, high in nutritive value. The native diet in these regions consists largely of protein and fat, which provides the required types of food. People living in arctic conditions for long periods of time are less affected by the cold.

1.12 ACCLIMATIZATION AND EXTREME COLD

The nude human body at rest begins to combat against hypothermia at the air temperature of approximately 31^{0}C (87.8°F). This temperature is known as the critical temperature. Consequently, the individual reduces the loss of heat from body to the environment and produces heat to increase body temperature.

A major mechanism for conserving heat is peripheral vasoconstriction. Constriction of the capillaries below the skin prevents warm blood from reaching to the surface of the skin, where much of the body's heat would be lost to the air. Additional body heat is produced voluntarily by exercise and involuntarily by shivering. A high degree of muscle activity yields heat. However, exercise can be performed only for limited periods of time depending on the physical fitness of an individual. More important is shivering. Low body temperature causes the hypothalamus of the brain to stimulate increased muscle tone, which results in shivering. At the peak of shivering, the increased muscle metabolism can increase the rate of heat production five times than that of the normal.

1.13 MECHANISMS OF HEAT LOSS

Humans survive more efficiently in the hot and arid climates than in the arctic regions of the world. This is generally due to lack or scant presence of body hair, which otherwise act as insulating material. Also, humans have a greater capacity to sweat than any other mammal.

In the hot climate as in desert it is essential for the human body needs to get rid of excess heat that is being absorbed by the body. In general, heat can be lost in any one of the four ways:

Conduction: It occurs when heat move from a warmer object to a cooler object by direct contact. Thus, if you stand barefoot on a hot pavement, the soles of your feet will heat to an uncomfortable temperature because of conduction.

Convection: Heat is transferred from warmer to surrounding cooler fluid, either liquid or air. Returning to our hot pavement, the heat from the pavement is transferred to the cooler air. As the air warms up, it expands, and expanding air rises above. Cooler air flows down to replace it. Thus currents set up in the air carry away heat.

Radiation: Heat is given off by an object as electromagnetic waves of a characteristic wavelength. Other forms of electromagnetic waves include visible light, ultraviolet radiation, and radio waves.

Evaporation: The heat is lost from the skin by evaporation of sweat as when water converts into vapor; a certain amount of energy is required in the form of heat. Therefore, when you get out of the swimming pool on a warm day, you feel cool because some of your body heat will be used up in the process of transforming the pool water left on your skin into water vapor.

Human body gets rid of excess heat in warm climates by all four methods, but at air temperatures above 35°C (95°F) evaporation is much efficient. Therefore, sweating is the most important method of controlling body temperature in warm climates. Humans have a high density of sweat glands over their bodies, although the number per square centimeter does differ in different parts of the body. An adult male averaged 206 sweat glands per square centimeter on the hand and 69 on the trunk; these numbers are greater than in any other mammal. The number of sweat glands does not differ significantly between desert- and non desert-dwelling populations.

1.14 ACCLIMATIZATION TO DESERT HABITATS

Acclimatising to desert life is not well understood, but within a few weeks of exposure to hot and arid climates individuals acquire some adjustments. Meanwhile, the sweat glands become sensitive and produce sweat. Sweat also contains salts, and much sodium is lost through sweating. With time, the concentration of salt in sweat is reduced, although the relatively high salt concentrations found in desert water easily compensate for salt loss. Urine volume also reduces, thus conserve water in the body. This same acclimatisation ability has been found in peoples from all parts of the world, so it appears to represent a basic ability of the human species instead of an adaptation of certain populations.

In addition, there are short-term reactions to increased heat loads. The physiological response involves vasodilatation of the capillaries under the skin. In vasodilatation, the bloodstream brings heat to the body surface, and is lost to the environment by conduction, convection, radiation or evaporation. Acclimatisation escalates the ability to work longer and more efficiently in hot climates.

People also adopt various behavioural adjustments to the hot climates. In desert regions people tend to reduce physical activity during the heat of the day, thereby reducing heat production by the body. Also, assume a relaxed body posture that increases the surface area of the body from which sweat may evaporate.

Adjustment to hot climates is aided by cultural factors such as clothing and shelter. Desert dwellers cover their bodies to protect the skin from ultraviolet radiation as well as to reduce the amount of heat from the sun which otherwise is absorbed by the body. Such clothing is designed to permit the free flow of air between the clothing and the body. This airflow is necessary to carry off the water vapor formed by the evaporation of sweat.

Interestingly, the color of clothing does not seem to make much difference in hot climates. An experiment conducted on black and white Bedouin robes shows that black robes gain about 2 ½ times as much heat as white robes. Yet the temperature of the skin under black robes is the same as that under white robes. Most likely, the greater convection currents between the black robe and the skin are responsible for this phenomenon.

In addition to physiological and cultural factors, psychological elements appear to play major roles in adjustments to intense heat. Some Europeans adapt quickly to desert life, others never seem to adjust to changing conditions of life. In an emergency, the European, anxious to do something, is active, gets hotter and uses up his limited supply of water. In contrast, the nomad, secure in the will of Allah, tends to relax and behave more calmly.

1.15 ADJUSTMENTS TO HIGH ALTITUDES

When a person travels into the mountains on vacation, he or she may experience high-altitude or mountain sickness. The symptoms include shortness of breath, respiratory distress, physical and mental fatigue, rapid pulse rate, interrupted sleep, and headaches intensified by activity. Slight digestive disorders and in some cases a marked loss of weight may also occur. In other cases the individual may feel dyspnea, nausea, and vomiting. Although most people eventually become acclimatised to high altitude, many do not. They will continue to suffer from chronic mountain sickness as long as they remain at high altitude.

Less than 1 percent of the world's population lives at high altitude, yet these populations are of great interest to anthropologists. High-altitude environments exert multiple-stress on human population. These stresses include low oxygen pressure, intense solar radiation, cold and dry wind, rough terrain, and relatively limited plant and animal life.

High-Altitude Hypoxia: As already known, the arctic and desert environments lay emphasis on culture as an efficient means of adjustment to stressful environments. Culture plays a pivotal role in high altitudes as well except in hypoxia. Hypoxia refers to low oxygen pressure, which occurs when relatively low levels of oxygen are supplied to the tissues of the body. Hypoxia may result from disease as well as environmental factors. High-altitude hypoxia represents one of the few environmental stresses that cannot be adjusted to by some cultural means. Although the use of oxygen tanks provides limited adjustment, this solution is available only in high-technology cultures and is practical only for short periods of time.

The earth's atmosphere exerts an average of 1 kilograms of pressure on every square centimeter (14.7 pounds per square inch) of surface area at sea level. This pressure is able to raise a column of mercury (which has the chemical symbol Hg) in a closed tube to an average height of 760 millimeters (29.92 inches). Therefore, we say that the average air pressure at sea level is 760 millimeters (29.92 inches) of mercury.

The atmosphere is composed of many gases and approximately 21 per cent of air is oxygen. The portion of the total atmospheric pressure due to oxygen is the partial pressure of oxygen, which measures 159 millimeters (6.26 inches) of mercury at sea level. At altitude, the partial pressure of oxygen decreases. At 4500 meters (14,765 feet) the partial pressure of oxygen is decreased by as much as 40 per cent, thus substantially reducing the amount of oxygen that can reach the tissues of the body.

The oxygen enters into the bloodstream via approximately 300 million alveoli of the lungs. The alveoli are small air sacs that are richly endowed with blood capillaries. Although the partial pressure of oxygen at sea level is 159 millimeters (6.26 inches) of mercury, the partial pressure of oxygen in the alveoli at sea level is 104 millimeters (4.16 inches) of mercury. This is due to the fact that not all the air in the lungs is replaced with each breath. The partial pressure of oxygen in the arteries and capillaries of the circulatory system is 95 millimeters (3.80 inches) of mercury, and in the tissues it is 40 millimeters (1.60 inches) of mercury.

As gas moves from higher to lower partial pressure, oxygen diffuses from the blood to the tissues. At high altitudes, the partial pressure of oxygen in the blood would be too low to permit diffusion of oxygen from the blood to the tissues unless certain physiological adjustments take place. These adjustments make high-altitude environments a possible human habitation.

When an individual inhabiting near sea level migrates to high mountains, he or she will probably notice an increase in the breathing rate, which may reach twice that of at sea level. The increased breathing rate brings more oxygen in the alveoli, and increases the partial pressure of oxygen in the blood.

This hyperventilation, or increased breathing rate, eventually reduces, to normal level as the person becomes acclimatised to the high altitude.

About 97 per cent of the oxygen in the blood is carried in chemical combinations with hemoglobin in the red blood cells; the other 3 per cent is dissolved in the plasma and may be ignored. The chemical association of oxygen and hemoglobin is loose and reversible. When the partial pressure of oxygen in the alveoli of the lungs is higher than that of blood, oxygen diffuses into blood vessels and combines with hemoglobin. When the hemoglobin molecule reaches the capillaries, oxygen diffuses into the cells where the partial pressure of oxygen is lower than blood.

When the blood leaves the lungs, the hemoglobin is about 97 percent saturated with oxygen. Some of the oxygen is then utilised by the tissues. As a result, the hemoglobin in the veins returning to the heart and lungs is only about 70 per cent saturated. At high altitudes, several factors operate to alter these percentages, thereby permitting the hemoglobin molecules to carry more oxygen to the tissues. As a result of hyperventilation, the concentration of carbon dioxide in the blood is decreased, thus altering the blood chemistry in a way to increase the amount of oxygen carried in the blood.

Other acclamatory changes include increase in the number of blood capillaries, thereby improves the diffusion of oxygen by shortening the distance between the cell and capillary. Increased number of red blood cells enhances oxygen carrying capacity due to elevated amount of hemoglobin. Therefore, although the partial pressure of oxygen as it enters the lungs differs at sea level and at high altitude, the partial pressure of oxygen in the blood is not very different by the time it reaches the capillaries. Many changes also occur at the cellular level that enables cells to carry out their metabolic functions at lower oxygen levels.

While the factors discussed above and many more, permit humans to live at high altitudes, people cannot overcome all the negative biological effects of high-altitude. For example, high altitude affects reproduction; birth weights are lower and infant mortality is higher. In addition, the growth and development of children are slower. A good example of developmental adjustment is found among the children of high altitudes. During growth the native develops greater chest circumferences than do those growing up at lower elevations.

1.16 GENETIC AND NON-GENETIC FACTORS IN CLIMATIC ADJUSTMENTS

Twin studies indicate that variations in body-shape, size, fat deposition, growth pattern, skeletal and physiological maturation are all determined by genetic constitution to a larger extent than by totally environmental factors. Population differences rest undoubtedly on distinct genotypes or multifactorial recombination, e.g. nose-shape or the ratio of limb length to trunk length remains unaffected by change in environment. The situation is, however, more complicated, because of the action of climate on body-weight and growth rate of non-indigenous peoples. Europeans in the tropics possess body-weights lower on the average than those in colder environments.

1.17 SUMMARY

In physical anthropology, ecological study plays an important role as always human beings have been studied in relation to their environment. The ecological concepts and principles permit a better understanding of the individual. Ecology is systematically studied by applying different methods and techniques. The subject matter include: genetic adaptation, developmental adaptation, seasonal acclimatisation, etc. Human beings have been distributed in different ecosystems namely, tropical, subtropical, temperate, semi-temperate and artic regions and have adjusted to these ecosystems in order to survive in a successful manner. Bodily and physiological adaptation has enhanced tolerance to extremes cold and hot climates. Behavioural adjustments are in coordination with cultural characteristics of a particular community or populations. At the same time, role of the genetic and non-genetic facts in climatic adjustments cannot be ruled out.

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Sample Questions

1) Explain the different basic concepts of ecological studies.
2) Discuss the different methods of studying human ecology.
3) Write an explanatory note on behavioural adjustments in ecological studies.
4) Briefly explain the role of genetic and non-genetic factors in climatic adjustments.

UNIT 2 ADAPTATION TO ENVIRONMENT

Contents

Learning Objectives

The objective is to

- learn about the biological and non-biological components of different habitats occupied by human populations all over the world;
- facilitate an understanding of the influence of thermal environment on human beings; and
- understand the mechanisms of human adaptation to these environmental stresses.

2.1 INTRODUCTION

Ecological anthropology is the multidisciplinary study of the dynamic interface between humans and their socio-cultural and biophysical environments. It focuses upon how a particular population purposely or unintentionally shapes its environment, and showcases how an environment shapes it's socio-cultural, economic and political life. Each population has its own adaptation to a wider environment. The term adaptation is a process whereby the organism has attained a beneficial adjustment to the environment.

> Adaptation encompasses the physiological, cultural, and genetic adaptations that allow individuals and populations to adjust to their environment in which they live.

The term Environment describes the sum total of abiotic and biotic conditions influencing the responses of organisms. More specifically, environment into which life penetrates is termed the biosphere which is made up of portion of the biosphere, hydrosphere, aerosphere and lithosphere. Population is not engaged with the total environment around them but rather with a habitat.

2.2 HABITAT

Habitat is a place where a plant or animal lives often characterised by either dominant plant forms or physical characteristics (e.g. grasslands habitat). Or a **Habitat** is a specific set of physical and chemical conditions (e.g. space, climate) that surrounds a single species, a group of species or a large community.

To appreciate the variety of ecosystem exploited by man we need to consider the range offered by different combinations of habitat and economy. Thus, classification of both habitats and economic groups are needed which will include the ecosystern of pre-literate and prehistoric man as well as of more advanced societies. A simple classification of habitat should indicate the chief climatic, floral, faunal and topographical characters, and a classification of economic or social groups should sufficiently indicate the mode of livelihood and the complexity of the community. Elaborate classifications of habitats, economies or ecosystems are not really called for since their variation is immense.

2.2.1 Classification of Habitats

Habitats may be roughly classified into 10 groups; the first nine depend broadly on geographical latitude and the last being determined by altitude. The ecological stresses vary in these different habitats, due to different combinations of climatic, nutritional diseases and other factors. In Table 2.1 are given the main feature of these 10 groups of habitats, and in Table 2.2 their geographical distribution in different continents is shown.

Table 2.1: Classification of Habitats

i	Equatorial forests: Dense rain forest, evergreens, tall and canopied, wet, will not burn, difficult to clear.
ii	Tropical forest and scrub: Less dense, semi-deciduous forest which can be cleared; scrub forest with grass or brush floor and some small thorny trees, merges with equatorial forest and with grassland.
iii	Tropical grasslands (savannahs): Great stretches of grassland with scattered trees or patches of forest or parkland and abundant animal life.
iv	Deserts and dry lands: Vegetation scanty, plants are (a) water-storing succulents and/or thorny cacti or aloes (b) annuals, dominant; (c) perennials with long roots. Surface water shade, animal life scarce, little shade climate ameliorated in oases and nearby river systems.
v	Temperate forests: The natural broad-leaf deciduous forest merging into coniferous forest and moorland with evergreen heaths on western European seaboard. Now large land has been cleared. Animal life is in abundance.
vi	Mediterranean scrub: The maquis-evergreen rather than deciduous (oaks and chestnuts) small trees and shrubs, plants deep-rooted and xerophytic, grassland in patches. Animals are not in abundance.
vii	Temperate grasslands: Steppes of short grass; prairies of long grass. The prairies and chernzem well watered and water-retaining.

viii	Boreal lands: Coniferous forest mostly of spruce, fir, larch, rarely birch, beech, polar lakes, rivers and swamps. Abundant animal life, e.g., moose, caribou, puma in America, tiger in Siberia.
ix	Polar lands and tundra: Tundra begins at edge of boreal forest as scrub of dwarf willows, ash, alder, then becomes carpeted tundra of sedges, mosses, lichens; then desert tundra with isolated patches of grass tundra, flowers blossoming in spring. Animals in abundance (e.g., fish, sea mammals) along with many Arctic species, e.g., foxes, hares, bears.
x	Mountain habitats: Depend on locality, altitude and orientation in relation to light and shade, e.g., at equator succession of tropical forest, mixed forest, conifers, alpine meadows.

2.2.2 Geographical Distribution of Habitats

Table 2.2: Habitats – geographical distribution (some examples)

Habitats	Africa	Asia	Europe	America	Australasia
i. Equatorial forests	Congo basin Cameroon	India South East Asia Indonesia		Amazon	New Guinea Melanesia
ii. Tropical forests and scrub	Angola Uganda Southern Sudan	India Southern China		Yucatan Gran Chaco	Polynesia Cairns regions
iii. Tropical grasslands (savannahs)	Sudan Tanzania	Indonesian grasslands		Pampas Lanos	Northern Australia
iv. Deserts and dry lands	Sahara Kalahari Namib	Arabian Indian Turkestan		Californian Atacama Paraguay	Central Australia
v. Temperate forests		China south of Great Wall and north of forest belt	Between Mediter-ranean and Boreal east of grasslands Gulf Stream coasts	East of Mississippi St. Lawrence Valley North-west coast of North America Chile	Australia Tasmania New Zealand
vi. Mediterra-nean scrub	South shore of Mediterra-nean Sea Cape Peninsula	Palestine Lebanon South coast of Black sea	Crimea Northern shore of Mediter-ranean	California to Vancouver Middle Chile	Perth region Adelaide region
vi. Temperate grasslands	High veld, Transvaal Strip south of Atlas mountains	Turkestan Manchuria Mongolia	Eastern Russian steppe Chernozem belt	Prairies Pampas Patagonia	
viii. Boreal		Siberia	Lapland	Northern Canada Alaska Extreme South America	New Zealand mountains
ix. Tundra		Siberia	Lapland	Greenland	Antarctica
x. Mountains	Ethiopia Basutoland	Tibet Hindu Kush	Swiss and Austrian Alps	Mexico Peru Chile	New Zealand in South Island

Source: Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds,V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

2.2.3 Population Distribution in Habitats

As shown in Table 2.3, the largest populations today are found in two very contrasting habitats, i.e.

a) Tropical forest and scrub lands

b) Temperate mixed forest lands.

The relative density of population is shown in the third column of the table. In all likelihood, the hominids originated in tropical grassland or scrub lands. Therefore, the modern man has effectively extended his area of occupation to attain high densities in habitats as different as tropical forest land (with twice the overall average density), Mediterranean scrub land (4 times the average), and the temperate mixed forest land (6 times). Mountain habitats have also been settled in fair density.

Table 2.3: Population distribution in Habitats

Habitat	Area percentage of total land area	Population percentage of total present world population	Relative density
Dry lands and deserts	18	4	0.2
Tropical forest lands	15	28	1.9
Tropical scrub land			
Tropical grasslands (savannah)	21	12	0.6
Temperate grassland (continental)			
Temperate mixed forest lands	7	39	5.6
Mediterranean scrub land	1	4	4.0
Boreal lands (cold temperate)	10	1	0.1
Polar lands and tundra	16	(<1)	0.01
Mountain habitats	12	12	1.00

Source: Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds, V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

2.2.4 Types of Economy

The type of economy may be roughly classified according to the major productive technique used (Table 2.4). This serves to indicate the volume of production, type of labor organisation as well as the social complexity of the community. In terms of technology, however, productive methods are seldom mutually exclusive and social structure may vary greatly among the groups using the same production technique. Though, too much emphasis should not be placed upon any classification.

It is quite evident that race is not an obstacle to so many types of occupation or economies in a wide spectrum of habitat. In specific habitats, one and the same racial group has established a succession of economies often of increasing complexity.

Habitats can be exploited in different ways. Development of certain economies is entirely precluded by some environmental circumstances of habitat, though not at all stages of economy emergence. A technology may flourish immensely in a particular habitat than in the other. However, given the technology of advanced cultivator, settlement of high density are possible in nearly every type of habitat, thus resulting in ecosystems varying greatly in their population densities.

Table 2.4: Types of economy

Food gatherers	Collect their food- small game, insects, root, fruit, honey. Their material culture (clothing, shelter, domestic utensils, etc.) is crude or scanty. The only domestic animal is the dog.
Higher hunters	Live by trapping and hunting, in addition to gathering. They often have good dwelling and some knowledge about pottery and weaving. The populations of the Palaeolithic and Mesolithic culture fall within these two categories.
Herdsmen and pastoralists	Live mainly by keeping herds of cattle; they may also have flocks of sheep and goats. They often have substantial house. Hunting or tilling being subsidiary.
Nomads	Herd of men who move in a regular seasonal cycle to tribal grazing lands.
Simple cultivators	Practice a simple garden agriculture, but also rely on gathering and hunting; a little domestication of pig or poultry may be added. The societies in the Neolithic cultural stage would be classified in this category.
Advanced cultivators	Agriculture is main subsistence economy. They appreciate the significance of soil fertility and importance of crop rotation. In post- Neolithic time, water conservation and irrigation began to be practiced.

The intrusion of human communities into natural ecosystem may lead to either stable or dynamic equilibrium. In the former situation the human population maintains its essential biological characteristics such as size, density, composition, general standard of living, energy and nutrient balance; more or less unchanged over long periods of time. The social structure and technology will reflect this conservatism. Approximations to ecological stability are attainable in different habitats, with different economies and at high or low population densities. Dynamic ecological equilibrium, which characterise many expanding and developing communities meet the constantly increasing needs for food, water, raw material, waste disposal by increasing activity, energy output and intensified exploitation of both the biotic and abiotic environment. This kind of equilibrium or even approximation to it is mostly typical of human communities in the period of industrialisation. This is not to forget that there have been times in the history of communities when ecological balance cannot be maintained with far-reaching social and biological consequences. Therefore, it becomes pertinent to understand the biological properties of the community and its families and individuals in terms of equilibrium and interchange processes – the energy flow, the transport of food and water, the transmission of pathogens – through the total ecosystem.

Ecological 'success' can be gauged in terms of 'standards of living using biological, medical or demographic as standards. The size of the population, its maintenance, the mortality, longevity or nutritional status is example of overall indices of 'fitness' or adjustment. Depopulation is possibly the most reflective index of maladjustment seen as failure of an immigrant group to establish itself. The analysis of the 'efficiency' and 'capacity' of an ecosystem necessitate thorough surveys of specific societies. It would not be surprising that limitations may be discovered in any of the organism-environmental relationships which could be attributed to climate in direct or indirect sense (e.g. of building material); nutritional inadequacies or to particular diseases which may arise only secondarily from defects in social organisation as perhaps in the organising of work over the yearly cycle – in the storage of food. Clearly some habitats are far less promising than others. For example, the tropical habitats of Africa and South America have always presented a consolidation of hostile conditions having poor soil, climate, and nutritional stress and debilitating diseases. The beginnings of the first complex societies and civilisation in the 'Fertile Crescent' were the consequence of the advantageous conditions existing concurrently in the ancient river valleys with abundant water supply, a favorable climate, easy riverine communications and the protection afforded by the surrounding arid lands.

2.3 CLIMATIC ADAPTATION

Every habitat is identified by a specific climatic regime and enforces it on man, his domestic animals, and crops. They vary extensively and it is only man who can make apt adjustments to occupy habitats more varied than those of any other mammalian species (except perhaps the rat). The human body is sensitive to various climatic elements of a region; this sensitivity and responsiveness result from the need to maintain homeostasis. Regulatory system acts to maintain the body temperature steady within relatively narrow limits (homeothermy), under conditions of extreme heat or cold. At high altitudes the respiratory system keeps the pressure of oxygen and carbon dioxide of the body-fluids adjusted within unwavering limits. Apart from the stresses imposed by thermal factors and low barometric pressure at high altitudes, other environmental hazards are provided by excess of short-wave radiation (ultraviolet light and ionising radiation).

2.3.1 The Thermal Environment

Climate and weather are terms used to denote the state of the atmosphere. Weather is atmospheric state in a given time and place; climate is a locality's weather as observed over a long period- in other words long term behaviour of weather. The characteristic of atmospheric making up the weather and the climate are recorded at regular intervals over a period of time and include the air temperature, humidity, speed and direction of the wind, amount and type of cloud, hours of sunshine and total radiant heat received, rainfall, snow, dust, and other special features.

The climate enveloping man is indeed made up of a series of climatic 'shells'- the microclimate of clothing, domestic and working enclosures, and the geographical macroclimate. The climatic factors of primary physiological significance are those which exert a direct influence on the rate of heat exchange between the body surface (nude or clothed) and the surroundings. If any thermal environment is specified; air temperature, humidity, wind speed, and the mean radiant temperature of the surroundings must be taken into account. There are situations when environmental heat adds to the 'internal' bodily heat derived from general metabolism and muscular activity. Heat is lost from the skin when body temperature is higher than environment. On the other hand heat is gained when external objects are warmer than human body. Thus, all thermal aspects of indoor (wall, furniture, etc.) or outdoor (terrain, etc.) surrounding determine the rate of heat that the body lose to exterior.

The disturbed homeotherm affects the body's efficiency. The adaptive relations of human body with the thermal environment are of three sorts:

- ❖ Physiological adjustments in the heat regulatory, metabolic and circulatory systems make it possible to work and survive in a wide variety of environments. These can be both, short and long-term. The ability to make these adjustments is a highly developed characteristic of the human species as a whole.
- ❖ Specialised physiological and anatomical adaptive responses based on particular genotypes are also observed.
- ❖ Cultural and social adjustments engage the provision of shelter, clothing, warmth, and ventilation. These cultural responses to biological requirements are like nutritional requirements, 'institutionalised' in Malinowski's sense, but have not been clearly analysed. The usefulness of these cultural responses can be judged by biological criteria.

The efficient adaptation of the human body to climatic change is necessary for:

- ❖ Attainment of bodily comfort,
- ❖ Performance of habitual physical work without undue fatigue,
- ❖ Performance of skilled work calling for alertness and dexterity with minimum errors,
- ❖ Attainment of normal growth and development,
- ❖ Ability to reproduce successfully.

An example is given to assess the human capacity to withstand climatic stress in the extreme conditions of human habitation: The village of Verkhoyansk in eastern Siberia almost on the Polar circle, experiences a mean temperature 35°C below the mean for the year (-10°C) in the coldest month January. Whereas, in the oasis of Insalah in the Algerian Sahara, the hottest month July (38°C), is approximately 12 °C above the annual mean. This reinforces that human communities are found surviving efficaciously in the extreme climates summer 55°C (-17 to 38°C) and winter -16°C to +28°C.

In contrast, the deep body temperature varies within a range of somewhat small amplitude compared to the extremes of high and low temperatures of surrounding. The body temperature is highest in the early evening and lowest at about 4 a.m reflecting a diurnal range of about 2°C. In tropical countries the diurnal cycle is shifted upwards by about 0.2°C while in Antarctic about 0· 2°C down from temperate values. This shift takes place regardless of race, e.g., Asian (in America or Europe) have body temperatures of the same values as indigenous peoples.

The body is sensitive towards the existence of fluctuation in different conditions like daily, seasonal and geographical. This is provided chiefly by a 'thermostatic' mechanism in the brain (hypothalamus) which is sensitive to a fluctuation of body temperature to a degree of threatening the normal level. Within a certain range of heat and cold stress (e.g. air temperatures between 27°C and 32°C approximately) the internal (rectal) body temperature of the nude subject is retained close to 37 °C without unwarranted change in skin temperature (within the limits of 30.5 °C and 33°C approximately), so that thermal comfort of body is not disturbed. However, when the degree of stress is higher, some heating or cooling of the periphery with associated discomfort can be tolerated to take care of a steady internal temperature and physical and mental efficiency. The limits to which climatic adjustment can be made must be looked through two biological processes-the maintenance of comfort and the overriding maintenance of heat balance.

The body is in a state of thermal equilibrium with its environment when it loses heat at exactly the same rate as it gains heat. The basic relation underlying homeothermy is: **Heat Gain-Heat Loss = ± Heat Storage,**

or, **M+C+R-E =+S**,

where, M = rate of heat produced by metabolism and work, C = rate of heat gain or loss by convection, R = rate of heat gain or loss by radiation, E = rate of heat loss by evaporation of skin moisture, S = net heat exchange. S can be kept relatively constant while the other variables change over a wide range. The changes in S represent additions or losses from, the total heat content of the body so that the overall change in heat content is largely inhibited. In this lies the flexibility of response to extremes of heat and cold. When this equilibrium is threatened (i.e. when storage or withdrawal of heat becomes excessive) a number of immediate counter-adjustments are made. Further long-term processes within the life time of an organism reduce the strain, referred as 'acclimatisation'. These physiological responses have been demonstrated in different races of human.

Bodily characters affecting thermal response: Organism attains equilibrium between heat production and heat loss in order to maintain a constant internal body temperature. The potential avenues of heat exchange include

Radiation: It refers to heat transfer in the form of electromagnetic waves emitted by one object and absorbed by other.

Convection: It refers to transfer of heat by a stream of molecules from a warmer object towards a cooler object. Convection current replace warmed air with cold air.

Conduction: Heat is lost from the skin as coming in direct contact with an object possessing a colder temperature.

Evaporation: Heat is lost from the skin by evaporation of sweat from body surface as heat is utilised in conversion of water to vapour.

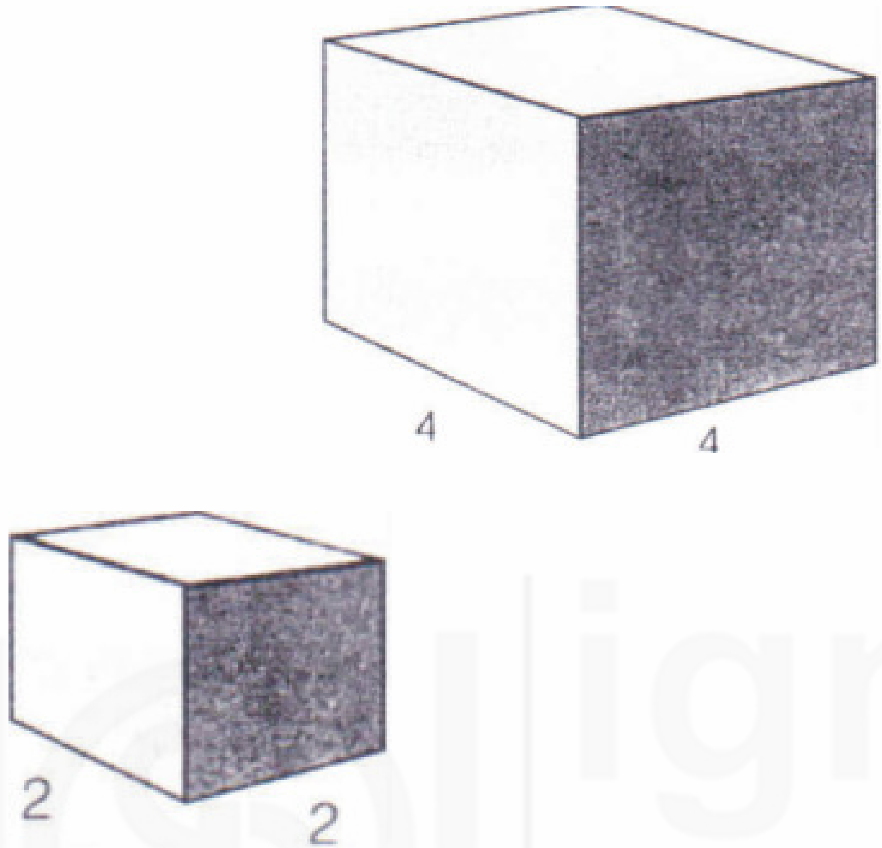
The rate of heat exchange by convection, evaporation and radiation is proportional to the surface area of skin. Larger the surface area the greater will be the loss of heat. When sweating provides the main channel of heat loss (with air temperature very near or above skin temperature) the total loss highly correlates with the surface area, but the actual correlation value (+0·8) makes clear the existence of quite considerable individual variability in sweat capacity.

The rate of heat exchange is to some extent influenced by body-size and shape. The amount of heat produced during a physical activity highly correlates with the body-weight of the subject. The heat produced per kilogram weight tends to be the same for both, large and small individuals. However, the heat output is not constant per unit surface area. As smaller subjects have greater surface area per unit of body weight, exposed to environment in contrast to larger individual who have greater body weight to surface area. Thus, smaller individuals dissipate heat at faster rate than larger individuals. This is based on the fact that the body-weight increases as the cube, while the surface area increases as the square; also for a given body-weight physique which approaches a linear (ectomorphic) rather than a spherical (endomorphic) shape will have a relatively greater surface area. These anatomical properties make it unnecessary for the smaller individual to sweat as much per unit area as the larger individual, and the total water requirement by the smaller individual is both relatively and absolutely less. The heavier subject, putting out more sweat per unit area, will need to have harder-working sweat glands (for it is likely the glands are not present in greater density). Thus, in hot environments individuals of smaller and of linear build would appear to possess some biological advantage.

Body-shape affects heat loss in another way. Both convective and evaporative coefficients (i.e. the heat loss per unit area and per unit temperature or vapour pressure gradient respectively) approach constant values for large surface but increase rapidly as the diameter of the limbs is reduced below a diameter of about 10 cm. The evaporative coefficient of heat loss will be twice for a limb of diameter 7 cm than of 15 cm.

2.3.2 Bergmann's and Allen's Rules

Human population has been exposed to a wide variety of different ecological stressors. Adaptive changes to these widely differing selective pressure results into diversity among human population. A strong relationship exists between the physical characters and environment which has led to formulation of several ecological rules. Bergman (1847) rule states that " within the same species of warm blooded animals, population having less bulky individuals are more often found in warm climates near the equator, while those with greater bulk or mass are found farther from equator, in colder regions". Basic to Bergman's rule is the principle that otherwise similar bodies, smaller one has larger skin surface in proportion to mass which enhance body heat loss. Therefore, it seems to be a hot climate adaptation. While larger individuals have increased mass to surface area ratio which reduces heat dissipation hence appear to be a cold climate adaptation. Thus indicating that heat production is a function of the total volume of an organism whereas heat loss is a function of total surface area. For example, consider two hypothetical organisms whose body shape is that of a cube. Imagine that one cube is 2 cm long and the other is 4 cm long in each dimension (Fig.2.1).



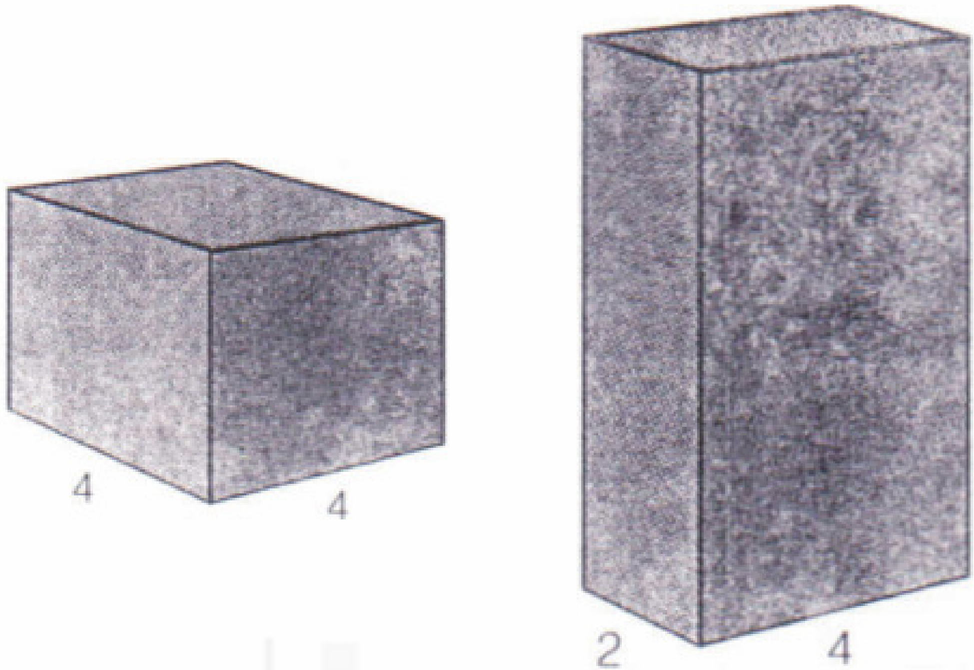
Surface area (length x width) x 6* = 24	Surface area (length x width) x 6 = 96
Volume (length x width x height) = 8	Volume (length x width x height) = 64
Surface area/volume = 3	Surface area/volume = 1.5

*Cube has six sides, so we multiply calculated surface area by 6.

Fig. 2.1: Geometric representation of Bergmann's rule relating body size and heat loss.

The volume of the 2 cm cube is 8 cm^3, and that of 4 cm cube is 64 cm^3. As a measure of heat production, the larger cube with greater volume produces more heat. This means, the greater the volume of a mammal, the more is heat produced. Surface area of the 2 cm cube is 24 cm^2, and that of the 4 cm cube is 96 cm^2. As a measure of heat loss, cube with the greater surface area seems to lose it at a greater rate. This indicates more heat production and loss by the larger cube produce. However, the relevant factor in heat loss in mammals is the ratio of surface area to volume. The surface area/volume ratio is 24/8 = 3 for smaller cube, and 96/64 = 1.5 for the larger cube. Therefore, the larger cube lose heat at a slower rate relative to heat production discerning better adaptation to colder climate while smaller cube lose heat at faster rate favouring adaptation to hot climate.

Bergmann's rule also involves the shape of an object and its relationship to heat loss. Fig. 2.2 shows two objects with the same volume but different shapes.



Surface area = 96
Volume = 64
Surface area/volume = 1.5

Surface area = 112
Volume = 64
Surface area/volume = 1.75

Fig.2.2: Geometric representation of Bergmann's rule relating body shape and heat loss.

The first object is a 4 cm cube of volume - 64 cm^3, surface area - 96 cm^2, and surface area/volume ratio - 1.5. The second object is a rectangular block 2 cm wide, 4 cm deep and 8 cm high. The volume of this object is also 64 cm^3, but the surface area is 112 cm^2 and surface area/volume ratio is 112/64 = 1.75. Even though both objects produce the same amount of heat as measured by their volumes, the rectangular object loses heat more quickly. This means, linear objects such as the rectangular block would be at an advantage in hot climate, whereas less linear objects, such as the cube, would be at an advantage in cold climates. Accordingly, Bergmann's rule predicts that mammals in hot climates will have linear body shapes and mammals in cold climates will have less linear body shapes.

Another zoologist, J. Allen, applied these principles to body limbs and other appendages. Allen's rule (1877) states "among warm blooded organism, individual in population of same species living in warmer climates near the equator tend to have longer limbs than do population living away from the equator in colder environments".

2.4 CLIMATIC STRESS AND MAN'S PHYSIOLOGICAL RESPONSE AND ACCLIMATIZATION

2.4.1 Hot Climate Adaptation

Responses to heat: The instant physiological response to overheating is a compensatory increase in heat dissipation from the body accomplished mainly through adjustment of cardiovascular system followed by sweating. There is increased flow of blood through skin due to vasodilatation to start with. Due to additional strain there is an elevated cardiac output accompanied by increased pulse rate. The heat brought to the surface thus elevates the skin temperature facilitating dissipation of heat to the surroundings by convection and radiation. This heat loss per unit surface area is proportional to the temperature gradient between skin and external environment; and square-root of the wind velocity.

When environmental temperature increases above the skin temperature circulatory adjustment are not adequate for heat dissipation by convection and radiation because of negative gradient, in fact it gains heat. This results in sweating and heat loss by evaporation of evenly distributed sweat is effective. The rate of heat loss by evaporation (latent heat of vaporisation) influences the variance between the vapor pressure at the skin surface and that of the air, extent of the wetted surface area and air movement. The rise in skin temperature reflects an increased vapor pressure at the skin surface. The sweating rate is raised by increasing the number of active sweat glands and rate of fluid output of each gland. A maximum water loss of about 1 lt per hour, equivalent to 2500 kJ heat loss per hour can be achieved.

Although the total number of sweat glands varies in different individuals, striking differences have not been reported between different racial groups as indicated in Table 2.5:

Table 2.5: Total number of glands of adult males (means in millions + S.D.)

Hindu	(6)	1.51+ 0.19	(Knip)
Indian	(19)	1.69+ 0.16	(Weiner)
Dutch	(9)	1.47+ 0.29	(Knip)
British	(2)	1.66+ 0.19	(Weiner)
European in West Africa	(21)	1.75	(Thomson)
West African	(26)	1.66	(Thomson)
Bush egro Surinam	(8)	1.69+ 0.14	(Knip)

Source: Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds,V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

The density and distribution of glands has been found to be similar (Table 2.6) in different population and decreases in the order:

- ❖ Upper limb-dorsum of hand, forearm, upper arm
- ❖ Lower limb-foot, leg, thigh; and
- ❖ Trunk-abdomen and thorax.

Table 2.6: Number of sweat glands per square centimeter (adult males)

		Trunk	Hand	Forearm	Arm	Foot	Leg	Thigh
European	(29)	69	206	98	85	132	87	59
Dutch	(9)	75	145	86	80	119	66	52
Indian	(19)	89	209	97	91	152	91	62
Hindu	(6)	87	170	121	93	119	81	60
West African	(26)	94	240	109	119	175	78	85

Source: Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds,V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

The flexibility of physiological response in a variety of habitats is clearly demonstrated by the way homeothermy is maintained against heat load. The hot environment can be classified as:

- Hot, humid, and still-air condition,
- Hot, dry conditions with moderate air movement and high solar radiation,
- Cool, dry condition with solar radiation, and
- Hot and moderate temperatures.

Acclimatisation to heat: Repeated exposure to heat results in acclimatisation enhancing tolerance to work under heat stress. In a laboratory experiment, the subjects were able to work for four hours on the fifth day of exposure, whereas they gave up after less than an hour on the first day accompanied by better circulatory performance. The initial high pulse rate and heart output, reduced markedly. The heat regulatory system became more efficient. The body and skin temperature, which rise rapidly to high levels on the early exposures, rises slowly or attains a 'plateau' on continued exposure to the heat. The bodily changes which are elicited under artificial conditions (acclimation) can also be revealed in natural environment (hot climates-equatorial or desert). The complex physiological changes which lead to acclimatisation has been demonstrated in population of different races living in hot climates e.g. Nigerians, Chinese, Indians, and Malayans living in Malaya, Kalahari Bushmen and South African Bantu, as well as in Europeans habituating tropics or hot deserts.

Since the emergence of genus 'Homo' in tropical region *Homo sapiens* have occupied diverse tropical and equatorial habitats. Acclimatisation as a consequence of physiological changes enable individual to inhabit wide variety of hot environments. This is evident from the distribution of population in relation to habitat shown in Table 2.3. Genetic selection of various bodily characters for life in diverse climates has been superimposed on physiological plasticity.

2.4.2 Cold Climate Adaptation

Responses to cooling: Within the thermo-neutral temperature range of 25ºC to 27ºC the individual is in thermal equilibrium, but below this range nude individual responds immediately through mechanism which permits both increased heat production and conservation. The major mechanism concerned with heat conservation is vasoconstriction (constriction of subcutaneous blood vessels). The lowered blood flow decreases skin temperature, reduces temperature gradient between skin surface and environment, consequently reducing the rate of heat loss or thermal conductance. Other important factor affecting heat loss is the degree of artificial or natural insulation. Subcutaneous fat layer has lower thermal conductance. The level to which skin temperatures fall on exposure to cold is highly correlated with skin-fold thickness. Differences in thickness of subcutaneous fat-layer are significant among populations. Fatter subjects show longer endurance on immersion in cold water. To survive in the extreme cold condition of Arctic man must be supplemented with extra insulation which can be obtained by the use of animal skins or other clothing material. Greater the insulatory layer the lower is the heat loss. Added insulation of 1 clo (an insulation roughly equivalent to a 0·6 cm still-air layer) will extend the critical temperature down to 20°C and 2 clo to 10°C, but below this progressive increase in metabolic heat is required to withstand exposures of several hours. Eskimo clothing of caribou fur 3.75-7.5 cm thick has a value of 7-12 clo. This goes far to meet all requirements at a temperature of -40°C as, while sleeping 10-12 clo and 4clo when activity is required. Eskimo dwellings are kept at 21°C during the day and 10°C during the night. Eskimos spend roughly 1-4 hours per day outdoors in winter, 5-9 hours in summer. Only the face and occasionally the hands are exposed to chilling.

Heat production is increased involuntarily by shivering and voluntarily by muscular activity. Shivering can provide about 3 times the resting heat production. It is induced by reflex stimulation of hypothalamic centre by cold receptors in response to fall in skin temperature. Large amounts of heat can be produced by voluntary exercise but is limited by physical fitness and availability of food. Eskimos have learned to run for long periods behind their sledges at a rate sufficient to keep them warm but not to exhaust them, and their fitness measured by standard tests is higher as compared to Canadian Whites (Shepherds).

When a body is exposed to extremely low temperature the skin surface of exposed area such as fingers of hand and feet freeze (frost bite).Thus there is intense vasoconstriction followed by vasodilatation. A cyclic continuation of these vasomotor changes prevents the tissue temperature dropping to frostbite level.

Acclimatisation to cold: On exposure to cold acclimatisation, that is, increased tolerance to cold develops gradually. Increased heat production and conservation reduces the extent of fall in the rectal temperature. On severe exposure to cold, physiological and metabolic process improve to maintain thermal equilibrium accounting for body comfort. For example, newcomers to Arctic regions will wear all their available clothing at the onset; but as air temperature falls further no protection is sought. Later they often wear less at work, or while asleep. It has been observed that members on expedition who spent the greater part of their time indoors suffered frostbite at low temperatures in 1 minutes, whereas an outdoor group resisted this for nearly 10 minutes. At the same time well-adapted individuals have a keen admiration of their lower limb and face and will take the necessary action to prevent frostbite (Irving). Evidences points to increased basal metabolic rate in concern to maintenance of thermal equilibrium. Eskimos show a larger increase (varying from +7 per cent to +30 per cent) than Europeans (+8 per cent) living in comparable cool conditions. However, it remains uncertain whether raised metabolism depends on cold exposure, altered endocrine function, or diet. The total food energy intake in the Arctic is high relative to that in the tropics but fluctuates widely, depending on indoor conditions as well as on work. Some believe that a higher protein intake account for the increased metabolic heat production. It seems, however, that fat is equally or perhaps more important than protein in exerting a protective effect against cold. Many Arctic explorers and others living in the north report that fat becomes positively desired. United States members of an Antarctic expedition who had an abhorrence of fat at home would eat fat in great quantity. Thus, the two processes common in the animal kingdom for enhancing adaptation to cold are also operative in man-(a) increase in heat production and (b) increase in fat insulation layers, though man depends, of course, on artificial insulation as well.

Experimental setup has provided evidences of ‘local’ acclimatization which are forthcoming. Subjects wearing heavy clothes but no gloves when exposed to be kept in a room at - 15°C, for 2 hours a day, 5 days a week for weeks showed reduced tactile discrimination, which gradually attained earlier level. On the other hand, outdoor groups scored higher. They have higher skin temperature particularly after severe exposure to cold indicating greater resting finger and hand blood flow, e.g., the ability of fishermen of Nova Scotia to tolerate immersion of their hand in ice-cold water has long been known.

Acclimatisation has been demonstrated in indigenous peoples also. Central Australian Aborigines do not wear clothing except for genital covering. The degree of cold exposure in sleeping microenvironment is below the thermo-neutral temperature (air temperatures about 0°C and radiant temperatures -45°C). Despite this cold stress they sleep naked comfortably without shivering, whereas the European controls studied under the same conditions shivered continuously and were unable to sleep. The Aborigines were able to endure greater fall of skin temperature than the Europeans.

The Bushmen of the Kalahari and the Australian Aborigines sleep in extremely cold conditions with single covering and a small fire as protection. A high degree of cold tolerance (reported also by Darwin of the Tierra del Fuegians) can to a large extent be acquired by Europeans. Norwegian students who lived in the open for 6 weeks with minimal protection were initially unable to sleep but subsequently were able to do so in spite of shivering.

Eskimos have greater tolerance to cold in the hands than white men. Evidence from the laboratory from a comparative study of finger temperatures following immersion in water at freezing-point among Eskimo, Indian, Negro and European shows greater tendency of Negroes to frostbite. In tests of sensory-motor function Eskimos and Indian young men in the North-West Territory of Canada were unquestionably superior to a similar group of European workers with only 6 weeks’ residence.

The capacity of acclimatised men, and especially the Eskimo, to use the hands well at low temperatures is linked with an increased blood-flow. When blood-flow was measured with forearms immersed in water at 24°C the following results can be concluded:

	Number	Observations	Blood flow (cm^3 per 100 cm^3 per min)	Skin temperature (°C)
Control subjects	5	122	4.7+0.19	32.8
Eskimo	6	148	8.6+0.43	33.8

Source: Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds,V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

Although the thyroid, like the adrenal gland, is involved in cold adjustments, no indication has been obtained by studies of any differences between American Indians, Eskimos and Europeans in Alaska.

2.4.3 High Altitude Adaptation

The effects of altitude: Approximately 10 million people live permanently at heights 3600m-4000m. Life at high altitudes imposes a complex ecological stress of low barometric pressure (which acts by lowering the oxygen and carbon-dioxide pressure in the inspired air), cold , low moisture content of the air and intense radiation. In addition, the rough terrain imposes higher muscular activity.

Lowered barometric pressure: Oxygen constitutes about 21 per cent of the atmosphere by volume; hence the pressure of oxygen is roughly one-fifth of the total barometric pressure. When the pressure is high as occurs at the sea-level (150mmHg) the oxygen diffuses across the lung membranes and proportion of hemoglobin saturated with oxygen is sufficient for all needs. While at altitude decreased barometric pressure reduces the rate of oxygen diffusion into lungs, proportionately decreasing the amount of oxygen available to the working tissues. At an altitude of 2400-3000 m and above oxygen demand during physical work is not met and beyond 4000m the rate of oxygen transfer is insufficient to satisfy efficiently even the needs of sedentary man. Immediate exposures of body to such conditions displays limited compensatory response and accompany breakdown. However, secondary response of physiological acclimatisation ensures physical work and permanent residence at high levels. The cultivated land in Tibet is at altitudes of 2700-4500 m, and permanent settlements in the Andes at 5200m, and daily visits to 5800m for mining and pastoralism with agriculture above 4000m substantiate it.

Responses: The immediate response to lack of oxygen (hypoxia) is an increase in the volume of air respired per minute. This is brought about by rapid and deeper respirations. The increased ventilation leads to the 'washing out' of carbon dioxide from the air passages and consequently from the blood. This loss of carbon dioxide alters the homeostatically controlled acid base balance of the body to a more alkaline level termed 'alkalosis'. This inhibit the stimulus for increased ventilation, which is counteracted by excretion of alkaline urine (bicarbonate ions) by kidney thereby shifts pH of blood to normal level.

The augmented heart rate and cardiac output attained in response to immediate exposure decline with acclimatisation. Heart rate reduces to normal sea level followed by reduced cardiac output.

Oxygen transport is aided by the pressure gradient between lung and blood at pulmonary level and between blood and tissue at organ level. At high pressure more oxygen and hemoglobin combine while hemoglobin dissociate from oxygen at low pressure. Exposure to hypoxia favors increase in red blood cell and consequently hemoglobin concentration, enhancing oxygen carrying capacity of blood. There is linear relation between hemoglobin (Hb) and barometric pressure. Upto 3500m it rises steeply. Augmented viscosity accompanying polycythemia contributes to increased pulmonary arterial pressure. This enhances effective blood gas interfacial area of alveoli and diffusing capacity of lung which permit effective arterial blood oxygenation. Long term morphological changes ensue- the enlarged thorax with the increased respiration and the vital capacity. Increased Hb concentration along with respiratory adjustments enables native residents to achieve arterial oxygen content above that of pressure at sea-level and increased ability of tissues to work at low oxygen tensions. Increased pulmonary arterial pressure is associated with right ventricular hypertrophy indicating increased workload characteristic of native population. Natives rely on moderate increase in pulmonary ventilation and polycythemic response while more on diffusion of oxygen from blood to tissue.

At 4500m acclimatisation takes place in approximately10 days. Clothing, shelter, and heating arrangements are generally effective in protecting against extreme cold climate of high altitude (Tibet, 5000m, -33°C and summer temperature rise only to 13°C), though some degree of physiological acclimatisation has been observed.

Populations at high altitude: Slight adaptive physiological changes have been found in population even at 2000m like Caucasus, Pyrenees, and even the High Veld of South Africa. A variety of racial groups inhabiting higher altitude includes the Tibetans living up to 4500 m, the inhabitants of Kashmir at 3000 m, those of the high uplands at 2500m, and the Andes at 5500m. They provide ample evidences of acclimatisation. For example the native inhabitants of Peru may have red-cell counts 30 per cent above the sea-level value.

Though the responses described here are secondary acquisitions, it is quite conceivable that some characteristics are fixed genetically due to selection pressure. The llama, the vicuna, and Bolivian goose, all native to high altitudes, have high values for red-cell count and increased affinity of the hemoglobin to oxygen and these characters are retained by first-generation llamas born at sea level. Monde argues that selection among the Spanish invaders of the Andes, eliminated the infertile individual and pure Spaniards established themselves after several generations. But convincing evidence of genotypes adaptive to altitude stress in man is yet to be established.

Pathological response

High altitude hypoxia elicit direct and indirect responses, some of them can cause mild to severe malformation, eventually becoming deleterious to organism. Monge disease or Mountain sickness is a complex pathophysiological condition that occur when normally acclimatised individual lose their ability to adapt to altitude as a consequence of anoxia and alkalosis. Symptoms include nausea, vomiting, headache, insomnia, acceleration of heart rate, deterioration of neuro-muscular co-ordination, diminished auditory perception, diminution of visual activity and fatigue.

2.5 SUMMARY

There exists a fascinating geographic variation among human. The intra and inter population differences in biological phenotypic traits are related to the effect of environmental stress and the adaptive responses that an organism makes during growth and development. Though, it occurs within the genetically determined limits in critical characters. Living organism being part of ecosystem modifies the environment and in turn, is also affected by such modification. The adjustment made in response to environmental stress such as cold, heat and hypoxia; can be temporary or permanent acquired either through short term or life time process. It aims at maintaining homeostasis, improving functional performance and survivability of organism in varying environmental circumstances.

Human are able to maintain a relatively constant internal body temperature independent of environmental temperature. Under heat stress, thermal equilibrium is maintained through integration of mechanism which enhances heat dissipation. The avenues of heat loss include conduction, convection, radiation and evaporation. Exposure to cold stimulates heat conservation accompanied by heat production through shivering and resultant increase in basal metabolic rate. Subcutaneous layer ensure insulation of body. Acclimatisation to altitude includes alteration in circulatory and respiratory system. There is increased number of red blood cell and hemoglobin accompanied by increased ventilation, diffusing capacity of lung and vascularity of tissue.

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Sample Questions

1) Define ‘Habitat’ and give the classification describing the flora and fauna of each of the habitat.
2) What do you understand by the term ‘Habitat’? Give geographical distribution of various habitats of the world.
3) What is ‘Thermal Environment’? Describe how thermal environment effects human body.
4) What are human being’s responses to severe cold climate, and how acclimatisation to extreme cold takes place?
5) Short Notes: (i) Ecological anthropology (ii) Habitat (iii) Types of economy (iv) Climatic adaptation (v) Thermal environment (vi) Bergmann’s rule (vii) Allen’s rule (viii) Hypoxia

UNIT 3 EPIDEMIOLOGICAL ANTHROPOLOGY

Contents

Learning Objectives

Once you have studied this unit, you should be able to:

- explain the relation between ecology and disease;
- describe the infectious diseases;
- indicate the ecology of malnutrition; and
- explain the effects of nutritional stress.

3.1 INTRODUCTION

Epidemiology is often defined as the study, distribution and determinants of disease and injuries in human population. Epidemiological anthropology elucidates etiological factors involved in a disease incidence; and emphasis on population variation in incidence and occurrence.

Human growth occurs along a genetically destined trajectory, but is influenced by environmental factors consequently affecting its longevity and health status. Consequently diseases exhibit the whole spectrum of causation, ranging from hereditary factors which play predominant role, to the environment. In many instances both factors have to be taken into account. We need to consider not only man's physical environment but also his social, cultural and psychological circumstances. For instance, environmental components of causation lie in lung cancer and degenerative arterial disease as in tuberculosis and small pox.

> Distribution of diseases as a special manifestation of human variation and ecology can be observed not only at individual level but also at population level which exhibit genotypically and phenotypically similar individuals and inhabit more or less uniform environments.

3.2 INFECTIOUS DISEASES

There exist a competitive interaction between man and environment. Man has been able to control his nearby environment or at least mitigate its worst effects by various adaptive mechanisms. On one hand, this struggle may be against un-alterable and passive opponent, e.g. physical and climatic factors (temperature or atmospheric pressure) and on the other hand, biological environment which is in itself capable of adaptive responses. Therefore, in the context of eradication of infectious diseases appropriate steps must be adopted to ensure adaptation of individual and mal-adaptation of disease causing agent to the environment.

The ecological aspects of disease can be revealed in two ways:

❖ Physical environment: It is a direct and immediate source of injury and ill health. There is consequently a clear geographical distribution of pathology manifested as a consequence of extreme climatic effect e.g. heat stroke (desert), mountain sickness (high altitude) and rodent ulcer (ultra-violet light). In recent years, air pollution due to smoke and associated substances has become an important environmental hazard in many countries.

❖ Biotic component of the environment harbours pathogenic organisms (viruses, bacteria, protozoa, fungi) dangerous animals as well as poisonous plants and insects. In addition nutritional disorders arise due to improper utilisation of food sources – animal and vegetable (and also mineral).

Besides, environmentally produced diseases, some illnesses make their overt appearance due to maladjustment of metabolic and regulatory functions during growth, but manifest completely in response to the external environment. Genetic defect may refer to an inability of the individual to support him, while psychological disorder is an inability to apprehend and respond to external events and demands.

Hunting-gathering practices, deforestation, swamp drainage and other activities have enabled man to dispose off his major competitors for space and food. This struggle for existence has even lead to extermination of many species. Indeed, a readjustment of ecological balance and an enlightened policy of conservation are urgently necessary if numerous species are to be saved from total extinction (this tragedy seems soon likely to overtake our hominoid relative the gorilla, an anthropoid probably even more intelligent than the chimpanzee and whose biology and ethology are far from well known).

Man contends with smaller creatures such as rodents, insects, fungi, and micro-organisms. Some of them are parasitic on his food and shelter while other to his body. The diseases emerged from man's contact with other living organisms and represent phases of ecological conflict which have not been yet entirely resolved in man's favour.

The geographical background is the prime single factor governing the abundance of specific type of parasites and pathogens in a region. Micro-organisms may be water-borne, air –borne, or carried by insects and other animals. The host-parasitic relation often takes a complex course depending on the number of stages and factors involved in a life cycle of parasite– vector, intermediate host and one or more reservoirs. Analysis of the locality eventually reveals that ecological relationships are strongly influenced by physical features such as wind, rainwater, drainage, temperature and humidity. The pathogen itself may have limited environmental tolerance. The vector usually requires specific conditions for breeding, e.g. ticks or fleas may need a dry climate. The carrier may have a restricted habitat, e.g., tree-living squirrels in the Malayan rain forest. The female Anopheles utilise water bodies for breeding. Site specific rainfall, soil type and its water-retaining properties determine persistence of water pools. The tsetse fly, vector of African sleeping sickness, requires a relatively dense vegetational cover.

The geographical distribution of many diseases is similar to that of their intermediate hosts and vectors. Schistosomiasis is common among reverie populations of warm climates as the bladder-worm needs a particular snail during one of its developmental stage. Rickettsial diseases, e.g. Rocky Mountain spotted fever, are linked with ticks found chiefly in North America, Bengal, and North Africa. The Asiatic form, scrub typhus, carried by mites, occurs in Japan, Formosa, and Oceania; the typhus group of Europe and central Asia is linked with fleas and lice. Brucellosis is transmitted through contaminated and untreated milk and milk products, and by direct contact with infected animals and hence is geographically related to cattle herds as the main reservoir.

The ecological relations are complex. A relatively few out of the thousands kinds of human parasites characterise any given locality. Thus, the ecological relations of most micro-organism disease will be unraveled only by specific regional analysis. For instance, Yaws, a microbial disease has strong relationship to climate. 80 per cent of the yaws affected areas have the 80^0 F mean annual isotherms. This disease is endemic where the annual rainfall ranges from 50 to 70 inches. The disease occurs therefore mostly between the north and south 40^{th} parallels.

Somaliland, a semi-desert country consists of thorn scrub country and has dry climate. Hence, cataract and eye infections are causally associated with the flying sand, sun-glare as well as the flies which breed freely due to the dry climate. The climate also favours the existence of soft ticks which causes relapsing fever. There is moderate incidence of Madura foot caused by inoculation of the fungal spores into the skin by the thorns. The intense dryness and frequent sand storms encourage sore throats, which the Somalis have been led to treat by snipping off the uvula. Thus sand, dryness, and glare are the prime physical factors that can be identified in this ecological complex. Another example may be drawn from the Arctic. Here, despite the enormous number and variety of mosquitoes and other arthropods, none are known to transmit infectious disease. But throughout the North American Arctic, dogs, which still provide the chief means of winter transport, serve as a reservoir in transmission of numerous infections among humans including salmonellae, meat and fish tape-worm, and rabies. The seasonal incidence of these diseases is due to unsanitary disposal of waste in the vicinity of dwellings which render pathogens innocuous in the frozen state but are released with the spring thaw.

The characteristic housing structure and settlements pattern of man may introduce favorable factors to the spread of particular diseases. Human settlement may require deforestation which may provide conditions favourable for the propagation of infectious diseases. Deforestation of the hills of Ceylon led to frequent pool formation during dry spell and successively to mosquito-breeding. In Malaya certain rats capable of carrying tick disease are very rare in the natural forest but after deforestation they occur in great numbers.

3.3 BIOLOGICAL RESPONSES

There are two fold responses to infectious diseases: immediate which depend on the adaptive flexibility of the individual and long-term responses which become evident after a long period but is action-specific.

Immediate responses are the physiological processes which counteract the effects of the invading organisms evident by symptoms and signs of the disease such as inflammation, pain, fever, etc. Prolonged exposure to infection may result into immunological responses. The proteins or polysaccharides of the invading organisms act as antigens and stimulate the production of antibodies. Once such antibodies are formed they may persist in the body or may rapidly be reformed during second infection.

If a disease is wide spread or severe in nature then it may act as an efficient selective agent. Individuals who are able to combat the disease will survive while others are eliminated. Such a resistance may be due to increased physiological adaptability, enhanced immune response or both. Prior exposure to such diseases ameliorates its severity in successive generations. Otherwise, the population would experience high morbidity and mortality rate. Many of the infectious diseases occur during the pre-reproductive and reproductive phases of life, thereby increasing their selective significance.

3.4 NON-INFECTIOUS DISEASES

In non-infectious disease, the whole complex of environmental factors and biological responses (inborn and acquired) must be considered to account for regional variation. The fact that Negroes are more susceptible to frostbite than Eskimos or North American Indians may be attributed to both lack of acclimatisation and genetic susceptibility. Many diseases have been accorded a ‘racial pathology’ but the distribution was entirely related to environmental peculiarities. Primary cancer of the liver, common among Africans seems to be a sequel of the widely prevalent liver cirrhosis. It is caused by consumption of diet chronically low in animal protein and rich in carbohydrate since infancy. Striking ‘racial’ differences in the incidence of coronary disease is associated with diets high in fat.

Many diseases and malformations are known to have genetic basis; the afflicted individual is usually homozygous for the recessive gene, though dominant genes are also involved in some conditions. Genetic diseases are very rare. However, certain populations have high frequency of such diseases. Thalassemia and sickle-cell anemia are haemoglobin variants caused by mutation in hemoglobin gene. Haemolytic disease of the new-born due to rhesus incompatibility is characteristic of European but not of most Mongoloid or Amerindian populations, since they are devoid of Rh-negative individuals. There is an increased risk of duodenal ulcers in individuals of blood group O and individuals with blood group A are more prone to stomach cancer than others.

3.5 ECOLOGY OF MALNUTRITION

The nutritional status of individuals and population span a broad range from extremes of deficiency to excess. Malnutrition refers to cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance and specific function. It is more prevalent among developing nations, primarily those undergoing the urbanisation. Severe malnutrition is frequent during war. Protein-caloric malnutrition is most common form of undernutrition. It includes Kwashiorkor and Marasmus.

Kwashiorkor, a Ghanaian word means 'second-child disease." Kwashiorkor is usually associated with the period immediately following weaning, which often takes place after the birth of second child. In many parts of the world, especially in the tropics, the child is resorted from mother's milk to a diet adequate in carbohydrates and has insufficient protein. The food usually comprises a starchy gruel made from yams, taro, corn, rice or millet. Animal protein is scarce and if available, is expensive. Thus the child may receive enough food to satisfy hunger, but does not receive the proteins vital for normal health, growth and development.

Characteristic symptoms of Kwashiorkor include edema or fluid retention in the feet, lower legs and seldom in other parts of the body. Growth and psychomotor development is retarded. Severe wasting of muscle and adipose tissue can be depicted from the thinness of upper arms. The child is unable to balance its head when pulled from a lying to sitting position. Extra vascular fluid retention distend the abdomen (potbelly).The child is apathetic, miserable, withdrawn and indifferent to its environment.

Marasmus is derived from Greek word which means withering or wasting. It results from a diet low in both protein and calories. It is more frequent among children younger than 5 years, but usually soon after weaning. Symptoms of Marasmus include extreme growth retardation, wasting of muscles and subcutaneous fat, diarrhea, and severe anemia. Since vital nutrients are absent during the period critical for brain growth, mental retardation often occurs. It results into death.

Kwashiorkor and Marasmus represent extreme examples of malnutrition and growth retardation. Lack of specific nutrients in the diet may lead to less severe form of malnutrition and other health risks.

Excessive amounts of nutrients are also hazardous to health. For example, excessive amounts of vitamin D lead to hypercalcemia, characterised by high levels of calcium in the blood. It results into sluggish nerve reflexes, weak muscles and unnatural calcification of soft tissue.

Obesity refers to excess fat accumulation which may unfavorably affect health of an individual leading to reduced life expectancy and increased health problems. An adult with BMI $\geq$ 30kg/m² is said to be obese while a child is considered obese when his or her body weight is 20 per cent greater than that for his sex and age-specific weight-for-height standard. Obese children mature earlier.

3.6 DISTRIBUTION OF DEFICIENCY DISEASES

American Geographical Society has provided an eminent image of the distribution of the nutritional deficiency diseases in different parts of the world. Protein deficiency is predominantly found in the South American, African, Indian and South-East Asian populations. Mineral deficiencies predominate in Northern American continent, upper part of South-East Asian countries and some African populations. The incidence of multi-vitamin deficiencies is rampant in Africa, Middle-East and some islands of Pacific Ocean.

3.7 EFFECTS OF NUTRITIONAL STRESS

❖ **Infant Mortality and Childhood Death**

Infant mortality rate in India is very high, computed as 80/1000 live births. Prolonged nutritional stress, specifically during infancy and preschool age is a major, although indirect factor leading to infant and early childhood mortality. For instance, diarrhea usually occurs during weaning period due to combined effect of infection and low food intake.

Decreased Resistance to Infection: The resistance to infections in human is adversely affected by malnutrition.

❖ The skin and mucosa do not provide effective physical barriers against infection.

❖ Cell mediated immunity responses against bacterial infection get reduced in severely malnourished individuals. The thymus gland and thymus dependent lymphoid tissues are atrophied.

❖ Humoral antibodies: Circulating immunoglobulin levels are usually normal or elevated in malnourished subjects due to frequent infection. As the secretary IgA is generally reduced, recovery from infections is delayed.

❖ **Under nutrition and Learning Abilities**

The period of active growth of human brain extends from 30th week of gestation to the end of the second year of life. Undernutrition during this period, appears to adversely affect the development of brain. In recent years, intensive investigations have focused on the relationship of nutritional deprivation in early life and subsequent development of brain and cognitive abilities. Evidences have been derived either from the association of malnutrition in early infancy with poor mental performance later in childhood or with the retarded brain growth or size as observed in autopsy specimens. In a study, 45 malnourished infants and age matched controls from similar socio-cultural background were investigated after a period of 4-6 years. The previously malnourished group showed poor inter-sensory organisation for recognition of geometric forms. However, the differences observed by Wechsler primary and preschool Scale of Intelligence in the I.Q. were minimal.

A recent study from Brazil on nineteen marasmic children aged less than six months, successfully treated for malnutrition, did not show significant lag in their IQ compared with their siblings and peers. Thus, malnutrition does not affect intelligence or is cause of mental retardation.

3.8 NUTRITIONAL STRESS IN MODERN SOCIETY

Prior to middle age, rice was used in South East Asia and some parts of Indian subcontinent, maize in central America, potatoes in South America, wheat in South West Asia and millets in Africa and parts of China. However, during middle age, long voyages undertaken by several groups of people led to the world wide dispersion of new domestic crops and animals. Rice cultivation was brought to Africa. The potatoes were also spread to many parts of the world. Horses, donkeys, cattle, sheep etc. were introduced into America that provided essential nutrients to many native populations.

Disruption of traditional diets and introduction of new food stuffs caused nutritional stress in many societies. The estimate of such a stress in earlier times is not known completely but by the beginning of 20^{th} century epidemics of goiter, pellagra and beriberi were evident. In urban areas, movement of people into the cash economies decreased the supply of proteins, making it costlier. Poorer sections of society in urban areas thus became victims of Kwashiorkor.

Though nutritional stresses are declining in the contemporary society, infectious diseases are being replaced by non-infectious diseases. An increased genetic heterosis is also indicated. Children in modern society are growing faster and taller. They are maturing sexually at an earlier age. However, in many third world countries the nutritional deficiency diseases are still found in a large scale.

3.9 SUMMARY

Epidemiological Anthropology confers to the determination, manifestation and distribution of certain diseases and disorders in human communities spread all over the globe. The spectrum of disease causing factors ranges from genetic to environment. Socio-cultural background also exhibit influential role as human settlement pattern enhance the spread of diseases. The biotic and abiotic components of the environment contribute to ecological aspects of diseases. The epidemiological aspects consider two kinds of diseases namely, infectious and non-infectious. Malnutrition is another contributory factor for the affliction of certain diseases. Nutritional stress is frequently observed during infancy and early childhood consequently causing infant and childhood mortality. Nowadays, nutritional stress is incident in different developing countries and effect different communities to a varying degree. African continent has maximum incidence of nutritional disorders.

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www.wikipedia.org

Sample Questions

1) Explain the concept of Epidemiological Anthropology.
2) Discuss the different factors responsible for infectious diseases.
3) Explain the relationship between environmental factors and non-infectious diseases.
4) Evaluate the role of malnutrition in relation to ecological conditions.

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