CHAPTER IV

ECOLOGY OF THE DISEASES

Organic survival in relation to environment is the concern of ecology, which is the science of the habitat. 'Ecology comes from the Greek word 'home', and medical ecology is the study of the 'home' of diseases, both within the individual organism and in the larger environment. Hence the ecology of human diseases deals with the relationship between diseases and their geographical environment in which they occur. Thus from the ecological point of view, disease is very simply that alteration of living tissues which jeopardizes their survival in their environment'.

In this definition, the term 'disease' becomes synonymous with 'Maladjustment'. It expresses a temporary State of the living cell in conflict with environmental challenges and trying to cope with them and survive. Such definition has the advantage of bypassing the problem of deciding what is 'normal'. It stresses the 'relative' character of the phenomenon by linking it with the place of occurrence.

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Disease, as defined by Webster and the English Dictionary, means, 'a discomfort, a condition in which bodily health is seriously attacked, deranged or impaired, a departure from a state of health, an alteration of the human body interrupting the performances of vital function and 'any departure from, or failure in possession of, normal physiological action in the material, constitution, or functional integrity of the living organism', respectively. The World Health Organization defines health as 'a state of complete physical, mental, and social well being and not merely the absence of disease and infirmity'. For the purpose of medical geography these definitions are inadequate in as much as none of them gives a criterion by which to decide where the disease state begins and where it ends. All of these definitions imply, but do not explicitly state, the much needed criterion against which disease can be measured, namely the ability of the diseased tissue or individual to survive in a given environment.

Diseases both transmissible and nontransmissible, appear as a 'complex': a two factor complex when only agent and host are involved, a three factor complex when host, agent and vector are needed, a four factor complex when in addition to the primary host, an intermediate host or a
reservoir is involved, and so on.

Diseases cannot arise without the convergence of two sets of factors at a certain point in time and space, firstly, factors that take the form of an environmental stimulus (a virus in the throat, poison in food, or an emotional stress), and secondly, factors that condition the response of the tissues. These stimuli and challenges to adjustment, are not the same in every environment. They vary with the geographical and cultural location. The response is conditioned by the genetic make-up of the recipient.

Environmental factors that may place human tissues in jeopardy can be studied under three headings: inorganic, organic, and socio-cultural.

The inorganic or soil and climatic factors have an influence on man's health and the growth of a disease, directly or indirectly. For example, human beings need chemicals directly from the environment, i.e. vitamins, proteins, minerals, etc. They come from the plants and animals that grow under particular climatic and soil conditions. The plants and animals differ from region to region depending on these factors. Accordingly the chemical, vitamin, protein, etc. available to man in different areas also vary. This is because, only under certain climatic conditions certain
plants and animals grow. As for example in Assam, we find vegetables like cucumber, gourd, pumkin, brinjal, etc. more, and the vitamin intake becomes poor, as compared to the northern States of India, where climatic conditions favour the growth of apple trees, grapes, carrots, peas, beans and many other fruits and vegetables of high nutritive value. Thus the intake of vitamins also vary in quantity from place to place. The inorganic factors challenge in various ways the living cells' ability to cope with and survive in an environment that contains them.

Inorganic factors affect human diseases indirectly in many ways. For example, living agents of a disease such as the malarial parasite, develop through various stages in the same way as the caterpillar becomes a butterfly, or the maggot a fly. The disease agent sometimes spends each stage of its development within the body of different hosts such as an insect, a fish, a bird, and a mammal. Thus, before an agent is ready to attack man, it must have gone through a succession of varying climatic conditions, each favourable to its host at a specific time. Any alteration or interruption of this succession may kill the host, the larval form of the agent, and thus the human disease pattern changes.
Many other inorganic, nonclimatic stimuli are also there in the environment, and in every minute our survivability is challenged. Degenerative diseases are the result of nonliving stimuli that produce detrimental alterations in human tissues (e.g. cancer). The air we breathe is permeated through fumes, dust, or sand that cause poisoning or transformation of lung tissue into fibrous tissue.

Organic factors are closely linked with the inorganic ones. We are to consider the functional chain between the various ecological 'niches' where plant, animal and human societies live and grow. In each case this probably will take us from the microclimates, where disease agents lurk, to the macroclimates, where whole of the population fights for survival. When all three, plants, animals and human societies are established in a balance, they are said to be in mutual harmony. An upsetting factor, such as a change in temperature or humidity can favour a form which is barely existing, and changes or transforms the dominance among competitors, establishing a new social pattern. This concept usually does not enter a physician's mind when discussing a human disease. However, this social pattern occurs everywhere in nature. It affects the internal environment.
of every living thing where their parasitic load is concerned. It plays a direct role in the epidemiology of transmissible diseases and an indirect one in the epidemiology of other maladjustments.

Disease agents are living beings that survive among other living beings in organized societies. Certain diseases can be present in one part of the world and not in another.

Cultural and social patterns also provide a wide range of stimuli that play a role in causing human diseases. Man, in building his township, has polluted the air he breathes to the point where his lungs respond with cancerous growths to the molecules that fill it. His life is regulated by laws, restrictions, frustrations which in turn, create tension and stress, facilitating heart diseases and neurosis. Thus social and cultural traits by themselves provide a number of disease stimuli.

Climate, food, air, disease agents and their vectors, intermediate hosts, reservoirs and cultural situations can be conceived as stimuli that combine to challenge man's ability to survive. Diseases are divided into and studied in communicable, degenerative or behavioral groups. These different types can combine and succeed each other. Diseases considered to be degenerative today, may be proved as commu-
Responses towards environmental challenges differ from person to person. One may be susceptible to a particular disease, in a particular environment, whereas another may be immune to the disease in the same environment due to the variation of genetic materials carried by the cells of an individual as inherited from his or her parents. Genes direct and govern all developments and reactions of the tissues of which they are a part. Developments and reactions are not fixed. Genetic material allows the tissues of a living organism to respond to outside challenges with a certain degree of variance.

Distributed throughout our tissues, this genetic material has two aspects - one fixed and the other plastic. The fixed characters are called the genotype and the plastic ones the phenotype. This is better understood when a comparison is made with a pellet of clay. Any given pellet of clay has a definite weight, density, volume and chemical composition. When environmental pressure is used while making a dagger or a horse or anything else for that matter, from the said pellet, the appearance only changes due to pressure, though basically it retains its original chemical composition, density, weight, etc. Thus the physical and
chemical characters of the pellet can be included in genotype while the various shapes that it assumes under external pressure as phenotype. Therefore we can understand, that there are infinite number of phenotype within a finite set of basic characteristics or genotypes.

The survival of an individual is, therefore, governed by a number of endogenous and exogenous factors. The exogenous factors represent the intensity of pressure and stimuli from the environment. Endogenous factors represent plasticity within an individual, which also involves the genotype, since plasticity is governed by the genotype which in turn conditions the response of the body towards environmental stimuli.

Though the genetic structure of an individual is stable, the tissues and functions of the individual are endowed, as stated earlier, with a certain plasticity that allows them to adapt to the environment. Plasticity can also be thought of as the ability to cope with stress. It represents the range within which stress does not produce lethal consequences. Thus, observable changes do occur in an individual, yet, they are always directed by a genetically controlled group of forces. The essence of adaptability is the way the individual utilizes the environment and controls
what he can. Hence, survival of the individual depends on the plasticity, which itself is controlled by the genotype.

Mutations are sudden phenomena in the genetic material of an organism, and therefore visible only in the offspring. Most mutant genes are believed to be harmful, because once the tissues are involved in a wound, they begin to undergo considerable changes such as mechanical damage and biological damage due to infection, and chemical damage fostered by innumerable foreign bodies. In course of time, the wound heals and all mechanical, biological and chemical damages are overcome, but the tissues will never be the same. Although the scar will not be transmitted to the offspring, the tendencies that have been influential in governing its formation will be transmitted and, combining with the tendencies of the sexual mate, will form the genotype of the new individual. But there are instances where a mutant gene could be beneficial. The example is sickle cell anaemia, the heterozygotes of which were found to be resistant to falciparum malaria.

Blood groups are determined by genes. During the past 10 years, researchers have been trying to find out the association of certain diseases with particular blood groups. However, only two diseases have so far shown
relation with the ABO blood groups. Duodenal ulcer and
gastric ulcer are common in 0 blood group and stomach
cancer in A blood group individuals.

Every decade, each country and each community produce its own pattern of diseases. This is well understood, when we compare the causes of death in the developed countries during the past 60 years. It is noticed that communicable diseases have declined in importance and have been replaced by non-communicable and chronic ones. In the United States of America, out of ten diseases, four were of infectious origin during 1900, whereas in 1967, only one was primarily a communicable disease. The other side of the story is that the mortality rate for cancer and cardiovascular diseases has sharply risen.

The common maladies prevalent in India during the past, were malaria and other fevers, respiratory diseases, gastrointestinal diseases (diarrhoea, dysentery, cholera, amoebiosis, enteric fever, infectious hepatitis), helminthiasis, small-pox, plague, leprosy, filariasis, tuberculosis, kala-azar, trachoma, and goitre.

There has been a definite change now in the disease pattern. There has been an increasing trend in viral

infections like poliomyelitis, encephalitis, diphtheria, enteric fever, rheumatic fever, peptic ulcer, cancer, leukaemia, hypertension, heart disease and allergic disorders. In Assam, the incidence of some of the diseases has increased. Malaria is back again in the State, and the second round of battle is on. Malaria cases were reduced in India to one lakh during 1965 from 7.50 crores in 1952. The incidence of malaria has risen to 64.67 lakhs in 1976.

Incidence of some of the infectious diseases, on the other hand, is falling. This is seen that out of the total patients admitted in Assam Medical College during the year 1967-71, 7.17 percent were suffering from peptic ulcer, followed by 4.22 percent suffering from tuberculosis and 4.08 percent affected by malignancy. The ratio of peptic ulcer is 49:1 when compared to gastric ulcer. The incidence of cancer in the throat region is the highest, especially those of laryngopharnyx, tonsil, base of tongue and oesophagus. Thus hospital records and statistics show the changing pattern of disease from dysentery and diarrhoea to

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heart diseases and cancer. This explains the urgency of studying the above mentioned diseases in particular.

Before going into the details of each disease, it must be pointed out, that despite our technological achievement, our susceptibility to diseases is a reminder, that we, humans, are only an element in the earth's larger ecological system.

Ecology of Malaria

History

Before the Second World War the League of Nations estimated that 650 million or about a third of the total population of the world had suffered from malaria every year. The term malaria is derived from two Italian words - Malo (bad) and aria (air). This term was applied as the old belief was that the disease was due to the inhalation of poisonous emanations from marshy grounds. The name malaria was given to the disease by an Italian writer in 1953, though long before this a satisfactory method of treatment of it was found out. In 1638 Countess Chinchon.

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wire of a Spanish Viceroy of Peru, suffering from intermittent fever, was believed to have been cured with the bark of an indigenous tree of Peru, which was later named 'Cinchona' in honour of the Countess. In 1820 quinine was isolated from the Cinchona bark. In 1847 Meckel discovered the presence of some characteristic pigment in the spleen of persons who had died of malaria. In 1880 Laveran discovered malaria parasites in the human blood. In 1894, Mason suggested that mosquitoes might be the vector of malaria, but he thought that it was transmitted to people through drinking water, which contained infected mosquitoes. In 1897-98 Ross proved that the disease was transmitted by a certain definite species of mosquito (now known as Anopheles) and conveyed to human host by the bite of the infested mosquitoes.

**Definition**

Malaria is a communicable disease caused by sporozoan parasites of the genus Plasmodium whose definitive host is the female Anopheline mosquito through which man is infected. The disease is characterised clinically by periodic chills of fever, enlargement of spleen and secondary anaemia with a tendency to relapses.

**Agent**

Causative agents, as explained in the first chapter, are those whose presence actually causes the
disease. In this case it is a protozoal parasite, a unicellular organism of the class sporozoa.

**Vector**

These causative agents are introduced into the human system only indirectly, i.e., through the action of a vector. Most vectors are arthropods. They may transmit the agent mechanically, as in the case of flies, or through their bite, as in the case of the mosquitoes.

The life and activity of these vectors are inescapably bound up with the factors of geographical environment. Different species of anopheline mosquitoes require different breeding habitats. *An. fluviatilis*, for example, prefers to breed in moving water. This habit restricts the species to hills and foot-hills in contrast to *An. culicifacies* which breeds in the stagnant water in the plains. The third species, *An. minimus*, is usually found in especially clear, slowly polluted moving water with grassy edges, or sheltered places in swifter streams. It is this type that act as the chief vector in Assam. During rains when stream water is swift and silty, breeding places are in clear and still pools of water, ponds, dead river stretches and sometimes ricefields. They normally do not breed in jungles with complete shade, though partial shade with patches of sun shine
is not discouraging for the purpose.

Malarial mosquitoes have various habits of life and flight, and their peculiarities influence the overall complex pattern of disease occurrence. In Assam they are recorded as 'domestic', for they inhabit dark rooms near earth floors, under bamboo beds and tables and feed on, apart from men, cows, poultry and other domestic animals after midnight. Their flight range is rarely over $\frac{1}{2}$ mile from their breeding place. However, since all species can adapt themselves to a new type of surrounding, there are infinite possibilities for the change in disease pattern. Though flying range depends on individual characteristics, wind direction and velocity, humidity and temperature have important influences on the behaviour of the mosquito and, therefore, have a direct bearing on the epidemiology of malaria.

**Factors Influencing Host Susceptibility**

The malaria parasite undergoes two cycles of development - the human cycle (asexual cycle) and the mosquito cycle (sexual cycle). Man is the intermediate host and

The Asexual Cycle begins when an infected mosquito bites a person and injects the sporozoites.

The Sexual Cycle is initiated when an Anopheline Mosquito capable of transmitting malaria feeds on a malaria patient.
mosquito the definitive host. The host is susceptible due to various factors irrespective of ages. Males are more frequently exposed to malaria because of the outdoor life they lead. Females in India, are usually well covered than males.

Ill-ventilated and ill-lighted houses provide ideal resting places for mosquitoes. Malaria is also acquired in most instances by the mosquito-bites within the house. As such the incidence of malaria is low in the families and areas which have better economic condition and consequently better residential houses.

Mention may be made here of the houses in Assam as written by B.C. Allen seven three quarters of a century ago. The conditions under which the people pass their days are far from conducive to a long duration of life. Their houses are small, dark and ill-ventilated and the rooms in summer must be exceedingly close and oppressive. They are built upon low mud plinths and are in consequence extremely damp. The houses are buried in groves of fruit trees and bamboos, which afford indeed a pleasant shade, but act as an affective barrier to the circulation of the air, and increase the

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humidity of the already overhumid atmosphere. The water supply is generally bad, and is drawn either from shallow holes, from rivers, or from tanks in which the villagers wash their clothes and person. All of these are undoubtedly factors which contribute to produce a high mortality, and nearly every one of them could be eliminated'. It is disheartening to note even after seventy-five years the housing condition in the State has substantially remained same.

Apart from the malaria prone habitats of Assam the disease can be brought by the migrants also. Many people, especially labourers connected with various engineering, irrigation, constructional and agricultural projects who come into Assam or those who come to settle permanently may carry malaria parasites in their blood and reintroduce it into areas where the parasite has been eradicated or controlled. Movement of population is an important factor in the epidemiology of malaria.

Habit is another factor for propagating malaria. For example, some people sleep in hammocks outside the house, or do not use mosquito nets. This is a difficulty encountered by the antimalarial teams, for the transmitting mosquitoes can feed without entering the houses and so escape the insecticide sprayed inside the houses.
Environmental Factors

Malaria is a seasonal disease. The maximum prevalence is normally from July to November. The optimum temperature needed for the development of the malaria parasite in the insect vector is between 20°C to 30°C. The parasite ceases to undergo development in the mosquito if the mean temperature is below 16°C. On the other hand any temperature above 30°C is also harmful to the parasite.

Humidity has a direct effect on the life span of the mosquito, although it has no effect on the parasite. Relative humidity of 60 percent is considered necessary for mosquitoes to achieve a normal life span, when relative humidity is high, they are more active and feed more voraciously. When humidity is low, they do not thrive long.

Rain in general provides opportunities for the breeding of mosquitoes, and it raises the atmospheric humidity too. However, heavy rain may have an adverse effect, in as much as it flushes out the breeding places.

Malaria is rare above an altitude of 2000 metres above sea level, due to low temperature and constant wind.

Apart from natural environmental factors, man-made environmental conditions also influence malaria. Burrow pits, garden pools, open drains, etc., which are made by
man turn out to be suitable places for the breeding by mosquitoes.

Geographical Distribution

Malaria, a seasonal disease, exists in places where there is high rainfall during the summer months accompanied with high temperature. Places with temperature below 16°C are not malarious, as the parasite does not grow in such areas. Regions with a high relative humidity of 60 percent are congenial for the mosquito.

At the end of 1975, of the 2015 million people estimated to be living in the originally malarious areas of the world, some 824 million (41 percent) were in the maintenance-phase areas where malaria eradication is claimed to have been achieved, 343 million (17 percent) were in areas which were not yet protected by specific antimalaria measures, and 848 million (42 percent) were residing in areas where malaria eradication or control measures were being carried out. Of the latter 437 million (51.5 percent) were in areas of case detection and treatment, 398 million (47 percent) were benefiting from extensive mosquito control

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8 All figures & percentages relating to world population of original malarious areas have been taken from 'WHO Chronicle', No. 12, Vol.30, Dec., 1976, pp. 486-493, World Health Organization, Geneva.
measures, and 13 million (1.5 percent) were living in areas where mass drug administration was carried out. Fewer people benefited from protection by extensive mosquito control measures in 1975 than in the previous year. Comparative data demonstrate that in spite of mounting difficulties, the global antimalaria programme is providing protection for an increasing number of people.

The drums have been beating loud and clear in villages and tiny hamlets across the Indian countryside informing—where and how to get anti-malaria drugs, and how to prevent the crafty Anopheles mosquito from breeding. Yet the malady could not be permanently got rid of. From about one lakh cases reported in 1965, the number soared to over 51 lakhs in 1975, as shown in the table 4.1.

From the present study it has been found, that in the Brahmaputra Valley the most malarious district is Goalpara. It is followed, according to descending order of incidence, by Lakhimpur, Darrang, Nowgong, Kamrup, Sibsagar and Dibrugarh. The trend of malaria incidence during the past and present in the Brahmaputra Valley has been shown by two graphs in Fig. 4.1.

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9 J.R. Park, Social & Preventive Medicine, 1976, Jabalpur, India.
REPORTED DEATHS FROM MALARIA IN THE BRAHMAPUTRA VALLEY (1951-60)

TREND OF MALARIA IN THE BRAHMAPUTRA VALLEY (1967-76)

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YEARS

INCIDENCE

DEATHS

1967 68 69 70 71 72 73 74 75 76

0 20 40 60 80 100 120 140 160 200

YEARS

INCIDENCE IN THOUSANDS

DEATHS IN THOUSANDS

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FIG 4.1
Table 4.1

Reported Cases of Malaria from 1961-1976

<table>
<thead>
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<th>Year</th>
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<td>1975</td>
<td>5166000*</td>
</tr>
<tr>
<td>1976</td>
<td>6467000*</td>
</tr>
</tbody>
</table>

* Figures taken from *India Today*, 1977, New Delhi, Published by Raj K. Wadhwa for Living Media India Private Ltd., New Delhi.
Correlation with the various environmental elements and malaria incidence will be discussed in the following chapter.

Ecology of Tuberculosis

The geographical pattern of tuberculosis is rendered complicated by the large number of strains and variants of the agent and the large number of hosts to which it is adapted. There is no clear-cut geographical pattern of the distribution of different strains of Mycobacterium tuberculosis, nor is there a definite relationship between a particular strain of the agent and a species of the host. It has also been noticed that there is no specific localization within a living being in respect of the occurrence of tuberculosis. It is, however, a dreaded disease and used to take a heavy toll of human and animal lives until B.C. and other medicines and treatments were discovered and applied.

The reasons why a certain host develop skin tuberculosis rather than that of the lungs, are by no means clear. Therefore, the portal of entry of the agent into the host is only a partial, and not a complete explanation to such a problem.

Tuberculosis evokes different responses in different tissues, creating symptoms so different from one another.
that it has taken physicians a long time to identify them and ascribe the same cause to them.

History

The earliest history of human tuberculosis is lacking in data and is principally based upon a limited number of cases of bone tuberculosis. The parts of a skeleton of a young man who died about 5,000 years B.C. near Heidelberg is regarded by one of the earliest evidence of tuberculosis. Greek, Roman and Arab doctors knew of lung tuberculosis in the ancient and mediaeval periods. They considered it as hereditary (habitus phthisicus), and this belief persisted among the physicians till very recent times.

Ancient writings on Indian medicine indicate that tuberculosis existed in India more than 2,000 years ago. In the statute book of Manu of 600 B.C., the noble Indians of the three highest castes were forbidden to marry from the families which suffered from tuberculosis, Neander calls this the world's first legislation for race purity.

In 1882 Robert Koch discovered the tubercle bacillus which ranks as one of the most important discoveries in

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bacteriology and in the history of medicine. In 1895, Rontgen discovered X-rays which later proved invaluable for the diagnosis of tuberculosis. In 1907, von Pirquet discovered the tuberculin test. Soon after the First World War, the B.C.G. vaccine evolved by the French scientists, Calmette and Guerin was tested in 1921. The success of B.C.G. vaccine led to larger trials. In India B.C.G. vaccine was introduced in 1949.

**Definition**

Tuberculosis is a specific communicable disease caused by *Mycobacterium tuberculosis*, an organism that was discovered by Koch in 1882. It affects both the pulmonary and non-pulmonary tissues of a living being. The disease may be acute or chronic, general or local. It is an ubiquitous disease found almost everywhere on the earth.

**Agent**

The agent of tuberculosis is a *Mycobacterium* of the family *Mycobacteriaceae*, of the order Actinomycetales. The numbers of the genus *Mycobacterium* have, of course, many properties in common, one of which is of particular importance to the bacteriologist: it is their ability to retain stains even if submitted to strong acids or alcohol.

The agent of tuberculosis is of three types: human, bovine, and avian.
The bovine and human types are able to infect human and animal hosts reciprocally. The avian type has very rarely been proved to adapt itself to the human being, although it does infect other mammalian hosts. These various types can be distinguished by the minor morphological differences visible under the microscope. The type that attacks human is more frequently found in lung, while the type that attacks bovine population is more commonly found in intestine, lymph node, and bone. This differentiation does not seem to be caused by any attraction of the various types to particular organs but rather by the portal of entry and the route followed by the agent once in the host.

Importance to man are the human and bovine strains of the bacillus. The human strain is responsible for the vast majority of cases of tuberculosis in India. The tubercle bacilli are fairly resistant to the action of chemicals and heat, as compared to most other bacteria. It takes about 24 hours for a 5 percent phenol and 6 hours of direct sunlight to kill them. But they are easily killed by the heat at 60°C in half an hour.11 In sheltered places, the

11 J.E. Park, Social & Preventive Medicine, Jabalpur, India, 1976.
bacilli may remain viable for several months. The lipoid covering with which they are encased helps them to survive open environment for long periods, under suitable conditions.

Bacillary cases of infection from human source is by far the most important. It is estimated that the number of tubercle bacilli that may be expectorated by a simple case of advanced pulmonery tuberculosis in 24 hours may be 200 crores or more. Persons with extra-pulmonary tuberculosis do not appear to be important sources of infection. The human type is commonly disseminated through the droplets of sputum and enters our body chiefly by inhalation.

There is no definite evidence that bovine tuberculosis is a problem in this country because of the practice of boiling milk before consumption. The reservoir of bovine tuberculosis is usually infected milk, milk products, meat and sputum.

The agent has different degrees of resistance to physical and chemical pressures. Heat and ultraviolet radiations in appropriate amounts destroy the bacilli. However, the tubercle bacilli are more resistant than others to antiseptics and chemical agents. They are also resistant

\[12 \text{ Ibid.}\]
to a number of the first antibiotics known, except streptomycin and some other medicines.

Host

The host range of the bacilli is practically unlimited. However, as already said, not all hosts are affected by every type of them. If we limit our description of host receptivity to man, we find many varieties of responses, and the sequence may be as follows -

(i) Primary infection: When a virgin host encounters the agent, the defence may be adequate. After a primary break in the tissues, (usually the lungs but occasionally the intestines), the invading agent may be sealed off by the defence of the tissue, creating a scar in which the agent, dead or alive is imprisoned for some time or forever. Such scars are detectable only by skin test. On the other hand, if the defence is inadequate, the agent multiplies inside the human tissues, both by contiguity and by metastasis. New foci are created in many places and eventually the patient dies. Between these two extremes, many intermediate types of responses may occur.

Whenever the defence becomes adequate, whether, promptly or slowly, the host is both immunized to a certain degree against some of the lethal molecules in the agent and sensitized to others. Thus the host will develop in
his tissues some immunity and save allergy. The degree to which these two phenomena combine is as in all other infectious diseases, the result of the agent's virulence and the host's genetically controlled resilience.

(ii) Reinfection: The host who has developed an adequate defence may be reinfected, either because the agent erupts in his own system from behind the walls of the scar tissues (endogenous infection), or because he contacts a new source of external infection (exogenous infection). In both the cases, the disease will again be governed by the amount of stimulus and the nature of response.

Thus the reservoir of disease comprises not only all the active cases but also all potential or arrested cases that have sealed off an aggression, for these potential cases can, under undetermined circumstances, open the gate to the dispersal of the agent in the hosts' own system and its transmission to other new hosts.

Factors Influencing Host Susceptibility

Tuberculosis can occur at any age, but majority of the patients in India are between the ages of 20 and 40 years. The disease is more prevalent among the males than females in India. This may be due to the frequent mobility
of males and consequently they have greater chances of infection than females who generally stay at home. Tuberculosis affects all races. It is not hereditary. The child of a mother with tuberculosis should be free from the disease if it is segregated from the mother immediately after birth and if it is not nursed on her milk.

Diet seems to have a great influence on susceptibility, because a person with a balanced diet will have a higher degree of resistance to any disease. For a long time, extra diet was recommended to tuberculosis patients to compensate for loss of weight and build up body resistance. But recent studies showed that diet had no discernible influence on the recovery of patients in the context of potent drugs.13

The hosts' susceptibility towards tuberculosis, in India, is governed by certain social factors, such as standard of living, housing, diet, etc.

The prevalence of tuberculosis, is intimately related with the peoples' standard of living, as demonstrated in the Western countries, where tuberculosis mortality declined with an increase in the standard of living. There is an undoubted correlation between low economic conditions, such

as poor nutrition, physical stress and strain, and close contacts with the infected people and prevalence of tuberculosis. Housing is a component of the standard of living of the people. It is accepted that poor housing, which lacks in cross ventilation, adequate lighting and floor space, favour the spread of the infection among the household contacts.

There is a definite correlation between the low income groups and high prevalence of tuberculosis, as will be seen in the coming chapter. Ignorance of the people towards health and sanitation due to lack of education coupled with poverty are major social causes of this disease.

A potent factor in the dissemination of infection is overcrowding, which helps in the rapid spread of infection by droplet infection or droplet nuclei. Overcrowding may be in the homes, factories, cinemas, trains and schools. The larger the family size, the larger will be the number of contacts in the homes especially where people are living in one or two rooms. Larger families are usually poorer, undernourished and overcrowded and thus have greater susceptibility to the disease.

A high incidence of tuberculosis coincided in the past with the rapid industrialization in the western
countries. It is often found that in the areas that draw their labour strength from underpaid people living in the crowded slums under conditions remote from their original culture, tuberculosis is a common disease. Example of such cases can be found in the developing countries where western industrialization has been imposed upon poor local labourers. Another effect of industrialization on the map of tuberculosis is the development of professions and occupations that tax the whole of the respiratory apparatus. The inhalation of dust, coal, silicon, and asbestos have already indicated the tuberculogenic action. The migration of newly infected population should also be listed among the important factors resulting in multiplicity of contacts.

The everyday hygiene and daily habits of the population also influence the spread of tuberculosis, such as the habit of spitting indiscriminately, and this is especially the case in countries where overcrowding is also the rule. Spitting inside rooms with no direct sunlight is more dangerous.

Smoking from a common 'hukka' or hubblebubble is a social custom in some parts of India, this too can serve as a cause of infection.
Early marriages, repeated pregnancies and frequent motherhood lower the body resistance and render the young mothers vulnerable to tuberculosis. Some people consider that tuberculosis is a social stigma. This attitude leads to concealment of the disease in the early stage and consequently late diagnosis. The sputum of such patients are loaded with bacilli, and living as they do in houses crowded together, is a constant source of danger to others who come in their contact.

In tuberculosis patients, the droplets of sputum, after each fit of coughing, sneezing, loud talking and yawning, are suspended in the air for hours. These droplets dry up and the bacilli are transported and deposited on the ground but they remain alive for months, although they appear to be dead. They are kept aloft during the storms and gusty winds and enter human body through the mouth and the nostrils. They come to life again, once they enter the body, and restart their work of devastation within.

As tuberculosis is spread by microbes discharged from the mouth and the nose, one can very much minimise its incidence and infection by observing cleanliness and hygienic habits. Some of the obvious sources of danger are soiled hands and fingers, dirty clothes and uncleaned utensils used for cooking and eating. Food infected by ants,
flies, cockroaches can also spread the germ. Spitting, coughing and sneezing without using a handkerchief, and counting currency notes by wetting the fingers with one's own saliva are dangerous habits so far the spread of tuberculosis is concerned.

The check on the spread of tuberculosis has so far been made by the use of B.C.G. The B.C.G. vaccine was prepared by Albert Calmette and Camille Guerin of the Pasteur Institute of Paris in 1921. It is obtained from the culture of living bovine bacilli in a dose which is too weak to cause disease but strong enough to create antibodies which protect against the tubercle bacilli when they attempt to invade human being. In India, all persons in the age group 0 to 20 years age given anti-tuberculosis vaccination without prior test.

In recent years the subject of rehabilitation of the tuberculosis patients has been given a thought, because of the success achieved in treating them on domiciliary lines without interfering with their normal life and work. The groups that need rehabilitation are those who are chronically ill and still excreting tubercle bacilli. Recent surveys show that 80 percent of all tuberculosis cases are suitable for domiciliary treatment, while about 10 percent require hospital treatment and about 10 percent need
accommodation in isolation centres.  

**Geographical Distribution**

It has been mentioned earlier that the tuberculosis is a ubiquitous disease prevailing in all geographical conditions. It still ranks in the world among the major health problems, especially in the developing countries where annual incidence of pulmonary tuberculosis is 200 - 250 per 100,000 inhabitants, and considering the unreported cases prevalence is usually at least twice as high. There is no single country which has succeeded in reaching the point of absolute control, that is less than 1 percent tuberculin positivity among children in the age group 0 - 14 years, a criterion laid down by the World Health Organization. However, there has been a spectacular decline in tuberculosis deaths in nearly all developed countries. The tuberculosis death rate has declined from 194.1 to just under 2 per 100,000 people in the United States during the period 1900 to

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15 Office of the Deputy Director of Health Service, (T.B.), Assam, Gauhati-6.
In slightly more than half century, the disease has declined in the United States from Number One killer disease to Number Twenty. However, in the less developed areas of the World, tuberculosis still continues to be a major problem. As in all other developing countries, tuberculosis is a problem in India. Tuberculin test affords the only means of estimating the prevalence of infection in a population. This test undertaken by the B.C.G. vaccination campaigns in India has shown the following prevalence rates. 

Table 4.2

<table>
<thead>
<tr>
<th>Age In Years</th>
<th>Percent of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 6</td>
<td>19.1</td>
</tr>
<tr>
<td>7 to 14</td>
<td>39.7</td>
</tr>
<tr>
<td>15 to 24</td>
<td>66.6</td>
</tr>
<tr>
<td>25 and above</td>
<td>83.7</td>
</tr>
</tbody>
</table>

The above figures indicate that tuberculosis infection is widespread in this country, and on the average 50

percent of the population are infected by it. Prevalence rate in the cities, towns and villages (according to the National sample survey 1955-58) was nearly of the same order. This shows that as long believed, attack by tuberculosis is not a problem only of the overcrowded urban areas, it is in fact equally prevalent in rural areas also. The fact that there is a higher prevalence among persons living in Kutcha houses in the urban areas as compared to those living in pucca houses, indicate the effect of economic and sanitary conditions.

Kerala leads all other States both in respiratory and other types of tuberculosis. Next in order in Maharashtra, followed by Tamil Nadu, Karnataka and other States. The incidence of this disease has been found to be comparatively low in the mountainous regions of northern India.

The number of recorded deaths due to tuberculosis in Assam was 200 during the first six months of 1976. Moreover, 25 percent of the cases tested were found to be positive.\(^{18}\) From the statistics given by the District Health Offices of the Brahmaputra Valley, it has been found

\(^{18}\) Report on T.B. Control Programme of Assam, Deputy Director (T.B.), Gauhati.
that Goalpara has the highest incidence of tuberculosis followed by Lakhimpur, Sibsagar, Dibrugarh, Nowgong, Darrang and Kamrup in that order, during the last ten years (Fig. 4.2).

In conclusion it could be said that overwork, badly ventilated houses, and over-crowded houses with insufficient sunlight facilitate the progress of the disease, whereas sunshine, fresh air and a balanced diet make the body strong and help it fight the germ. The eradication of tuberculosis is possible only if the population cooperates actively with those engaged in such programmes.

Ecology of Peptic Ulcer

Benign ulcers of the oesophagus, stomach and duodenum have been termed "peptic ulcers", because they are found in the regions bathed by the acid gastric juice and it is thought that the ulcer results in part from the eroding action of the juice. Peptic ulcer cannot be ascribed to a single cause. The ulcer is a local manifestation of a generalized disturbance which results in a circumscribed loss of the lining mucosa.¹⁹

TREND OF PULMONARY TUBERCULOSIS IN
THE BRAHMAPUTRA VALLEY
1967–76

---

INCIDENCE IN THOUSANDS

DEATHS

---

YEARS

INCIDENCE

DEATHS

---

Fig. 4.2
History

Peptic ulcer appears to have had its beginning with man's occupation of this planet. Ancient writings, dating from the time of Aesculapius and Celsus, mentioned the occurrence of ulcer and even made certain suggestions for its treatment.

The first ulcers that were recognized clinically were the ones that perforated the intestine. Duodenal ulcers began to be recognized about the middle of the nineteenth century. About the same time, attempts were made to treat ulcers by dietary measures. The French clinicians proposed the use of milk and eggs in the treatment of peptic ulcers. Subsequently, there was a period when starvation was used in the erroneous belief that it would rest the stomach. Fenwick in 1868 stressed the importance of small bland feedings for the ulcer patient, and the use of sodium bicarbonate to control acidity. However, little attention was paid to the dietary treatment of ulcer until 1915, when Sippy again re-emphasized the necessity for a strict progressive bland diet along with massive alkalinization. This was followed by the work of Meulengracht in 1935, who demonstrated the value of early feeding in the treatment of

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bleeding duodenal ulcer.

The first surgery was carried out in the 1880's for peptic ulcer. After it was learnt that surgery could be carried out safely, great strides were made in Europe and the United States.

Since the end of the First World War there has been a marked increase in the prevalence of the duodenal ulcer, and apparently this tendency still persists (Alsted, 1953)\textsuperscript{21}.

Definition

The term 'peptic ulcer' refers to an ulcer found either in the lower end of the oesophagus including the stomach, the duodenum, and the small intestine anastomosed to the stomach, or rarely at the junction of a Meckel's diverticulum with the small intestine, and is caused by the acid - pepsin digestion of the mucosa.

Agent

Despite great progress in medical sciences, the exact agent that causes peptic ulcer has so far not been identified. It is however, widely believed that this

\textsuperscript{21} Cited by B. Hazarika, Unpublished M.S. Thesis Titled \textit{A Clinical Study of Peptic Ulcer}, 1962, Gauhati.
disease is a psycho-somatic one.

The pathogenesis of peptic ulcer is a controversial subject. It is controversial partly because neither its cause is known nor its etiology is clearly understood, and partly because the accumulated evidence suggests a complex, multifactorial genesis of the malady.

During recent years a great deal has come to light about the causation of peptic ulcers. Three factors have been implicated. The first two, involved in the production of all types of peptic ulcers, are the eroding factors which include both chemical and mechanical components, and the local tissues' capacity for resistance and defence. The third one as classified by Smith and Rivers, is the systematic and constitutional diathesis factor that may be involved and that may determine, to some degree, which individuals will develop an ulcer and which will not. Our present viewpoint is that peptic ulcer is the result of the interplay of several or all of the three factors, differing in different persons as also changing in the same person under varying conditions.

Factors that Help in the Growth of Peptic Ulcer

There are a number of studies which show that heredity may be a factor in human peptic ulcer. Surveys show that the incidence of ulcer in certain families is higher than others. It should be remembered at the same time that, family susceptibility is not equivalent to making a diagnosis of hereditary illness. Emotional, economic, and other environmental factors present in the family situation must be taken into consideration.

Although it is evident that peptic ulcer is not limited to certain types of persons, it has been observed that some personality factors are more closely associated with some disease conditions. Persons susceptible to peptic ulcer, are usually highly emotional and tension worn in the form of anxiety, hostility and depression. This relationship is easily understood when we think of our system, we find the gastro-intestinal tract is the most vulnerable to emotional stress compared to the rest of the organs. The worries, fears, conflicts and anxieties of daily life can produce gastro-intestinal disorders ranging from the 'nervous stomach' which most of us know at first hand, to the painful and often disabling ulcers which are traditional occupational disease of the business executives.
The connection between emotional disturbance, stomach secretions and ulcers have been well documented by a recent study of 2000 Army draftees in the U.S.A. It was found that those who were emotionally disturbed and had excessive gastric secretion during their initial physical examination, developed ulcers later on under the strains of military life.23

Ulcer personality may have some relation to the pattern of recurrences of the disease. Fatigue, emotional conflict, and infection may be responsible in determining recurrences. The frequently emotional conflict may be related to the patient's occupation, over which the patient has little or no control. Bus drivers, transport workers, businessmen, surgeons and doctors are liable to peptic ulcerations because of worries and anxieties inherent in their day to day life.

It is interesting to note that the incidence of peptic ulcer according to sex has shown a curious change during the recent past. Women were in the past more affected than men with the ratio of patients in the two sexes being 5 and 1 respectively. Of late, however, more of the

males has been found to be suffering from this disease and now there is 1 male patient for every 3 female ones. The cause for increasing susceptibility of male has so far not been determined.

A disease, the incidence of which is changing invites consideration of environmental causes and the greater incidence of duodenal ulcer in men may be due to an increased exposure to some external agent.

The socio-economic status of the people too count in the incidence of this disease. The lower income group seems to suffer more than the higher income group. But this is in variance with the record of western writers who believe that peptic ulcer is a disease of the well-to-do intelligentsia belonging to the urban areas.

Food and eating habits are also important in the development of ulceration. Actually, no food is sufficiently acidic to have any harmful effect on the mucous membrane of the stomach. But some foods and drinks, e.g. hot spicy food, repeated cups of coffee and tea, excessive drinking of hard liquor, etc. provoke more secretion of acidic digestive juice than others. Moreover, heavy dosage of certain medicines may damage the stomach lining, paving the way for ulceration. Besides, erratic and irregular
timing of meals may also lead to ulcers.

Food deficiency may play a part in the pathogenesis of peptic ulcer in some regions of alimentary canal. It is found that there is an extreme frequency of duodenal ulcer in southern India particularly in Kerala and this is said to be due to certain food deficiency.

Peptic ulcer is one of those diseases which may not be responsible for a high rate of mortality, but once it occurs and develops unchecked, the ulcer is likely to last a lifetime, disabling the normal life of a person and causing painful complications. Peptic ulcers have become more common these days as the disease is closely associated with the mental and physical tensions which are mounting in the context of the stress and strain of modern life, particularly in the urban areas.

The doctor diagnoses peptic ulcer from the symptoms and a few laboratory tests like gastric analysis and X-rays. The main symptom is a burning pain in the stomach. Discomfort or pain above the naval region which tends to come directly after a meal might suggest a stomach ulcer. If the pain comes two to three hours after a meal it might indicate duodenal trouble. A characteristic of duodenal ulcer is that it wakes the patient up in the small hours of the night with pain. Some of the other symptoms of peptic
ulcer are nausea, vomiting, frequent irritations and gas formation.

The dietary treatment has three general purposes: (i) to avoid foods which stimulate the flow of acid, (ii) to administer foods which are effective neutralizers of gastric acid and (iii) to prevent irritation of the ulcer by rough foods.

Milk is one of the most important constituents of any ulcer diet and it serves to satisfy all three aims of dietary treatment. Of the common constituents proteins and vitamin C must be present in the diet for rapid healing of the ulcers.

Certain general rules of diet are to be followed by ulcer patients. Such as:

1) Never allow the stomach to be empty for more than two-and-a-half hours. Snaks, with a milk drink between the three main meals is an ideal routine.

2) Overeating is not advisable as this leads to discomfort and distention.

3) Meal timings should be regular, inspite of other works, and patient must take its own time while eating. The patient must not gobble his or her food in a tense atmosphere.

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4) Although all foods in general have a neutralising effect on the acid gastric juices, protein foods are more effective buffers and thus there is less free acid to irritate the ulcer when they are consumed.

5) Strong beverages like tea & coffee and alcoholic drinks should be avoided, since they stimulate the flow of acids in the stomach. Similarly clear soups are also stimulating and should be reduced as much as possible.

6) Intake of acid food like tamarind and sour buttermilk should either be minimised or counterbalanced with alkaline food, since they add to the acidity of stomach secretion. However, lemons and oranges are useful although they are mildly acidic, as these are important sources of vitamin C.

7) Spices should be avoided, though cinnamon and mace are better tolerated than chilli, mustard, clove and black pepper, hot pickle and 'chutney'.

Although many restrictions have been mentioned in the diet for the ulcer patient, food tolerance is a highly individual matter. Psychological and emotional factors often play an important part in the acceptance or rejection of a particular food. Hence foods which give either real or imaginary distress should be best avoided, and a moderate
selection could be made from agreeable items.

There is an association between peptic ulcer and blood group 0. Patients of this group being 40 percent more liable to develop the disorder than those of the groups A, B, and AB.\(^\text{25}\)

The mucosa of the blood group 0 people may respond to stimuli by producing larger quantities of acid than others, a probability that could also explain the high incidence of stomach ulceration in this group.\(^\text{26}\)

According to Boyd\(^\text{27}\) the blood group substances known as mucopolysaccharides, are present in larger quantities in persons belonging to group 0 than those belonging to the other groups. The mucopolysaccharides are present in much larger amounts in gastric and salivary secretions than in the red blood cells, where they are antigenes

\(\text{25 (a) Aird, et. al., 'The Blood Groups in Relation to Peptic Ulceration and Carcinoma of Colon, Rectum, Breast and Bronchus, British Medical Journal, Vol. 12, p. 315, 1954.}\\)

\(\text{(b) C.A. Clarke, Genetics for the Clinician, Oxford Blackwell, London, 1962.}\\)


responsible for group reactions. They are particularly abundant in the mucosal cells of the pyloric and pre-pyloric regions, as well as in the duodenum. Persons in group A are more prone to cancer of the stomach than members of the other groups. It may be that the mucopolysaccharides influence resistance to an exogenous ulcerogenic or carcinogenic factor. For instance, blood group A protecting against ulcerogenic factors, and group O protecting against carcinogenic factors.

Geographical Distribution

Accurate knowledge of the geographical distribution of peptic ulcer is difficult to obtain compared with diseases like malaria where precision in diagnosis is easy. Proper clinical, radiological, and pathological facilities are not available in many parts of the world. The evidence so far seems to dispel traditional beliefs rather than help in the etiology. Peptic ulcer can no longer be regarded as a prerogative of the civilised races for it is found to be common in all the world over even among the primitive tribes. In a careful survey undertaken in Africa (Raper, 1958) it was found that 15.3 percent of men and 4.7

percent of the women covered by the survey had ulcer.

There may be a variability in racial susceptibility within the same region. A survey carried out in Java revealed that the Chinese living in that island were much more susceptible to this disease than the Javanese labourers (Kouwenaar, 1930) although they lived in the same neighbourhood and under similar economic conditions. Such a difference therefore may be due to diatic reasons or emotional problems.

Peptic ulcer is a common disorder affecting an estimated 10 percent of the world's population. It is also said to be the twelfth most costly disease in terms of disability.

Geographical pathology, or geomedicine, is now in its infancy, but in the future, important information may come from studying the clinical patterns of peptic ulcer in different parts of the world and correlating these with the ways of life, particularly eating and drinking habits.


30 C. Bonne, et. al., 'Morphology of the Stomach and Gastric Secretion In Malays and Chinese and the Different Incidence of Gastric Ulcer and Cancer in these Races', American Journal of Cancer, Vol. 33, p. 265, 1938.
According to Chuttani\textsuperscript{31} the incidence of peptic ulcer in India as recorded from different regions of the country from various hospitals during the sixties show that 0.59 to 3.5 percent of the hospital population suffer from peptic ulcer. The incidence is about 2 percent more in men than in women. There is, however, a positive correlation between income and the incidence of peptic ulcer as can be seen from the table below.\textsuperscript{32}

<table>
<thead>
<tr>
<th>Per Capita Income Per Annum in Rupees</th>
<th>Total Hospital Population</th>
<th>Peptic Ulcer Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 199</td>
<td>1291</td>
<td>2</td>
<td>.154</td>
</tr>
<tr>
<td>200 - 399</td>
<td>3525</td>
<td>20</td>
<td>.587</td>
</tr>
<tr>
<td>400 - 599</td>
<td>3164</td>
<td>14</td>
<td>.442</td>
</tr>
<tr>
<td>500 - 1999</td>
<td>1912</td>
<td>20</td>
<td>1.046</td>
</tr>
<tr>
<td>2000 and above</td>
<td>204</td>
<td>6</td>
<td>2.941</td>
</tr>
</tbody>
</table>

\textsuperscript{31} Dr. C.S. Chuttani, et. al., *Indian Journal of Medical Sciences*, Vol. 55, October 1967, p. 1121.

There seems to be an association between mental stress and this disease. The incidence of peptic ulceration in professionals has been found to be as high as 4.16 percent as compared with 0.40 percent in the general population. It is also found that the level of incidence of this disease seems high among the heavy smokers. So far age-groups are concerned maximum incidence was found between the ages of 30 - 40 years.

A sample survey undertaken by Jerath during 1970 in Assam revealed that out of 600 subjects of which 414 were males, (69 percent) and 31 percent (186) were females, who suffered from peptic ulcer. Broken down communitywise it was found that, 60 percent of the 600 cases were Hindus, 36 percent Muslims and only 4 percent Christians. It was further observed that 55 percent of the 600 patients had unpleasant emotional experiences in the form of anxiety, tension, hostility and depression.

The study shows that 39 percent were from the low income group (below ₹. 300), 26 percent from lower middle class with an income of ₹. 300 - 500 and 20 percent from middle class with an income of ₹. 600 - 1000 and 15 percent of from the high income group of above ₹. 1000.

33 Ibid.
Another survey carried out in 1962 by Hazarika\textsuperscript{34} showed that 54 percent of 175 cases were cultivators. Next comes the petty business men. This does bear a comparison with the figures reported by Dogra and Somervell (1940) that the disease is mostly prevalent in the low income group of a society. This is also in variance with the record of Jerath\textsuperscript{35} showing the prevalence of it more among the high income group, and the western researchers who believe that peptic ulcer is a disease of the well-to-do, belonging to the urban areas.

It was found in Assam that betel-nut chewing and smoking cigarettes, bidis, etc. are important causes of peptic ulcer, for about 86 percent of the patients questioned in the above survey were found to consume betel-nut and about 55 percent were smokers.

It has been observed too that stopping of betel-nut chewing and smoking resulted in healing of peptic ulcer.

According to the present study it has been found that the incidence of peptic ulcer per 10,000 population during the last ten years is highest in Dibrugarh, followed

\textsuperscript{34} B. Hazarika, Unpublished M.S. Thesis Titled \textit{A Clinical Study of Peptic Ulcer}, Gauhati University, 1962.

\textsuperscript{35} Opp. cit.
by Kamrup, Darrang, Nowgong, Sibsagar, Lakhimpur and Goalpara in that order (Fig. 4.3).

Ecology of Cancer

Cancer is in essence a change in cell metabolism.

The infinitely intricate and delicately balanced regulating mechanism of chromosomal metabolism and cellular reproduction, could be upset in various ways. The interference may lead to permanent changes or mutations in the genes. If these mutations are serious enough, they may be lethal and the cell will die. But if the change is such as to permanently speed up the mitotic rate the result will be cancer.

There is no reason to assume that there is a single cause for cancer. It is perhaps justifiable at the present time to speak of exogenous and endogenous carcinogenic agents as the root cause of the malady. For most of our knowledge about external agents comes naturally from observations done by others on laboratory animals. Human cancer may be caused due to external agents, such as radiation, stress and strain exerted on a particular organ in the occupation followed, excessive cigarette smoking, etc.
TREND OF PEPTIC ULCER IN THE BRAHMAPUTRA VALLEY (1967-76)

Fig. 4.3

--- INCIDENCE
--- DEATHS
History

The disease cancer must have been very old, but was not diagnosed. The concept of viruses being connected with neoplasia, was published by Peyton Rous following his epoch-making observations that a cell-free filtrate of a fowl sarcoma could produce a new tumour when inoculated into another fowl of the same breed. He predicted carcinogenesis to occur within four years in the second fowl and this exactly happened. Development of tumours on a living body caused by filter-passing agents were described by physicians many times, but these did not arouse much enthusiasm for further prove as such tumours were mostly confined to birds. Shope in 1932 demonstrated that a papilloma of the skin in the wild cotton-tail rabbit was similar to the tumour in a bird. He further demonstrated that when the viral agents was injected into the domestic rabbit an aggressive lesion was produced, which developed into a true cancer. When this state was reached the active

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agent would no longer be isolated from the malignant lesion, a fact perhaps of great significance. The important discovery in 1936 by Bittner, was that cancer of the breast in mice could be transmitted to the new born by an agent present in mothers milk.

Gross\textsuperscript{38} in 1951 showed that cell-free extracts of leukemic tissue of mice of a high (spontaneous) leukemic strain when injected into the new born mice of a low strain would induce the development of leukemia some months latter. This was followed by the demonstration of Sarah Stewart\textsuperscript{39} that some of the mice injected developed carcinoma of the parotid gland or fibrosarcoma of connective tissue. Still more startling was the discovery by Stewart and her associates that when the same leukemic agent was grown in tissue culture and a cell-free extract was injected into the new born mice, the latter developed a broad spectrum of more than a dozen apparently unrelated tumours. The viruses are not found in the tumours at the end of one week, which may be related to the absence of virus in human cancer.


To be more specific, cancer can occur at any site. In this work, however, particular emphasis will be given to that in the throat region of man.

Early medical accounts\(^{40}\) show that cancer of the larynx was known as a malady in the time of Aretacus (A.D. 100) and Galen (A.D. 200). Certain tracheostomy was performed by ancient physicians. Aesklepiades,\(^{41}\) a Greek Physician, practising in Rome about 90 B.C., performed tracheostomy probably for diphtheria. However, no particular advances were made in the knowledge of cancer of the larynx until the seventeenth and eighteenth centuries when Boerhave, in 1668, and Morgani in 1732, described the cause of death as being tumors of the pharynx and larynx\(^{42}\) through autopsy studies. Obviously, the diagnosis of laryngeal cancer in a living subject was difficult until the middle of the nineteenth century, when a way was found to visualize the larynx. But early physicians were certainly aware that


\(^{42}\) Opp. cit.
laryngeal tumors, both benign and malignant, occurred.

Definition

Cancer may best be regarded as a group of diseases caused by many factors. Since the fertilisation of the ovum by spermatozoa, a series of cell divisions and multiplications occur which continues till the new-born baby sees the light of the world. The process within the physiological limits is a balanced one and never exceeds requirements of normal wear and tear. But unfortunately, in some individuals, excessive cell division may occur disharmoniously, producing neoplasms or tumours of which cancer is the deadly form.

The human cancer has an uncontrollable manner in which cells grow, and an ability to invade other tissues, and finally the death of the afflicted person, if the tumour has progressed beyond the state of successful removal. Cancer can occur at any site or tissue of the body and may involve any type of cells.

Agent

Epidemiological, clinical, pathological and experimental studies have disclosed a variety of factors constantly associated with the pathogenesis of cancer. 43

Physical agents, which are carcinogenic, are ultraviolet rays, ionizing radiation, solar radiation and continuing heat. For example Leukaemia's high incidence is attributed to the frequent help sought in radiological treatments in developed countries. Exposure to continuing heat is said to be another factor responsible for skin cancer.

The list of chemical agents for cancer is a long one and mention may be made of tars and dyes, aromatic amines, urethane, various metals and minerals. Persons in constant contact with these materials are more liable to develop skin cancer.

Apart from other causes deficiency of proteins, vitamins and iodine, food contaminants and alcohol are also implicated in the pathogenesis of cancer. Some doctors again associate metazoan parasites with cancer in man.44

Mechanical agents also help in the growth of cancer. For instance the 'Dhoti Cancer' below the uniblicus seen among Maharashtrian men and women, is attributed to the habit of wearing tight clothes around their waist. This is due to the chronic irritation caused by the grip of the tightly clad dhoti. Other carcinogens that might either be, mechanical or chemical are the 'chotta' and the 'kangri'. The

chotta is smoked in southern India with the lighted end in the mouth. Addicts have a high incidence of the cancer of the mouth. The inhabitants of Kashmir carry a hot basket of charcoal, the 'kangri', under their clothes above the belly to keep themselves warm, and as a result many of them have cancer of the abdominal wall. This is unknown elsewhere in India.

Factors Responsible for Host Susceptibility

The susceptibility to cancer increases with age. Man is particularly vulnerable after the age of 50 years. Why it is so, is not known. This could be due to the ageing process or of a long incubation period or long exposure to a carcinogen.\(^45\) There is a difference in the prevalence of cancer among the males and females. Men are more prone to lung and oesophagus cancer than women. Breast cancer patients are found more in the sophisticated and developed countries than in the underdeveloped countries and among the primitive people. Women having children after 30 years have a greater risk of breast cancer than those who have their first child in the late teens and early thirties.\(^46\)


Cancer incidence and socio-economic status seem to have a definite relationship. For instance, stomach, skin and cervix cancers are more common in the low income groups of people than in the high income group.

There are numerous customs and habits predisposed to cancer. For example the areas where the habit of chewing betel-nut and tobacco prevail, occurrence of tumors of the mouth and throat are said to be high. The causal relationship between cigarette smoking and lung cancer is generally accepted. Epidemiological studies have shown a clear relationship between the number of cigarettes smoked and the incidence of lung cancer. 'Beedi' smoking has been associated with cancer of the tonsil, oesophagus, hypopharynx and base of the tongue. The peculiar habit of reverse smoking as mentioned earlier is linked with palate cancer. Chewing of areca nut (Suphari) a common habit among some of the Indians may cause trauma and predisposes to oral cancer. Excessive drinking of alcohol leads to cancer of the mouth, larynx and oesophagus. Hot, spicy foods are said to encourage ulcer which may lead to the development of cancer.

Air pollution is a factor of importance in the causation of lung cancer in man. It has been found that the incidence of lung cancer abounds three times more among the
city dwellers than among the ruralities.  

Fair-complexioned individuals have an excessive incidence of skin cancer, especially of the face and neck than the dark-complexioned ones. Genetic influences have long been suspected for the growth of cancer. Napolean died of stomach cancer and so did his father, brothers and sisters.

Occupation cancer was first described by Sir Percival Pott in 1775 who observed soot as a carcinogen inducing cancer scrotum among chimney sweeps in the U.K. The introduction of hygienic methods led to the remarkable decline in the incidence of this cancer. However, occupational carcinogens pose a great threat to man in various industries. Industrial exposure to ionizing radiations, nickel, bichromates, asbestos dust, arsenic, and coal gas are all associated with the risk of acquiring cancer.

Geographical Distribution

In Europe and North America, approximately one out of five deaths is due to cancer. According to the statistics of the WHO, the number of deaths from cancer throughout the world increased by 20 per cent within ten years from 1954

to 1964. The increase in cancer is attributed to increase in the proportion of the aged population, increasing skill and efficiency in diagnosis, and increase in the number of people seeking medical care.

Although the overall incidence of cancer in various populations of the world were, more or less alike, the type and the organ affected by cancer varied from area to area. Certain it is, that the forms of cancer varies greatly from country to country and even from one area to another within the same country. Oral and cervical cancers seemed particularly common among the coloured people of the world, but cervical cancer was low among the Muslims and Jews. Nose and the pharyngeal cancer seems to be common in China while stomach cancer in Japan.

It is also noticed that the women in the primitive societies seem to suffer less from breast cancer than those in the sophisticated ones as stated earlier. These features lead the researchers to study the possible factors that govern the life, habits and environment of these communities which ultimately help us indentity the environmental carcinogens.

Statistical data relating to cancer in India are still inadequate as in all other underdeveloped countries.
It is, however, estimated by Jussawala\textsuperscript{49} that in our country 4 to 5 lakhs persons die annually from cancer, and it can be safely assumed that another 5 lakhs suffer every year. According to Jussawala's (1973) observation\textsuperscript{50} cancer is one of the 10 leading causes of death today in India, and is advancing in rank day by day.

In the various studies undertaken about the incidence of cancer, it is found that 40 to 50 per cent of the cases are seen in the region of the head and neck.

Recent studies undertaken by the Kidwai Memorial Cancer Institute, Bangalore, reveal that about 36 per cent of cancer cases are from the region of the throat, which includes lips, mouth, oral cavity, pharynx, larynx, hypopharynx, i.e. lower down in the throat and oesophagus i.e. food pipe.

The throat cancers have a low prevalence in Punjab. In Andhra Pradesh, cancer of the palate is high, and in Assam, cancer of hypopharynx has a high incidence.

The incidence of cancer, is said to be the highest in the north eastern region of India, with Assam claiming

\textsuperscript{49} Dr. C.M. Gurumurthy, Head and Neck Cancer, Akashvani Science Special No. November 14, 1976.

the largest number of cases. Every year nearly 4000 cancer patients come to the hospitals in Assam for treatment, and the number has been steadily increasing. Considering the fact that a large number of cases go unreported in the hospitals, the actual figure will probably be much higher.

The incidence of cancer in the region of the throat is the highest in Assam, specially those of laryngopharynx, tonsils, base of tongue and oesophagus according to Dr. B. Das, Head, E.N.T. Department, Gauhati Medical College.

In a study of ten years data by Borborah in Assam Medical College, Dibrugarh, with 8957 cases of different malignant tumours, it was found that 2473 (26.7 per cent) were of hypopharynx and larynx, 1786 (20 per cent) of the oesophagus, 721 (8.06 per cent) of the tongue, while the rest were distributed among the various sites. Cancer of the throat region was found more among the age group of 40-50 years, with males outnumbering females. When broken down community wise it was found that 88 per cent out of the 8957 patients were Hindus, 11.5 per cent Muslims and 0.5


percent Christians. It was also found that 30 percent of the patients were habituated in consuming liquor.

The strikingly dissimilar organwise distribution of cancer in different groups of population and communities is attributed to genetic or racial factors, difference in habits, customs, occupational pursuits, nutritional status and stages of economic development. In this study by Dr. Borborah, 60 percent of the patients were found to belong to the lower income group and 63 percent were betel-nut chewers.

In the present study it has been found that Dibrugarh has the highest incidence of throat cancer, followed by Darrang, Sibsagar, Nowgong, Kamrup and Goalpara in that order. This is in variance with a study undertaken by Dr. Das of Gauhati Medical College, which showed that Kamrup had the highest incidence. High incidence, as seen in the district of Dibrugarh, could be because there is a Cobalt Therapy Unit, and about 85 to 90 percent of all cancer patients in Assam go there for treatment, and thus they are registered in that district (Fig. 4.4).
TREND OF THROAT CANCER IN THE BRAHMAPUTRA VALLEY 1967-76

**Fig. 4.4**